Report on the surgical cases noted in the South African War, 1899-1902. / edited by Surgeon-General W. F. Stevenson.

REPORT

ON THE

SURGICAL CASES NOTED IN THE SOUTH AFRICAN WAR, 1899–1902.

EDITED BY

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From

SURGEON-GENERAL W. F. STEVENSON, A.M.S.,

To

THE DIRECTOR-GENERAL, A.M.S.

68, VICTORIA STREET, S.W.,
February 16th, 1905.

SIR,

I HAVE the honour to forward to you the Report on the Surgical Cases noted during the Boer War, 1899 to 1902, prepared by me in compliance with an order from the late Commander-in-Chief and the Director-General, A.M.S.

The difficulties met with in its compilation, due to the small amount of material available from the War, and, in some cases, to its unsatisfactory character, have been alluded to in the Introductory Remarks.

I have added, as an Appendix, a paper on "Gunshot Injuries of Peripheral Nerves," by Dr A. Young, late Civil Surgeon, South Africa, because it is a valuable contribution on a subject of considerable interest both to Military and Civil Surgeons.

The detailed statistics of killed and wounded for the War are not yet completed.

I have the honour to be,
Sir,
Your obedient servant,
W. F. STEVENSON,
Surgeon-General, A.M.S.
(*Late P.M.O., Headquarter Staff, South Africa*).

Report on the Surgical Cases noted in the South African War, 1899–1902.

INTRODUCTORY REMARKS.

Committee on Report.

For the preparation of this Report a Committee of Officers, all of whom had served in South Africa during the Boer War, was formed.

The members of the Committee and the allotment of the various portions of the work were as follows:—

Surgeon-General Stevenson...	Injuries of the head. Injuries of the spine.
Lieut.-Colonel Sylvester ...	Injuries of blood-vessels and nerves.
Major Mallins	Injuries of abdomen and genital organs.
Brevet Lieut.-Col. Hickson ...	Injuries of long bones and joints.
Major Holt, D.S.O.	Injuries of chest and neck.

Material for Report.

All the case-books, records, and returns available from the war were placed at the disposal of the Committee, and from them, as well as from the individual personal experience of the members themselves, the Report has been prepared. In the editorial work I have been ably assisted by Major Freyer, C.M.G., during most of the time it has occupied in compilation.

Unfortunately, Major Mallins was, at an early date, ordered to Canada, and he only had time to make the notes of the abdominal cases on which he meant to base his report before he left. This portion of the Report, therefore, fell to me to complete.

Difficulties in obtaining it.

It is, of course, certain to happen in all campaigns, that the noting and recording of cases in war hospitals will not be as complete as they ought to be, and as they usually are in a civil hospital under peace conditions, and that the cases noted will not be as numerous as it is desirable they should be. This is, indeed, a necessity of the circumstances of the case. The work in war hospitals is done at high pressure, and the medical and surgical treatment of the patients is rightly considered of more paramount importance than merely keeping returns and making notes of matters of surgical interest. But these returns and notes are the material from which subsequently a report such as this has to be compiled, and if they are not full and numerous and correctly made out, the matter on which the report is based is deficient, and the history of the surgical occurrences of the war must suffer and be incomplete in a corresponding degree.

The conditions which, in general, interfere with the noting of cases and compilation of returns in all wars were peculiarly well marked during the Boer War. The medical officers found themselves in the presence of many times more medical and surgical work than had been expected and than provision had, at first, been made for; it thus happens that the materials for this Report are much more meagre than under more favourable circumstances they would have been. The medical and surgical work had to be done, and when it was completed very little time remained for note-taking.

Material for Report much less than it should have been.

The members of the Committee had placed at their disposal all the case-books and returns from the war, and selected from them all the cases which were so fully noted that something could be learnt from the records made of them. That the materials for this Report were very much less than, with time and facilities for preparing them, they should have been becomes apparent when it is remembered that, although nearly 23,000 wounded officers, non-commissioned officers and men (and some Boers and natives as well) were treated in the various hospitals, only about 1,650 cases have been found of use to the members of the Committee as bringing forward anything of surgical interest and bearing on the treatment of gunshot injuries, and as showing the death-rates resulting from them.

Besides the official case-books and returns, the writings of Mr. Makins,* of Messrs. Bowlby and Wallace,† and the Report of the Imperial Yeomanry Field Hospital, by Major Stonham, as well as various papers in the medical journals by Sir Frederick Treves, Mr. Watson Cheyne, Mr. G. L. Cheatle, and others, have all been put under contribution for the purposes of the Report, as well for notes of cases as for statements of fact and opinion.

Noting of cases difficult in the movable field hospitals.

It was at the field hospitals, no doubt, that the greatest difficulty of taking notes of cases was experienced; in the stationary and base hospitals it was less felt, and accordingly most of the data we have to work on were supplied from these units. It therefore happens that records of the condition of the wounded in the early stages of the cases are deficient, and that most of those we have are of the less severely wounded men.

Tables of statistics in this Report not those of whole war.

For the same reason, the statistics given in the various tables throughout the Report must not be taken as representing, in any instance, the statistics of the war, and more especially does this apply to the death-rates shown in these tables; they are statistics afforded by a few out of many cases, and they are taken, for the most part, from the records of general hospitals. They are therefore likely to be more favourable than the complete statistics of the war will prove to be.

Much surgical experience lost.

It is greatly to be regretted that, from the causes above referred to, much of the experience of the surgery of small-bore bullet injuries which might have been obtained in the late war was lost; but, under the conditions prevalent in South Africa, this was inevitable.

How to avoid this in future wars.

A similar wastage of material will occur in all great wars, and the only way it can be reduced to a minimum will be by having a statistical bureau at the base of operations through which all returns shall pass on their way to the P.M.O. of the Army and to the War Office. It would then be unlikely that such vague diagnoses as "gunshot wound," no locality being specified, or "gunshot wound of leg," no reference to fracture being made, would be accepted, as was done many times in South Africa. To make the registration of cases as nearly perfect as may be under the circumstances, all that would then be required is a concise form on which the salient points of each case of wound received on active service could be entered. The process of registration of cases and the material from which war statistics worth considering can be prepared will never be as they should be until all useful information is recorded for each case separately, from the first and in each hospital the patient passes through towards and at the base of operations. This would amount to the employment of the "card system" from the first field hospital into which a patient is admitted to his arrival at a general hospital at home, instead of the preparation of the "cards" from the admission and discharge books after the war has ended. This can be done by means of the special form above mentioned; or, better still, by the use of admission and discharge books on the counterfoil principle, as suggested by Lieut.-Colonel Simpson, C.M.G., R.A.M.C.

Were this method employed, all the experience of a war would become available for the instruction of military surgeons, and a report of the medical and surgical transactions of the campaign would be easy to prepare, instead of being, as in this case, a difficult and unsatisfactory work; and, above all things, it would be complete and correct in the teaching to be derived from it.

The uses of such a Report if complete.

Without the possibility of the study of the surgery of previous wars, surgeons must necessarily undertake their duties in the field with their preconceived ideas of surgery in war uncorrected by a knowledge of the experience of others in like circumstances, a state of things which must be detrimental to the welfare of the patients whom they have to deal with.

As regards the general and complete statistics of the war, showing the percentage of casualties to strength, the numbers of killed and wounded for the whole army sent to South Africa or enlisted there for the purposes of the war, the death rates for injuries of particular regions of the body, and various other matters of interest from a statistical point of view, these are not yet ready; but they are being prepared, and will be published at a later date.

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* "Surgical Experiences in South Africa."
† "A Civilian War Hospital."

Civilian "consulting surgeons."

A new departure was made in this war by sending out to South Africa a number of eminent surgeons selected from the members of the profession in the United Kingdom and in the Colonies to act as consultants during the campaign. The suggestion that this would be advisable was made by the then Secretary of State for War, Lord Lansdowne, and accepted by the Director-General, Surgeon-General Jameson, C.B. At first only two were appointed, but later this number was added to, and the complete list of those thus employed is as follows :—

Their names.

Mr. G. Lenthal Cheatle, C.B.
Professor John Chiene, C.B.
Mr. W. Watson Cheyne, C.B.
Sir T. Fitzgerald, C.B. (Melbourne).
Sir Kendal Franks, C.B. (Orange River Colony).
Sir Wm. MacCormac, Bart., K.C.V.O.
Mr. G. H. Makins, C.B.
Sir Wm. Stokes.
Sir Frederick Treves, Bart., G.C.V.O., C.B.

Sir Wm. MacCormac and Mr. Makins arrived in Cape Town in November, 1899, and the others had all arrived by February, 1900. Messrs. Cheatle, Watson Cheyne, Makins, and Sir Kendal Franks were attached to the army under the immediate command of Lord Roberts ; the others were on the Natal side.

That the work done by most of these distinguished surgeons was the best possible, and that their presence in the Military Hospitals and their advice and assistance as consultants and as operators were a source of comfort and a satisfaction to the much over-worked officers of the medical service and to the civil surgeons working with them, "goes without saying" ; but they did not remain very long in South Africa. They had entered into no contract as to the duration of their stay in the country ; the only conditions laid down for them were that they should go to the war and receive pay at a specified rate.

When it became apparent, soon after the capture of Pretoria in June, 1900, that the campaign was likely to be prolonged, the consulting surgeons, naturally, had to begin to have consideration for their more personal interests at home. Thus it happened that by August, 1900, all but one, Sir Kendal Franks, who had previously been for many years in practice in the Transvaal, had left for home.

It is in this connection that a valuable lesson may be learned for future guidance, viz., that all civilian medical men officially appointed to work in War Hospitals shall only do so under proper contract, especially as regards the duration of their service in the campaign, and perhaps in other respects also. The officers and men wounded during the last two years of the war required the services of the civilian consulting surgeons as much as did those injured during the first eight months, but consultants were not available during the former period, except in the case of Sir Kendal Franks, who alone remained at the seat of war.

Of the work done by the consulting surgeons in South Africa, it is unnecessary for me to say much ; being the men they were, it must have been, and was, most valuable. Many of them, too, have made their experience in the campaign available for others by publications in books and in the medical Press, wherein they show how different surgery in war is to that in civil practice, how much opposed the ordinary conditions of a campaign are to the successful carrying out of modern surgical procedures, and how cramped and restricted surgical treatment on active service must always be in the absence of the ideal conditions of a civil hospital at home, which it is impossible to attain in war.

The Army Medical Service.

But little is known by the general public of the work done by the officers, men, and lady nurses of the Medical Service, and by their colleagues, the civil surgeons attached to the various medical units in the field. Those who saw it, and those who benefited by it, know that words can only approximate a description of the devotion and complete disregard of self with which all classes, whose duty it was to attend on them, expended themselves in the service of the sick and wounded. The treatment of the wounded at the front

after many of the more important engagements, at and south of Modder River Station, for instance, and in Natal before the relief of Ladysmith, was laborious and incessant, frequently lasting 24 hours or more on a stretch, while those who did it were without sleep, and obtained food as best they could or not at all.

At the stationary and general hospitals, while the work only occasionally came with the same kind of rush so frequently seen at the front, it was continuous and unending; yet never in the history of war were seen such efficient and well-worked and equipped base hospitals as were the three General Hospitals and the Portland Hospital opened at Wynberg and Rondebosch during the early days of the war, and the similar units in the Orange River Colony and Transvaal at later periods.

The work of the Medical Service during the war has been reviewed by a Royal Commission at the conclusion of the campaign, but, on this occasion, while certain deficiencies and failures, most of them inseparable from a state of war, were very rightly exposed, the general conclusion was that "in no previous war had the sick and wounded been so well attended to," a verdict with which the Army, the Royal Army Medical Corps, and the public, may very well rest satisfied.

SECTION I.

(By the Editor.)

WOUNDS AND INJURIES OF THE HEAD.

Classification.

Descriptions of the injuries of this class seen in the South African War will be given under the following categories:—

I.—Accidental cases, exclusive of injuries received in action, viz.:—Scalp wounds, contusions, and fracture of the cranial bones, the results of falls, railway accidents, injuries produced by wagon wheels, &c.; in fact, similar cases to those seen in civil hospitals.

II.—Gunshot wounds of the head, which will be further sub-divided into—

(*a*) Scalp wounds and contusion of the cranial bones; and
(*b*) Fractures.

As the Boers carried no weapon but the rifle, injuries of other kinds than gunshots, so fully referred to with regard to other wars, cannot be dealt with in this report. Some few accidental injuries by bayonets came under observation, but will require only a very cursory notice.

Accidental Injuries.

Class I.—The injuries to the head of this class comprise a fairly large number, the majority of which were due to falls from horses and otherwise, railway accidents, and injuries from the wheels of wagons and vehicles of various kinds.

This class of injury, as met with in warfare, presents no points of special interest as compared to similar cases seen in civil life, but some of them are interesting as surgical cases.

Notes of Accidental Injuries of the Head.

Accident—Depressed fracture—No signs of brain injury—Operation—Recovered.

Case 1.—Sapper L. received depressed fracture of frontal bone, extending from left supra orbital ridge to coronal suture, with other injuries, from accidental mine explosion, 11th October, 1901. Admitted 17 General Hospital six hours after. All depressed bone was removed; dura showed signs of contusion; gauze drain. Temperature normal in a week; perfect recovery.—(Civil Surgeon O'Sullivan.)

Accident—Depressed fracture—Coma—Jacksonian epilepsy—Operation—Recovered.

Case 2.—Private B., sentry on railway bridge, struck in centre of forehead by a piece of coal which fell from engine, 19th March, 1900. Admitted same day 16 General Hospital, unconscious; breathing stertorous; frequent convulsive twitchings of left side, face, and body. Ragged wound in centre of forehead size of half-crown, with fractured and depressed bone. Wound enlarged and bone which was depressed over area of five shilling piece, elevated. Loose pieces of bone and fragment of coal removed. Lacerated dura sutured and bleeding vessel tied. Wounds healed sixth day. Good recovery.—(Lieutenant Smith, R.A.M.C.)

Accident—Depressed fracture—Paralysis—Operation—Invalided.

Case 3.—Corporal D., kicked on right side of head by a horse, 15th March, 1902. Admitted 18 General Hospital a few hours after. Unconscious, with left hemiplegia; scalp wound over right frontal and

temporal regions. Trephined at once; many pieces of depressed bone elevated and removed as well as extra dural clot and brain *débris*. Dura not injured. Hemiplegia disappeared. Invalided to England with slight dilitation of right pupil.—(Major MALLINS, R.A.M.C.)

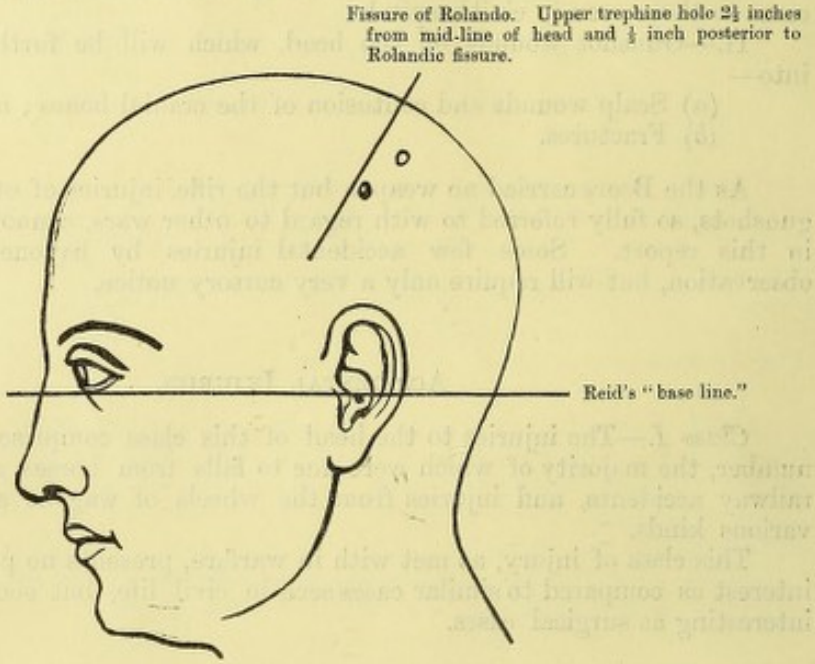
Accident—Depressed fracture—Coma—Operation—Died.

CASE 4.—Engine driver G. K., entering bridge over Komati River, came in contact with iron girder and was knocked off engine, taken to hospital at once. Insensible; breathing stertorous; pupils reacting. Had a deep scalp wound on left side of head. Wound explored; depressed fracture 2 inches long over left parietal eminence; trephined; elevated and removed bone. Dura not injured. Consciousness did not return, and he died next evening.

Post mortem.—Brain underlying fracture discoloured; sinuses full of dark blood; brain deeply congested; no other fracture.—(Captain WITHERS, R.A.M.C.)

Accident—Depressed fracture—No signs of brain injury—Operation—Recovered.

CASE 5.—Transport boy, L., hit on head by another boy, 3rd July, 1902, with a brick, near Bethulie. Admitted three days after into 12 General



Hospital. Horizontal wound 1-inch long over middle of left Rolandic area, contused and gaping. Probe detected fracture. No paralysis, nor fits; temperature normal; wound clean. Four days after admission was explored and fracture of "pond" variety found. On trephining, inner table was seen to be fractured and depressed; two trephine discs removed. Some clot found on dura, and slight laceration in latter. Dura incised, but no clot being found underneath, it was sutured up again; all clots and spiculæ of bone removed; discs not replaced. Drainage tube put in. There was visible pulsation in scar when stitches were being removed. Discharged to duty one month later.—(Lieutenant WILSON, R.A.M.C.)

Accident—Fracture of vault and base—Penetration—Coma (hæmorrhage)—Operation—Died.

CASE 6.—Private G. M., admitted Stationary Hospital, Queenstown, 31st May, 1902, unconscious; wound over left parietal eminence; pulse 76, intermitting; stertorous; temperature 101·2° F.; rigidity of right arm; pupils dilated, equal, and reacting. Three days after temperature 101° F.; Cheyne-Stokes respiration. Flap reflected off left parietal eminence. Linear fracture found running from near post. sup. angle of parietal into left temporal fossa, crossed by another about 1½ inches above ext. awd. meatus, which extended from ex. ang. process of frontal to base of mastoid process. Near intersection two discs of vault were removed, and a large extra dural clot seen. The whole of this latter could not be removed. Dura not opened. Brain then

pulsated, and pulse and respiration became regular. Later, coma deepened, and he died the same evening,

Post mortem.—Fractures extended into base through orbital plate of frontal and sphenoid ; patches of extravasated blood on under surfaces of frontal and temp. sphenoidal lobes, left Rolandic area flattened from compression.—(Captain BEYTS, R.A.M.C.)

CASE 7.—Private V. fell off ladder at block house, 18th May, 1902, admitted next day Aliwal North. Scalp abrasion over left parietal eminence ; semi-conscious, drowsy, and resented being touched ; right knee jerk exaggerated. No fracture felt. Able to swallow ; spoke incoherently. Cheyne-Stokes respiration that evening ; no return of consciousness. Following day scalp reflected at abrasion revealed fissured fracture. Trephined, dura incised and extensive clot removed from surface of brain. Patient came round, but later same evening coma set in again and he died. Accident—Fissured fracture—Coma (hæmorrhage)—Operation—Died.

Post mortem.—Fissured fracture extended round behind foramen magnum to right temporal fossa. Sub- and extra-dural clot sufficient to cause compression was found.—(Civil-Surgeon RANDALL.)

CASE 8.—Private T. L., admitted 26th June, 1900, semi-conscious, with lacerated scalp wound 4 inches long over right lambdoid suture, exposing extensive fracture of vault, without depression. Paresis of left arm. Patient soon became comatose, and died same evening. Accident—Fracture—Coma—No operation—Died.

Post mortem.—Fracture extended from middle of right parietal, backwards through lambdoid suture, and down to right of foramen magnum, beginning near sphenoid bone. No extravasated blood found.—(Civil Surgeon HALL.)

CASE 9.—Private F. S., accidentally struck on head with pick-axe, 12th December, 1901. Wound stitched. Nausea and headache since. Admitted Mooi River a month later with slowness of speech, weakness of right arm and leg, and defective vision. Temperature 100° F. to 101° F. at night. Large scar at left parietal eminence, where injured. Trephined over latter a fortnight later. Puncture in bone closed. Dura pulseless, but not adherent, and not punctured. On incising dura, a small quantity of pus escaped. Brain explored ; no more found ; bone not replaced ; gauze drain. Operation relieved all symptoms, and temperature never rose above normal. Invalided.—(Captain HEALY, R.A.M.C.) Accident—Punctured fracture—Paresis—Operation—Abscess—Recovered.

CASE 10.—Private P. F. fell out of train near Springfontein, 30th October, 1901. Admitted to 12 General Hospital same day. Had a depressed "pond" fracture in right parietal region near middle line ; no paralysis ; quite sensible. (Had also a compound-comminuted fracture of left leg, necessitating amputation, and a simple fracture of right femur in lower third.) On day of admission a trephine disc was removed from outer table of skull, when it was found that depression was confined to outer table, the inner table being quite intact. Progress good, but owing to extensive laceration of scalp wound healed by granulation. Wound soundly healed five months after.—(Major LOUGHEED, R.A.M.C.) Accident—Depressed fracture—No signs of brain injury—Operation—Recovered.

CASE 11.—Trooper J. W., standing on step of engine as train entered Bronkhurst Spruit Station, his head struck stand pipe of water tank. Unconscious, pupils dilated and inactive ; pulse 50 ; no paralysis. Wound on each temple $\frac{1}{2}$ inch long ; left one not reaching to bone ; right showing a piece of bone chipped out, leaving a hole in outer table the size of the top of little finger. Accident—Depressed fracture of outer table—Coma—Operation—Died.

Trephine used on right side. Inner table found uninjured ; membranes bulged without pulsation. Dura incised ; no blood clot seen. Wound closed and drainage tube put in. Temperature rose 104° F. Consciousness not regained ; died under 48 hours.

Post mortem.—Sub-arachnoid hæmorrhage over base and both parietal regions. Injured vessel not found. No other fracture of skull.—(Lieut.-Colonel SYLVESTER, R.A.M.C.)

Accident—Contusion—Aphasia—Paralysis—Jacksonian epilepsy—Operation—Died—Rupture of spleen.

CASE 12.—Drummer-Sergeant C. D. fell off wagon, and wheel passed over him, 12th November; was unconscious, but occasionally shouting for six days, when admitted to No. 2 General Hospital. Still partially unconscious, with marked signs of cerebral irritation, aphasia, and right hemiplegia. Right side of face also paralysed; pupils small but acting; temperature, 97·4° F. No signs of head injury except slight bruise over left eye. Over spleen also slight bruise noticed, but abdomen otherwise normal. Urine passed invol. Swallowed with difficulty, and resented being fed. Next day three attacks of clonic twitchings of right side of body. Following day trephined over lower third left Rolandic fissure. Brain pulsated; dura incised; nothing abnormal found. Symptoms continued with sub-normal temperature till he died day after operation.

Post mortem.—No fracture of skull or injury to brain, except a patch of softening ¾ inch from surface beneath trephine hole. Gentle irrigation washed out this, leaving cavity size of walnut, with shreddy walls. Over a pint of blood in abdominal cavity, with recent tear in spleen, now healed.—(Civil Surgeon WILSON.)

Accident—Contusion—Laceration of brain—Coma—No operation—Died.

CASE 13.—Sergeant J. E. thrown violently on his head from horse 25th December, 1901. Admitted at once 12 General Hospital. Unconscious, with breathing inclined to stertor; pupils small, regular, and slowly acting. Urine had to be drawn off. Moves right limbs, but not left. Plantar reflexes present; pulse full, 82; puffy swelling in left temporal region, but no abrasion of skin, nor fracture. Remained unconscious till he died at 5 p.m.

Post mortem.—No fracture of vault or base. Blood clot, 1 inch by 1½ inches, with laceration of brain in centre of right temp.-sphenoidal lobe; similar hæmorrhage with laceration on left cerebellum in the arbor vitæ; brain anæmic.—(Major LOUGHEED, R.A.M.C.)

Accident—Contusion—Coma—No operation—Died.

CASE 14.—Lance-Corporal G. thrown off horse 29th September, 1901. Admitted soon after 12 General Hospital. Unconscious; first metacarpal bone fractured; no marks on head; pupils regular and acting; could be roused to say "Yes" and "No" only. Next day could not be roused; twitching of left leg; throws arms about. No improvement; died six days after.

Post mortem.—No fracture of vault or base; a narrow strip of meningitis on each side of longitudinal sinus, with adherent membranes. Brain very anæmic, but not otherwise abnormal.—(Lieutenant WILSON, R.A.M.C.)

Accident—Contusion—Coma—No operation—Recovered.

CASE 15.—Private J. S. said to have been knocked down by a tramcar. Admitted Port Elizabeth, 2nd June, 1900. Unconscious; bleeding from ears and nostrils; pupils small, not reacting; no conjunctival reflexes. Scalp wound 1 inch long above right ear; no fracture detected. Pulse 60; temperature normal. Bleeding continued during night, with Cheyne-Stokes respiration. On second day bleeding ceased, and reflexes began to return, but he recognised nobody, and, muttering, fancied he was playing cards. Two months and a half after he was up, gradually recovering, but had headaches.—(Hospital Records.)

Accident—Contusion—Operation—Invalided.

CASE 16.—Shoeing-Smith W. J. L. kicked by horse 1st March, 1902. Admitted Mooi River eight weeks later. Severe headache; staggering gait; left pupil slightly dilated; deafness right ear, and sickness. At junction of lower with middle third of right occipito-parietal suture was a star-shaped scar, pressure on which caused intense pain. Night after admission was violent, and had to be held in bed. No rise of temperature. Trephined at scar, but nothing abnormal found. Headache and sickness apparently

relieved by the operation, and general improvement when invalided one month later.—(Major FREYER, R.A.M.C.)

There were then 16 accidental cases of injury to the head noted, of which five were apparently mere contusions or scalp wounds, and 11 included fracture of the bones of the skull. Of these, eight recovered and eight died. Remarks on accidental cases.

Contusions.—In two cases of this class, operation showed slight injury to the outer table of the bone, while the inner remained intact, a distinctly unusual condition to occur. Operation for the removal or elevation of fragments of bone, or for symptoms of hæmorrhage, were performed in two cases; of these one died. In three cases no operations were performed, and one died. Rupture of the spleen was found in one of the fatal cases, and a large quantity of blood in the abdominal cavity. Aphasia and epilepsy occurred in one case; the death rate of the five cases was 60·0, this high percentage being accounted for by the small number of cases, and the fact that two of them were complicated by rupture of the spleen or laceration of the brain substance. Of the cases operated on 50 per cent., and of those not operated on 33·3 per cent., died.

In one case of fracture an abscess of the brain formed, which was opened and drained after trephining had been done and recovered. The abscess was situated over the lower part of the left Rolandic area. The principal symptoms in this case were right hemiplegia, facial paralysis, and aphasia.

Fracture Cases.—There were 11 cases of this class with five deaths, or a mortality of 45·4 per cent. In one case only were cerebral symptoms absent; in the others paralysis, coma, or signs of brain irritation presented themselves.

In two cases the base was fractured as well as the vault. Trephining was done in 10 cases, and omitted only in one. Of the former four died, a mortality of 40 per cent.; the case not operated on died. In two cases large intra-cranial hæmorrhages were found, and both proved fatal, but one of them had also sustained fracture of the base of the skull.

The following table gives some of the details of these cases:—

TABLE 1.—Accidental Injuries of the Head, not Gunshots (16 cases).

——	Cases.	Recovered.	Died.	Death-rate.
				per cent.
Scalp wounds and contusion	5	2	3*	60·0
Fractures	11	6	5	45·4
Total cases	16	8	8	50·0
Operations on the skull	12	7	5	41·6
Cases with coma	9	2	7	77·7
Abscess of brain	1	1	..	..

* One of these fatal cases had also a rupture of the spleen, and another a laceration of the brain.

GUNSHOT INJURIES OF THE HEAD.

The two classes under which these injuries will be described comprise (*a*) Scalp wounds and contusions of the skull, and (*b*) Fractures. Classification.

Scalp Wounds and Contusions.

The production of a scalp wound by a bullet must depend on one or other of two conditions, either that the missile is travelling at a very low rate of velocity, or that its line of impact is so oblique that the bone is not actually touched. The latter mode of production of these wounds must be exceptional, and in the former case there must be more or less contusion of the cranium,

Contusion of skull usually accompanies scalp wounds by missiles.

although no fracture results. The force of the contusion the bones sustain must, in many cases, have been considerable, yet a large number of them showed no effects due to it. Some, on the other hand, were accompanied by distinct signs of concussion and other slight cerebral damage, and a smaller number even by those of compression as well, due to small intra- or extra-dural hæmorrhages.

Wounds of the scalp alone are, therefore, difficult or impossible to classify separately from those complicated with more or less contusion of the bones of the cranium, and are, moreover, of no more special interest when due to bullets than when produced in other ways. Scalp wounds and contusions of the skull will, therefore, be referred to as one class. There were noted 18 injuries of this class during the war, and all recovered.

Signs of concussion or of hæmorrhage common.

In many of the cases signs of intra-cranial damage presented themselves, such as those of concussion, those due to compression from hæmorrhage, or those depending on laceration of the brain cortex. These symptoms were paresis of certain groups of muscles, hemiplegia, more or less complete, aphasia, interference with special senses, especially of sight and hearing, and signs of brain irritation, as rigidity or twitchings of muscles due to injury to the cortex. In the majority of cases the symptoms were slight—headache, confused and slow cerebration, interference with vision, &c., sometimes lasting only a short time, but occasionally of considerable duration, the most persistent of all being headache and paresis of certain muscles.

The following notes of the 18 cases of injuries of this class give a fairly correct idea of the course, symptoms, and results to be expected in these cases :—

Gunshot Scalp Wounds and Contusions.

(18 Cases.)

Scalp—No signs of brain injury—Recovered.

Case 1.—Private R., wounded 24th January, 1900. Entrance at back of neck; exit in concha left ear; bullet "passed beneath muscles of mastoid"; nine days later wound healed; complains of slight headache.—(Lieutenant Phipps, R.A.M.C.)

Scalp—No signs of brain injury—Recovered.

Case 2.—Private McG., wounded 18th February, 1900. Scalp wound 3 inches long, over vertex, not involving bone. No head symptoms; wound granulating. Discharged cured three weeks after.—(Civil Surgeon Maxwell.)

Scalp—No signs of brain injury—Recovered.

Case 3.—Driver R., wounded 8th February, 1900. "Entrance on left side near mid line, midway between occip. protub. and crown of head; exit 2 inches further forward." When sent from the front and admitted at the General Hospital a week later, wound healing. Discharged completely cured in 10 days' time.—(Civil Surgeon Brinker.)

Scalp—No signs of brain injury—Recovered.

Case 4.—Private M., wounded 18th February, 1900. Shot grazed scalp for 2 inches from before backwards, in front and on left side. When admitted a week later, wound healing. Discharged completely cured in 10 days' time.—(Civil Surgeon Brinker.)

Scalp—No signs of brain injury—Recovered.

Case 5.—Lance-Corporal S., wounded 29th March, 1900; admitted Bloemfontein a fortnight later. Bullet grazed lobe of ear, entered skin just behind, and took a superficial course under scalp for about 2 inches; emerged without injuring bone. Wounds, though painful, are progressing favourably.—(Civil Surgeon Brinker.)

Scalp—Lost consciousness—Recovered.

Case 6.—2nd Lieutenant P., admitted 23rd November, 1900. Two small wounds in scalp caused by splashes of bullet—piece of bullet removed. Unconscious for some hours after injury. Wounds healed; discharged convalescent 10th day.—(Hospital Records.)

CASE 7.—Private N., wounded 11th June, 1900. Struck by Mauser bullet on left eye-brow; slight gutter-shaped wound in skin resulted. Wound quite healed three weeks after.—(Civil Surgeon JOHNSON.) — Scalp—No signs of brain injury—Recovered.

CASE 8.—Private W., wounded 28th July, 1900, at range of 150 to 200 yards; admitted at Estcourt from the front three weeks after. A linear scar, 3 inches long, in upper occipital region; "apparently no depressed bone." Transferred to hospital ship for other wounds eight days later.—(Civil Surgeon INGALL.) — Scalp—No signs of brain injury—Recovered.

CASE 9.—(1) Private McK., admitted 6 General Hospital, 25th February, 1900. Entrance and exit quite distinct from each other, over left parietal; bone apparently not touched. No signs whatever of cerebral injury; healed rapidly. Discharged 22nd day. — Scalp—No signs of brain injury—Recovered.

CASE 10.—(2) Private G., a precisely similar case to above. No head symptoms followed. Discharged 19th day.—(Civil Surgeon PARHAM.) — Scalp—No signs of brain injury—Recovered.

CASE 11.—Private V. B., wounded 16th April, 1901. Unconscious 10 minutes; admitted 12 General Hospital from the front two days later.

Quite sensible; complete motor and sensory paralysis right arm; slight headache.

Septic; horizontal, ragged gunshot wound, 2 inches long, just above left parietal eminence, involving scalp only.

Trephined four days later; no fracture or depression; very small clot between bone and dura; latter incised and 2 drms. of clot removed from beneath; dura sutured and drain left. Uninterrupted progress; arm nearly recovered six weeks after, when invalided.—(Major LOUGHEED, R.A.M.C.) — Contusion—Septic—Paralysis—Operation—Recovered.

CASE 12.—Private F., wounded 11th June, 1900, by fragments of pompom shell. Contused and lacerated wound over base of right mastoid proc.; outer table comminuted, inner bare, but not fissured; fragments of the shell and cloth had been removed.

Slight suppuration; deafness, with large rupture of right tymp. membrane; no brain symptoms. Wound healed three weeks after; still deaf.—(Civil Surgeon THOMPSON.) — Contusion (shell)—Septic—No brain symptoms—No operation—Recovered (deaf right ear).

CASE 13.—Driver T., admitted 20 General Hospital, 24th January, 1901, for shrapnel wound in right occipital region. Wound healed but scar tender; severe and persistent headache. Flap raised; bone rough under scar; trephined; nothing found that would account for the pain, which latter was not relieved by the operation.—(Civil Surgeon SEDDON.) — Contusion—Shrapnel bullet—No signs of brain injury—Operation—Recovered (headache persisted).

CASE 14.—Private B., wounded 16th April, 1901; admitted 12 General Hospital from the front two days later. Septic, ragged wound, 2 inches long, ran horizontally over left Rolandic area, slightly above parietal eminence; scalp only divided, bone not bared.

Recovered consciousness 10 minutes after being wounded, and found he could not use right arm. Quite sensible now; complete motor and sensory paralysis right arm; slight headache. Trephined four days after admission. No fracture or depression, very small clot between bone and dura; dura incised, and 2 drms. blood clot removed; dura sutured, wound drained. Some sensation and movement in arm next day; had nearly recovered in six weeks, when he was invalided.—(Hospital Records.) — Contusion—Paralysis—Operation—Recovered.

CASE 15.—Private B., wounded 18th February, 1900; admitted 6 General Hospital 10 days after. Healed scalp wound over vertex, at junction of sagittal and lambdoid sutures. Mental condition confused; some loss of memory; occasional delusions; rational for most part; fields of vision diminished, no paralysis, nor vomiting; some occipital and vertical — Contusion—No paralysis—Mental disturbance—No operation—Recovered.

headache. Improved steadily. Discharged in a month's time.—(Hospital Records.)

Contusion—No signs of brain injury—Operation—Recovered.

CASE 16.—Private McK., wounded 18th February, 1900, in soft parts above right ear. No injury to bone detected; no brain symptoms; 18 days after intense pain in wound; temperature, 104°. This continued, necrosed bone was detected, and four days later wound was opened up; groove in external table with necrosed edges found; scraped; boric fomentations. Recovered; transferred to base 35th day.—(Civil Surgeon PARHAM.)

Contusion—Paralysis—Aphasia—No operation—Recovered.

CASE 17.—Trooper B., wounded 11th June, 1900; admitted same day to Yeomanry Field Hospital. Triangular wound of scalp 2¼ inches behind and above external orbital angle; no fracture or depression detected. Slight aphasia; paralysis right arm; pupils equal and active. Two days later facial paralysis well marked; aphasia diminishing. Following day "doing well, sent to Kroonstadt."—(Civil Surgeon EVANS.)

Concussion—Deafness—No operation—Recovered (with deafness).

CASE 18.—Lieutenant C., wounded 6th January, 1900. Entrance through right ala of nose, exit 2¾ inches behind tip of left mastoid process, and 1 inch below external meatus. Deafness left ear; semi-comatose but easily roused, when he asks for his servant, &c.; catheter drew off urine; tongue and palate extremely foul; pulse and respiration very slow; pupils re-act to light. Invalided 120 days later with deafness persisting.—(Records Ladysmith.)

Remarks on gunshot scalp wounds and contusions.

Of the above 18 cases of scalp wounds and contusion of the skull due to gunshot, as many as 11 showed no symptoms of injury to the brain. In one of these, although the wound healed rapidly, trephining had to be performed later, in consequence of tenderness at the point struck, and severe and persistent headache; but the symptoms were not relieved by the operation, nor was any condition discovered to which they could be attributed.

Results of operations.

The success which followed operations in the four cases so treated was very satisfactory, as none of them died, and the symptoms present were relieved in three. In one case in which aphasia and paralysis were observed, no operation was performed, as improvement was taking place, when the man was sent to a base hospital at Kroonstadt. Two of the cases were the result of shell wounds; one of these was septic, but both recovered.

The following table gives some of the details of these cases:—

TABLE 2.—Scalp Wounds and Contusions of the Skull.

Gunshot Cases.	Cases.	Recovered.	Died.	Death-rate.
Scalp wounds and contusions of skull ..	18	18	—	—
No signs of brain injury in	11	11	—	—
Paralysis in	3	3	—	—
Aphasia in	1	1	—	—
Concussion in	2	2	—	—
Operations performed in	4	4	—	—

Gunshot Fractures of the Skull.

Interesting class of cases.

Gunshot fractures of the skull, as seen in the Boer War, formed a peculiarly interesting class of injuries from many surgical points of view, and particularly from that of the treatment which it is desirable to carry out in these cases.

Brain and bone damage in living men unlike that seen in experiments.

The amount of comminution of the cranial bones and the degree of destruction of the brain substance which were seen during the war were quite different from what experiments with modern rifle bullets on dead men led surgeons to expect.

The fractures of the bones and the pulping and general destruction of the brain matter are much less in living than they are in dead skulls; and while the general rule holds good, that the injuries are extensive as the range is short and the velocity of the bullet high, and that they decrease in severity as the velocity diminishes and the range increases, it was found that in living skulls the rapidity with which the extent of injury decreased with diminished velocity was greater than was expected, judging from the effects of small bullets on dead men. At quite short ranges—8 to 10 yards—the destruction of the skull and brain are in both cases, no doubt, enormous; but in the case of living men the injury so rapidly decreases in extent that at ranges of over 100 yards the fracture is often confined to the entrance and exit wounds, with fissures extending around both for short distances only, and the brain may be pulped and destroyed only to the extent of the bullet track. The damage done at such ranges as 100 yards are not nearly always of such slight degrees as those just mentioned, but cases of this kind do occur; whereas in dead skulls the fissuring was always much more extensive, the natural sutures were blown apart, cracks occurred across both vault and base, and the brain was more or less pulped throughout.

Injury more rapidly decreases with increase of range.

Injuries produced in living skulls.

At medium and long ranges, in perforating cases, the apertures in the skull are circular when the bullet strikes perpendicularly to the surface of the bone, and oval and of greater dimensions as the bullet enters more obliquely. The fissures around the perforations are short—from ½ inch to 2 inches—and they are for the most part thread-like, with the pericranium untorn over them, while the brain injury is more strictly confined to the bullet track. The entrance wound in the skull is more often a clean-cut perforation than is the exit wound, which at these ranges is frequently not of this kind. The exit aperture is frequently represented by a larger and more irregular fracture, a piece or pieces of the whole thickness of the bone being driven outwards; and the general character of the fracture and the fissuring which occurs at this side is usually more severe than is seen at the entrance side. This is probably due to the bullet having been somewhat turned over when passing through the entrance wound at a comparatively low rate of velocity, and so striking at the exit side with a more extended surface, its energy, therefore, being expended over a larger area.

At medium and long ranges.

At entrance side.

At exit side.

All combinations of fractures of the two tables of the skull, with or without depression of both or of one or other table, may be produced by projectiles, the commonest being fracture, with depression or comminution of both tables. Many cases of fracture of the outer table without implication of the inner were met with in the Boer War; but the converse of this condition, fracture of the inner table without implication of the outer, was, if seen at all, very exceptional. This must not be looked upon as evidence that this kind of fracture did not occur, but merely that in the cases noted during the war the symptoms produced were slight, and that operation was not resorted to in their treatment. On the contrary, we know that fracture of the inner table without fracture of the outer is not an uncommon condition to find on trephining in head cases, but it is only to be discovered by that means. Fissures of the vault, without any more localised fracture at the point of impact, were seen, but they also, as might be expected, were exceptional. At quite short ranges—mostly cases produced accidentally—large portions of the skull may be blown away, but this class of case seldom, if ever, occurs in battle, and certainly they do not reach the field hospitals for treatment. Practically all cases of gunshot of the skull produced at short ranges are accompanied by such enormously destructive effects that death takes place immediately or within a few hours. But at medium and long ranges, say from ranges of over 400 yards, fractures are produced which, although the injuries are great, may not be either immediately or remotely fatal. Exceptional cases, too, occurring at much shorter ranges have been followed by recovery.

Kinds of fracture met with.

Gunshot fracture at short ranges nearly all fatal.

At medium and long ranges not so.

When both tables of the skull are implicated in a fracture, gunshot or otherwise, the inner table has always borne the reputation of exhibiting the greater degree of damage, in consequence of its supposed greater brittleness; but undeservedly so. It is not a question of more or less brittleness of one or other table on which the greater or less damage to either depends; for in

The reason of greater damage to one table as compared to that of the other.

perforating gunshot cases, although the inner table is fractured to a greater extent on the entrance side, the reverse condition obtains on the exit side, and here the outer table exhibits the greater injury. This is not an occasional occurrence only, it is practically a condition uniformly experienced; and it depends on the fact that the inner table is less firmly supported on the entrance side than is the outer, and consequently suffers more damage than the latter, which is supported at the moment of fracture by the diploe and inner table. At the exit side, as the bullet passes from within outwards, the outer table is less firmly supported than the inner, which has the diploe and outer table in front of it, and consequently suffers the greater damage. On the entrance side the outer table is cleanly pierced by a bullet passing through it perpendicularly, and the inner table irregularly fractured; while at the exit side of the skull exactly the converse condition obtains.

All a question of which table is least supported as bullet passes through.

Brain injury.

The vast majority of gunshot fractures of the skull are accompanied by more or less marked symptoms of brain injury: paresis of certain groups of muscles; paralysis, motor and sensory; loss or impairment of special senses, usually of vision or of hearing; Jacksonian epilepsy; twitchings and contractions of certain muscles, signs of brain irritation due to injury of the cortex—in fact, all the symptoms of brain damage in all their varying combinations. Usually these symptoms are in correspondence with those to be expected in consequence of injury to the brain areas evidently implicated in the track of the bullet, but occasionally symptoms are apparent which are not to be accounted for by interference with those brain centres through which the bullet has passed. These symptoms must be due to injury to outlying portions of the brain which has been produced by vibration or commotion due to the wave action through the comparatively fluid brain substance communicated to it by the passage of the bullet.

All symptoms occasionally not due to injury to brain in bullet track alone.

The kinds of fractures usually seen.

The fractures of the skull ordinarily produced by rifle bullets are: (*a*) gutter fractures, (*b*) penetrating fractures, and (*c*) complete perforations. Those due to shell fragments, and sometimes to shrapnel bullets, may be of the simple fissure kind, depressed fractures without actual penetration of the skull by the missile, or extensively comminuted fractures accompanied by larger apertures in the calvarium. The former classes of injury are by far those most usually met with.

Gutter Fractures.

The typical gutter fracture.

In a typical gutter fracture there are two apertures in the scalp, with a trench ploughed through the outer table and diploe of the calvarium; the inner table, forming the floor of the gutter, is usually comminuted extensively, and some of the fragments may be displaced towards the dura and brain, or sideways beneath the edges of the trench. Fissuring is not very marked in these cases, and is most often seen at either end in the form of a single fissure of from ¼ inch to 1½ inches in length.

The length to which gutter fractures may extend depends on the degree of curvature of the surface of the skull at the point struck. Gutters, therefore, in the antero-posterior direction are more likely to be prolonged and to be more serious injuries than those the direction of which is transverse, because the area over which the brain cortex is damaged is greater in the former case, and this is of importance with regard to interference with various motor areas.

When the contact of the bullet with the skull is still more superficial, there may only be one opening in the scalp, the scalp wound, in fact, being also in the form of a gutter.

In 133 cases of gunshot fracture of the skull, of which detailed histories are at present available, or of which the condition of fracture and the results are known, 60 were of the gutter form; these gave a death rate of 21·6, the lowest percentage of deaths following fractures of any of the three types above specified.

Mortality of gutter fractures in cases noted.

The following notes of the cases show the salient points in connection with them as concisely as is possible:—

CASE 1.—Private H. H., wounded 23rd February, 1900; admitted 4 General Hospital, Mooi River, 17 days later. "Gutter" across mid-line obliquely from right frontal to left parietal eminence. Hemiplegia and aphasia, improving till a fortnight later, when convulsions set in suddenly. Trephined at once at each end; many pieces of comminuted bone removed; gutter track between opened up, and cleared of loose fragments; abscess in brain at middle of track, contained 1 drm. pus; fluid brain matter irrigated out, and protruding particles of brain cut away; much fissuring of skull. Gutter—Septic—Paralysis—Aphasia—Jacksonian epilepsy—Operation—Abscess—Recovered.

Convulsions and aphasia ceased immediately; hemiplegia was disappearing rapidly, and wound was nearly covered in, when invalided 10 days later. Wrote on 4th June, 1900, evidently with right hand: "I have neither pain nor ache in my head now; I haven't right power of my arm or leg, but am able to move about with the help of a stick."—(Major FREYER, R.A.M.C.)

CASE 2.—Private J. H., wounded 20th January, 1900; admitted 4 General Hospital, Mooi River, 10 days later. Horizontal "gutter" left side of head, 2 inches above ear; septic, with bare bone at bottom. Had difficulty of speech, intense headache and vomiting, all of which passed off before arrival here. Only slight headache remained, till eight days after admission, when he became suddenly comatose. Trephined; pus welled up; depressed inner table removed; dura incised, and abscess found in brain substance, from which 3 ozs. of pus escaped; boric irrigation; drained. Chloroform required towards end of operation; pupils reacted. Remained unconscious; died next day. Gutter—Septic—Coma—Operation—Abscess—Died. (Lat. ventricle invaded).

Post mortem.—Abscess cavity in temp. Sphenoid-lobe; only filmy partition separated it from lat. ventricle; small perforation in partition, with trace of pus in ventricle.—(Major FREYER, R.A.M.C.)

CASE 3.—Private A. J. M., wounded 23rd February, 1900; admitted 4 General Hospital, Mooi River, three days later. Gutter from posterior margin of right frontal, just above ant. inf. angle of parietal to parietal eminence same side. Total left hemiplegia. Trephined three days after; abscess struck in brain substance, at entrance end, from which 1½ ozs. pus escaped; exit end also trephined; all loose bone in track between removed; drained. Steady improvement; perceptible return of power in arm and leg when invalided a month later. Wrote 7th July, 1900, saying: "I got the use of my left leg back on the 17th April last. . . . I can raise my arm but very little."—(Major FREYER, R.A.M.C.) Gutter—Septic—Paralysis—Operation—Abscess—Recovered.

CASE 4.—Lance-corporal T., wounded 27th February, 1900; admitted 4 General Hospital eight days later. Septic, lacerated shell wound 3 inches by 3 inches, situated on vertex, over parieto-occip. region, involving more of left than right side. Gutter (shell wound)—Septic—Paralysis—Hernia—Operation—Died.

Complete right hemiplegia; comminuted bone, with pieces depressed into lacerated brain; also loose pieces of hair, scalp, helmet, &c.; severe headache; temperature, 101°; vomiting. Removed loose bone and foreign matter, after which symptoms subsided, and he could raise hand. On 26th March, 1900, severe headache returned; hernia forming. A week later, trephined by Sir W. Stokes; a small piece of depressed bone removed but no abscess found; improved; erysipelas 10 days later; recovered from this; hernia increased, and headache continued. On 6th May, 1900, had epileptic fit, and became unconscious; died two days later.—(Civil Surgeon COPLEY.)

CASE 5.—Lieutenant C. G. D., admitted Maritzburg 23rd January, 1899, with gunshot wound grooving skull, and leaving a large piece of bare dead bone; temperature ran high for some time, latterly normal. Ten weeks after admission two pieces of dead bone, including both tables, were removed; brain beneath pulsating; wound healing now.—(Civil Surgeon JOHNSTON.) Gutter—No paralysis—Operation—Recovered.

Gutter—No paralysis—Operation—Recovered.

Case 6.—Boer prisoner, J. B., admitted Bloemfontein 28th June, 1901, a few days after being wounded.

Wound, small and circular, like Lee-Metford; fracture felt with probe; X-ray failed to show bullet. Two days later two trephine discs and several loose pieces of bone were removed. Fracture, 1½ inches long, of "gutter" variety; looked as if caused by sharp-pointed instrument. Dura torn, but had closed up. Trephine discs replaced, and drain put in. Case did well. A month after there was a small sinus, probably due to dead bone remaining.—(Captain Cameron, R.A.M.C.)

Gutter—Operation—Paralysis—Recovered.

Case 7.—Boer prisoner, P. K., admitted 9 General Hospital 27th July, 1901, with gunshot wound over right frontal region, inflicted six days previous. Trephined, and removed area of bone size of crown piece. A fortnight after left hemiplegia set in. Improved; became quite sensible; some movement in left hand.—(Hospital Records.)

Gutter—Aphasia—Paralysis—Operation—Recovered.

Case 8.—Private L. G., wounded at long range at Magersfontein, 11th December, 1899; admitted 2 General Hospital a few days later. Entrance 1 inch from mid-line over left coronal suture; exit same side, over lambdoid suture, 1 inch from mid-line. Distance between wounds 4 inches; broken bone felt under track. Drowsy; speech, thick and slow; pulse, 60; temperature normal; complete loss of power and sensation in right leg, arm, and lower face. Next day "gutter" fracture exposed; piece of bone 1 inch square at entrance, and many from gutter and imbedded, were removed; dura much damaged, and brain extensively pulped. Drainage tube put in. Eight days later could move arm and leg well; sensation nearly complete; no suppuration. One week later noticed a few twitches in arm, but speech much improved. Two months after admission, when invalided, speech was normal, leg and face had almost recovered but arm was weak.—(Major Lougheed, R.A.M.C.)

Gutter—Septic—Operation—Abscess—Died.

Case 9.—Private F. O., received at long range, over 1,000 yards, glancing bullet wound 1¼ inches long, 2 inches above right eyebrow, 25th November, 1899. No bare bone or fracture detected; septic. Headache, high temperature, rigor, vomiting and puffiness of right eyelid followed in 2 General Hospital, and three weeks after injury wound was explored. Small stellate fracture trephined, and fragments removed; 1½ drms. pus escaped from between dura and bone; dura inflamed, but not torn; drainage tube inserted. Became drowsy eight days after operation, when the wound was re-opened under anæsthetic, and probe passed between vault and dura all round opening, but no pus found. Died suddenly three days later.

Post mortem.—Abscess containing 1½ ozs. pus, with defined wall, in right frontal lobe, quite an inch beneath surface; communicated with extra dural one through small track.—(Civil Surgeon Pegg.)

Gutter—Paralysis—Aphasia—Operation—Recovered.

Case 10.—Private W. P., wounded at long range 11th December, 1899; admitted 2 General Hospital in a few days. Had a "gutter" fracture, 1½ inches long, horizontally across centre of left parietal bone with scalp divided over it. Left facial paralysis; complete paralysis of tongue; paresis and partial anæsthesia right arm; slight internal squint, left eye; aphasia, principally motor; pulse, 40; temperature, normal. Trephined one week later; spiculæ and some clot removed. Dura not torn, of dark blue colour, and not pulsating; incised; clot removed from surface of brain, which then pulsated slowly; dura not sutured, nor disc replaced. The symptoms persisted for four days, and then rapidly disappeared. Only some weakness of right arm remained when invalided six weeks after operation.—(Civil Surgeon Day.)

Gutter—Septic—Paralysis—Epilepsy—

Case 11.—Private H. D., received "gutter" fracture, 4 inches long, through centre of left Rolandic area, 11th December, 1899, at 250 yards range. Admitted 2 General Hospital 12 days later. Drowsy and aphasic;

paresis right arm ; paralysis right face and tongue ; Jacksonian epilepsy ; pulse, normal, and temperature 99·9° ; suppurating ; pulsating hernia. Operation. Hernia and many loose pieces of bone removed ; wound drained. Discharge and temperature continuing, wound was re-opened 26 days later, and pus found oozing through dura. Director passed 2½ inches into brain struck abscess ; 1 oz. pus ; drainage tube inserted. Invalided two months later, with wound healed, and speech recovered, but arm still very weak.—(Civil Surgeon Day.) — Aphasia—Operation—Abscess—Recovered.

Case 12.—Private J. R., wounded 11th December, 1899 ; admitted 2 General Hospital after few days. Bullet struck skull ¾ inch above, and to right of occipital protuberance, and glanced off, causing three fissures. Trephined ; dura lacerated ; 12 fragments bone, mostly inner table, removed from depth of 1½ inches ; dura could not be brought together ; drain inserted. Wound healed 12 days after operation ; excellent recovery. Invalided.—(Major Lougheed, R.A.M.C.) — Gutter—No paralysis—Operation—Recovered.

Case 13.—Private S., wounded 28th November, 1899 ; admitted 2 General Hospital four days later. Entrance ½ inch above and to left of occip. protub. showing "gutter" fracture over lateral sinus ; no exit wound ; emphysematous crackling over right side and back of neck. Patient so bad that anæsthetic had to be discontinued ; restlessness, and acute delirium ; coughed up fœtid blood and pus ; right lung consolidated ; temperature, 102°. Died 18 days later. — Gutter—No paralysis (chest perforated)—No operation—Died.

Post mortem.—Mauser bullet embedded in right quadratus, near crest of ilium. "Gutter" fracture of occipital bone, 1½ inches long ; much comminution ; large fragment in lower left occipital lobe, which was pulped ; spicula projected into lateral sinus, but did not penetrate ; cerebellum much bruised. Bullet traversed muscles of back of neck, and entered chest. Right lung badly lacerated in vertical direction ; contained piece of rib. Second and third dorsal vertebra deeply grooved on right side of bodies. Eighth and ninth ribs grooved, and tenth and eleventh fractured close to angles.—(Major Lougheed, R.A.M.C.)

Case 14.—Private S. B., admitted 12 General Hospital 21st August, 1901, for old gunshot wound of skull—"gutter" fracture in vicinity of left motor area—received 18 months ago, and for which he had been trephined, as he suffered from hemiplegia and aphasia. Invalided home then, but recovered sufficiently to return to campaign. Has full use of arm and leg ; facial paralysis ; speech, memory, writing, and reading slightly affected. Two pieces of dead bone now removed by Major Lougheed. Improved. Invalided again.—(Lieutenant Wilson, R.A.M.C.) — Gutter—Paralysis—Aphasia—Operation—Invalided.

Case 15.—Private J. M., wounded 11th December, 1899. Left parietal deeply grooved, and splintered through both tables ; fragments embedded in brain ; latter lacerated and oozing out. Complete aphasia and right hemiplegia, ptosis, and facial paralysis. All splinters, many of them embedded in brain, removed. Three weeks later hemiplegia gone and aphasia improved. Sent to Wynburg.—(Hospital Records.) — Gutter—Paralysis—Aphasia—Operation—Recovered.

Case 16.—Private J. R., admitted Orange River 13th December, 1899. Deep "gutter" of left parietal protuberance 2½ inches long, with jagged edges ; brain oozing out ; a large piece of bone embedded in brain, with much starring of fracture. Dimness of vision ; intense headache ; no motor or sensory symptoms. Six days later trephined ; splinters and large piece depressed bone removed. A week after operation headache had nearly disappeared ; able to read and write. Sent to base.—(Hospital Records.) — Gutter—No paralysis—Operation—Recovered.

Case 17.—Lieutenant M. Entrance and exit in occipital region 2¾ inches apart ; almost complete right hemiplegia, slight loss of sensation ; — Gutter—Paralysis—

Jacksonian epilepsy—Hemianopia—Operation—Recovered.

epileptiform seizures, beginning in right forearm; temperature, 101·9°; pulse, 96, had control over sphincters. Trephined; "gutter" fracture 1¾ inches by ¾ inch; dura uninjured, though widely separated from bone; depressed and loose fragments removed; drained. Had one fit following day. Paralysis practically disappeared in a month, but had some hemianopia, headache, and giddiness. After a year well in every respect, and returned to duty.—(Captain McDermott, R.A.M.C.)

Gutter—Septic—No paralysis—Operation—Died.

Case 18.—Private H. Revolver (·450) accident 16th August, 1901. Admitted 12 General Hospital three weeks later. Entrance in centre of left upper eyelid; exit size of a penny, in frontal bone, 4 inches above right supra orbital margin, and ½ inch to right of mid-line; brain visible; "Gutter" fracture felt between the apertures. Septic, conscious, no paralysis; control over bladder and rectum. Operation; two large and 36 small pieces of bone removed; drained.

No improvement; much cerebro-spinal fluid oozing from both wounds; became gradually comatose, and died 10 days later.

Post mortem.—5 ozs. greenish pus escaped from cavity, size of child's fist, in frontal lobes; anterior part of lobes absent; no meningitis; orbital plates fissured and loose; coronal suture widely open.—(Major Lougheed, R.A.M.C.)

Gutter—Septic—Paralysis—Operation—Recovered.

Case 19.—Boer prisoner, G. M., wounded 17th February, 1900; admitted 5 General Hospital after 27 days. "Gutter" fracture 1 inch by ½ inch, situated 5 inches above and ½ inch ant. to right ext. aud. meatus; septic; left hemiplegia, with wasting of muscles; sensation slightly impaired; patellar reflex exag.; ankle clonus marked. Flap deflected; pus exuded from lacerated brain; 16 fragments of bone—making area size of penny—extracted from depth of 2 inches in brain; lead and grit irrigated out. Steady improvement. About three months later paralysis had disappeared, only for a little dragging of foot in walking.—(Major Moffett, R.A.M.C.)

Gutter—Septic—No paralysis—Abscess—Operation—Recovered. (Reduced fields of vision.)

Case 20.—Private W., wounded 27th December, 1900; admitted 2 General Hospital 10 days after wound. Single wound, ragged and suppurating, 2]inches above occip. protub., and 1 inch from mid-line. Conscious when roused; drowsy; very irritable: pupils equal and active; no paralysis; temperature elevated. Wound explored; many small fragments of bone removed; brain protruding; pus escaping from hole in latter; orifice dilated, giving exit to 4 ozs. pus; drained. Uninterrupted recovery, but with fields of vision much diminished.—(Civil Surgeon Sanders.)

Gutter—Septic—Paralysis—Aphasia—Abscess—Operation—Recovered.

Case 21.—Private B., wounded 13th December, 1900, by piece of pompom shell; admitted 2 General Hospital 21 days later. Small suppurating wound 3½ inches above right ext. aud. meatus. Unconscious for 20 minutes after wound; next day slight aphasia; left arm and face paralysed, also leg slightly; temperature raised for some days. Could walk on admission, but hemiplegia with anæsthesia still present. Four days later explored. Opening in skull ¾ inch by ½ inch; hair found on dura; pus escaping through hole in latter; dura incised, and 2-inch cavity in brain exposed, containing 2 drms. pus with fluid brain; many fragments bone removed, one being ½ inch square, drainage tube. Abscess healed, but motor power and sensation somewhat defective when he left hospital.—(Civil Surgeon Sanders.)

Gutter—No paralysis—Mania—No operation—Recovered.

Case 22.—Trooper H., wounded 25th December, 1901, by Mauser. Entrance 1½ inches to left of occip. protub.; no exit. Stupid; apathetic; pain over right mastoid; maniacal attack 23rd day; rational and quiet a few days later. Complete recovery.—(Lieut.-Colonel Westcott, R.A.M.C.)

Gutter—Paralysis—No operation—Recovered.

CASE 23.—Trooper McL., wounded 24th February, 1902; admitted 19 Stationary Hospital four days later. "Gutter" fracture 2½ inches long on left side of vertex. Almost quite unconscious; paresis right arm; incont. urine and fæces. "By ninth day all symptoms had cleared up—wound healed without suppuration."—(Lieut.-Colonel WESTCOTT, R.A.M.C.)

Gutter—Septic—No paralysis—Jacksonian epilepsy—Eyeball removed—Recovered.

CASE 24.—Trooper McK., wounded 24th February, 1902. Entrance through right eye. Bullet passed obliquely upwards and backwards; frontal bone fissured. Drowsy; delirious; incont. urine and fæces. Right eyeball removed; not trephined. For three days had Jacksonian epilepsy, beginning left side of mouth, and passing to left extremities; wound septic. By ninth day fits had ceased; necrosed fragments frontal bone came away, or removed during month. Recovered completely.—(Lieut.-Colonel WESTCOTT, R.A.M.C.)

Gutter—No paralysis—Aphasia—No operation—Recovered.

CASE 25.—Private B., wounded 18th February, 1900; admitted General Hospital 10 days later. Healed scalp wound on vertex at junction of lambdoid and sagittal sutures. Constant headache; mental condition confused—loss of memory; occasional delirium, but sometimes quite rational; fields of vision diminished; no paralysis. No operation; discharged, apparently quite well, a month after being wounded.—(Civil Surgeon MURSELL.)

Gutter—Septic—Paralysis—Hernia—Operation—Died.

CASE 26.—Private P., wounded 25th July, 1900; admitted 6 General Hospital a week later. Wound on vertex to right of mid-line; septic; hernia. Conscious, but drowsy; left hemiplegia; temperature, 102°. A week after admission temperature increased with twitchings right face, arm, and leg. Trephined over "arm centre"; brain did not pulsate or bulge; explored with needle, but no pus found; wound closed; died next day.—(Hospital Records.)

Gutter—Septic—No signs of brain injury—Bullet lodged—Extracted—Operation—Recovered.

CASE 27.—Private T., wounded 18th February, 1900; admitted 6 General Hospital 15 days later. Bullet passed through muscles of right shoulder upwards, lodging in temporal bone, close behind and below ext. aud. meatus. In hands of Boers five days unattended to; septic. Bullet extracted previously at Field Hospital. Here all loose spiculæ and a large piece of mastoid process removed; depression found in petrous bone, and fissure extended through squamous; drained. Successful; no brain symptoms; convalescent 36th day.—(Civil Surgeon BRINKER.)

Gutter—Septic—No paralysis—Operation—Died.

CASE 28.—Private E., wounded 9th February, 1901; admitted 6 Stationary Hospital six days later. Septic "gutter" 3 inches long over front of left parietal; large amount of brain protruding. Unconscious, but could be roused; paralysis of sphincters; pulse slow; left pupil dilated. Next day explored. Aperture in skull enlarged, but no loose bone found; irrigated. No improvement; died 10 days later.

Post mortem.—Fragments bone found in brain and lat. ventricle; large area of brain destroyed.—(Lieutenant SIMSON, R.A.M.C.)

Gutter—No paralysis—Mania—Operation—Died.

CASE 29.—Private C., wounded 6th August, 1901; admitted 17 General Hospital four days later. Deep "gutter" right side from ½ inch outside occip. protub. through occip. and temp. bones, ending above right ear. A large piece of depressed bone 2½ inches by 1 inch along upper margin of gutter. Maniacal. Operation six days later; depressed bone removed; much brain matter lost; wound irrigated; dura sutured. No improvement. Died 20th day.—(Lieutenant WROUGHTON, R.A.M.C.)

Gutter—Septic—No paralysis—Operation—Recovery

CASE 30.—Sergeant P., admitted Imperial Yeomanry Field Hospital. Large scalp wound 1 inch behind right pariet. emin. Semi-conscious; no paralysis. Wound enlarged; gutter fracture; seven splinters removed,

leaving opening into skull 1½ inches by 1 inch; linear wound ½ inch long in dura; small quantity of brain matter came away; stitch put in dura. Conscious, but restless and excitable third day; sixth day, hemiplegia, convulsions, and temperature, 103·2°. Wound re-opened; sub-dural abscess and clot evacuated; drained. "Did well."—(Major OPENSHAW, C.M.G., R.A.M.C. (V.).)

Gutter—Paralysis—Bullet lodged—Not extracted—No operation—Recovered.

CASE 31.—Sergeant-Major J., wounded 20th April, 1902; admitted 20 General Hospital 18 days later. Entrance at occip. protub.; bullet lodged in neck close below base of skull (Fig. 2). Lost speech for three hours, but not consciousness; paralysed in all limbs for five days, when motion began to return in legs; not to arms for another week; full power over all except left arm on admission; pain in neck and head; large bedsore over sacrum. Bedsore healed slowly, and muscular power increased.—(Lieutenant PRESCOTT, R.A.M.C.)

Gutter—Septic—Paralysis—Hernia—Operation—Recovered.

CASE 32.—Private J., wounded 6th May, 1901; admitted 20 General Hospital 24 days later. Wounds in mid-line of vault; entrance 5 inches in front of occip. protub.; exit close in front of occip. protub. Unconscious for quarter of an hour; paralysis with loss of sensation in both legs and right arm. Operation; "loose bone removed." Arm recovered, and after four months could move legs slightly, but he suffered much from headache; aperture 1½ inches long in vertex, with dead bone; visible pulsation of brain. Trephined 109th day over motor area right leg; dura adherent to skull; sub-dural blood clot size of a shilling; drain left in. Wound suppurated; hernia formed; restless and dazed; paralysis returned. Hernia increased; explored by needle, but no abscess struck. When invalided six months after being wounded, all limbs were more or less paralysed; hernia reduced in size; intelligent, and in fairly good health.—(Hospital Records.)

Gutter—Paralysis—Aphasia—Operation—Recovered.

CASE 33.—Driver C., wounded 1st April, 1901; admitted 20 General Hospital 17 days later. Had been operated on in field hospital for "gutter" fracture of parietal; depressed bone removed; much improvement followed. Now has complete aphasia; paralysis right face and paresis right hand; tongue protruded to right; quite intelligent otherwise. Three days after, sudden improvement in aphasia. Invalided 54th day; aphasia lessening; still some paresis in face and hand.—(Lieutenant BRANSBURY, R.A.M.C.)

Gutter—Paralysis—Operation—Hernia—Died. (Lat. venticle invaded.)

CASE 34.—Boer prisoner, Du T., admitted 6 General Hospital 20th October, 1900. Bullet had grooved outer table in right parietal region for 2 inches; brain matter escaping freely. Hemiplegia and pyrexia. Three days later explored; outer table chipped with forceps; large amount of damage to inner table; loose pieces removed; large cavity extending vertically into parietal lobe, from bottom of which a piece of inner table was removed. Hernia size of tangerine orange formed, and was removed 11 days later; temperature, 100° to 103° F.; free suppuration. After this patient became violent, and tore off bandages; meningitis and coma. Died 29 days from admission.

Post mortem.—Laceration extending to level of lateral ventricle; both lateral sinuses filled with purulent fluid; purulent basal meningitis.—(Civil Surgeon MAXWELL.)

Gutter—No paralysis (deafness)—No operation—Recovered

CASE 35.—Trooper H., wounded 20th July, 1901, at 30 yards range; admitted next day 26 Stationary Hospital. Entrance middle of right mastoid proc.; exit 1 inch above upper part of right ear—3 inches distance between wounds.

Remembered nothing for half an hour after injury. Now deaf in right ear; no paralysis. No operation, but a few pieces of bone removed at dressing two days after admission. Healed when transferred a month later.—(Captain EVANS, R.A.M.C.)

Gutter—Paralysis—Aphasia—Operation—Hernia—Recovered.

CASE 36.—Sergeant M., wounded 4th February, 1902; brought in 45 miles to 26 Stationary Hospital. Entrance left side of mid-line, over coronal suture; exit 3 inches farther back, on same side, near lambdoid suture, and same distance from mid-line. Unconscious; right motor hemiplegia—no sensory disturbance; brain substance exuding from exit. Trephined; "gutter" 2 inches long; removed much depressed bone; dura could not be brought together; wound closed. Stitches suppurated; hernia formed, which disappeared under pad, and pressure; paralysis cleared up a good deal; speech improved. Transferred a month later in fair general condition, but with speech thick.—(Civil Surgeon CARRON.)

Gutter—Septic—Coma—Operation—Died. (Lat. ventricle damaged).

CASE 37.—Private H. E., wounded 9th February, 1901; admitted 17 General Hospital six days later. Large suppurating scalp wound over front of left parietal; gutter fracture of both tables for 3 inches; large mass of protruding brain. Roused with difficulty; breathing deep; pulse slow; left pupil dilated and fixed; no paralysis of limbs, nor incontinence; probe passed 4 inches into brain. Next day hole enlarged to admit finger; no loose bone; irrigated. Four days after had paralysis right face, arm, and leg; died following day,

Post mortem.—Large track from wound to lat. ventricle, in which were found small pieces of bone; softening of motor area.—(Lieutenant SIMSON, R.A.M.C.)

Gutter—Septic—Paralysis—Aphasia—Operation—Recovered.

CASE 38.—Lance-Corporal S., wounded 21st October, 1899; admitted Maritzburg. Comp. comm. depressed fracture of parietal; septic.

Paralysis and aphasia. Trephined; removed spicules of bone from brain. Satisfactory; sent to Wynberg 18 days later; recovered from paralysis, but still aphasic.—(Civil Surgeon JOHNSTON.)

Gutter—No paralysis—Operation—Recovered.

CASE 39.—Captain C., admitted 1 General Hospital with horizontal gutter fracture right frontal, below hairy scalp. Had been operated on, and splintered bone removed. "Dura exposed, but brain not injured. Now healing; memory somewhat impaired, and rather light-headed at night." Also signs of a cavity in right apex. Discharged on leave seven weeks later, wound healed.—(Civil Surgeon WATSON.)

Gutter—Paralysis—No operation mentioned—Recovered.

CASE 40.—Captain B., wounded 10th December, 1899; transferred to 1 General Hospital three months later. "Gutter" fracture obliquely across post. end of sagittal suture, now healed. At time of injury complete paraplegia; now only some headache, and weakness in legs. Invalided 10 days after admission to 1 General Hospital.—(Civil Surgeon WATSON.)

Gutter—Septic—Paralysis—Jacksonian epilepsy—Operation—Died.

CASE 41.—Lance-Corporal D., admitted 1 General Hospital with sceptic wound across upper and back part of left parietal. Complete paral. right leg; weakness right arm; Jacksonian epilepsy. Operation; parietal found guttered for 2½ inches; several pieces of inner table driven into brain; brain tissue much damaged, began to ooze out. Improved for three days, when temperature rose to 105°, and he died next day.

Post mortem.—Extensive suppurative meningitis; brain tissue over leg area destroyed.—(Civil Surgeon THORNTON.)

Gutter—Septic—Paralysis—Aphasia—Hernia—Operation—Recovered.

CASE 42.—Lieutenant S., wounded 28th September, 1900, at 200 yards range; admitted 3 General Hospital five days later.

"Gutter" of vertex 2½ inches long, in antero-post. direction, to left of mid-line, parietal area. Was trephined on day of injury by Lieut.-Colonel Murray, R.A.M.C. Two discs and loose bone removed from "gutter." Motor and sensory paral. right leg, arm, and face; aphasia; perfectly conscious but cannot make himself understood, and then gets irritable and noisy; control

over sphincters; pupils equal; twitchings and spasmodic rolling of eyes to right; septic; brain protruding. Wound re-opened two days after; hernia pared down; sharp edges of gutter removed; fissure from gutter towards mid-line.

When transferred to Cape Town three months later, spoke slowly; fair movement in leg and arm; no pulsation in scar.—(Major POOLE, R.A.M.C.)

Gutter—No paralysis—Operation—Recovered.

CASE 43.—Lieutenant W., wounded 28th December, 1900; Mauser, at 2,500 yards range; admitted 3 General Hospital next day. Entrance and exit small; former on left and close to mid-line, about centre of sagittal suture; latter 2 inches distant, downwards and backwards, over left parietal emin. Unconscious for ½ hour after injury; no paralysis nor aphasia. Trephined; gutter 1½ inches long, with depressed comm. inner table; loose spicules removed; torn dura sutured; gauze drain. Progress good. Invalided a month later.—(Major POOLE, R.A.M.C.)

Gutter—Paralysis—Aphasia—Operation—Recovered.

CASE 44.—Burgher boy (aged 14), W. B., admitted Heilbron, 18th February, 1902. Entrance 5 inches above left ext. aud. meatus; exit same side 2 inches above orbit; comminuted bone in the 5-inch track between. Aphasia and right hemiplegia. Wound explored; loose bone removed. Hernia formed, but disappeared under treatment; paralysis improving; was learning English words—having forgotten Dutch—three months after, when discharged. One month later walked with limp; could speak words but not frame sentences.—(Civil Surgeon BOYD.)

Gutter—Paralysis—Aphasia—Operation—Recovered.

CASE 45.—Private M., wounded 11th December, 1899; admitted Orange River Field Hospital four days later. Entrance and exit 3 inches apart, over left motor area, one above the other in vertical line. Aphasia; right hemiplegia; tongue protruding to right; right ptosis. Explored; skull much broken up between entrance and exit; brain much lacerated; loose pieces of bone removed. One week later, when transferred to base, paralysis had improved a little, and he could make himself understood in words.—(Hospital Records.)

Gutter—Paralysis—No operation—Recovered.

CASE 46.—Captain H., wounded 3rd November, 1899; admitted Ladysmith same day. Large lacerated wound of scalp, with fracture of skull in left temporal region (piece of shell).

No symptoms except twitching of fingers of right hand. Wound dressed; kept under observation; next day paralysis right arm, and to less extent right leg; this soon passed off, leaving only slight paralysis of hand; several small fragments of bone came away; wound granulating, but bare bone still seen and felt in centre.

Wound immediately over motor area, but speech not affected. On 83rd day was sufficiently recovered for duty at home (Medical Board opinion).—(Records Ladysmith).

Gutter—Operation—Died.

CASE 47.—A. (Royal Naval Brigade), received from 12 Field Hospital into Ladysmith, 5th December, 1899. Wound immediately over outer end right superciliary ridge, extending upwards and inwards for about 2 inches. Cold and pulseless. Removed two pieces dead bone two days later; next day good pulse; temperature "up a bit"; excited talking and delirium; died six days later.—(Colonel BRUCE, R.A.M.C.)

In all of the cases many of the symptoms detailed were present together; but Table 3 serves to show, amongst other things, that in this particular series, paralysis, aphasia, and Jacksonian epilepsy were not symptoms of fatal import; while coma, abscess, and hernia cerebri were present in 10 out of 12 which died.

The treatment of "gutter" fractures will be referred to with that of the other types of fracture at the end of this section.

The principal symptoms present in these cases are shown in Table 3, as well as the numbers of recoveries and deaths, &c. To the cases noted above, 13 others, of which full details are not available, but in which the results are known, have been added, making the total up to 60.

TABLE 3.—Gutter Fractures of the Skull (60 Cases).

Symptoms present.	Paralysis.	Aphasia.	Jacksonian epilepsy.	Coma.	Abscess of brain.	Hernia cerebri.	Operation.	No operation done.	Total.	Percentage.
Recovered	29	15	7	2	6	5	33	14	47	78·3
Died	6	1	1	4	4	3	12	1	13	21·6
Total	35	16	8	6	10	8	45	15	60	—
Percentage of cases in which the above conditions were present ..	58·3	26·6	13·3	10·0	16·6	13·3	75·0	25·0	—	—

PENETRATING GUNSHOT FRACTURES OF THE SKULL.

The injuries of the skull to which the term "penetrating fracture" is meant to refer are those in which there is only one aperture in the calvarium. In the majority of these cases, when they are caused by rifle bullets, the missile penetrates the skull, but lodges there, not having sufficient energy to carry it through at the opposite side; but there is no necessary relation between mere penetration and lodgment of the bullet. While it is true that in the great majority of these cases lodgment does occur, in some the bullet would seem to have rebounded and failed to enter the skull, this being the only possible explanation of the occurrence. Some cases of this kind are produced by rifle bullets travelling at low rates of velocity, and many of them are the result of fracture by fragments of shell or by shrapnel bullets. The aperture at the site of fracture is seldom of the typical size or circular shape usually produced by a rifle bullet which penetrates the skull; it is more often a fracture of irregular shape, triangular or more or less square in form, and larger than the ordinary entrance-hole usually produced in the skull. Sometimes the aperture left in the skull represents a wide area, and in all cases the fragments depressed or driven into the dura and brain are of larger size than the comminution fragments which are seen in perforating cases, but they are not driven in so far as they are in the latter; nevertheless, the laceration of the meninges and brain substance due to them is often of considerable extent. These more extensive injuries are usually seen in shell and shrapnel cases, and in these lodgment is uncommon, at least in those cases which reach the field hospitals. Fissures proceeding from the sides and corners of the aperture are common, but they are seldom of great length—perhaps 2 inches or 3 inches at the outside. Naturally, in consequence of the greater superficial size of these injuries hæmorrhage within the cranium is not an uncommon complication; and, for the same reason, septic changes in the wound are very liable to occur. Depression and large fragmentation are the special characteristics of this class of fracture when due to shell injuries. As it happens, there are no notes of cases showing penetration by rifle bullets without lodgment at present available, but cases were seen during the war.

Bullet usually lodges in these cases;

But not always.

Entrance often irregular and large.

Considerable injury to dura and brain.

Fissuring common.

Cases likely to become septic.

As a quite exceptional occurrence, lodgment of the bullet at the site of fracture sometimes takes place. An instance of this condition is detailed in the notes of cases on a later page, and a photograph of the bullet (a Mauser) and of the piece of bone in which it was embedded will be found at the end of the section, Fig. 4.

Bullet lodged at entrance side.

The following notes show concisely the salient points of these cases :—

Penetration—Paralysis—Bullet lodged—Operation—Extracted—Recovered.

CASE 1.—Private O'L., admitted Maritzburg 18th December, 1899, with left hemiplegia and diplopia. A bullet was removed from left side of occipital bone, through which latter the nose was protruding. Entrance in right temporal bone, causing star fracture; depressed bone elevated; brain matter exuded from both wounds. Recovered.—(Civil Surgeon HALL OWEN.)

Penetration—Fracture of base—Septic—Coma—No operation—Died.

CASE 2.—Private P., wounded at 100 yards range, 10th March, 1901; admitted 12 General Hospital next day. Entrance over middle of back of neck $\frac{3}{4}$ inch to right of middle line, small, circular, and clean; exit similar, $\frac{1}{2}$ inch below right malar prominence. Headache; no fracture of lower jaw detected; buccal cavity not entered; slight ecchymosis behind right ear and under right conjunctiva. Wounds cleaned, and sealed with gauze and collodion. Six days later, temperature 101° F.; ecchymosis under both conjunctiva; twitchings of right limbs; drowsy. Gauze removed; wounds quite healthy. Two days later, insensible; temperature, 107°; right pupil widely dilated, left contracted. He died that afternoon.

Post mortem.—Pus at base and around pons, spreading up over left Rolandic area. (He lay on that side.) Semi-gelatinous lymph over both Rolandic areas. Great wing of sphenoid and adjoining petrous bone fractured into foramen lac. med., the piece being loosely attached. Neck of condyle of jaw fractured; the latter had evidently been forced through base.—(Major LOUGHEED, R.A.M.C.)

Penetration—Paralysis—Coma—Abscess—Bullet lodged—Not extracted—Operation—Died.

CASE 3.—Major-General W., wounded 24th January, 1900; admitted next day 4 Stationary Hospital. Entrance at ext. angle right orbit; no exit. Much bruising right malar and eyelids; vision lost in that eye; delirious; signs of irritation of brain, but no paralysis. Explored; "track passed horizontally backwards and inwards above base of skull, causing extensive fissuring of bones"; bullet not found; wound plugged with gauze. A week later no change; wound again explored by Sir F. Treves; several loose pieces bone removed, and eyeball excised. Nineteen days later admitted Mooi River. Sinus right temple; feeble-minded, restless and noisy, but with rational intervals; partial paralysis left leg. Operation refused by his relatives till coma developed 23rd March, 1900, when Sir W. Stokes trephined in right zygomatic fossa, where entrance-hole in skull was found; removed eight pieces dead bone, and struck abscess in frontal lobe; evacuated 2 ozs. pus. Movement in leg returned, but not consciousness; died three hours later.—(Major HACKETT, R.A.M.C.)

Penetration—Coma—Bullet lodged—Not extracted—Operation—Died. (Lat. ventricle damaged.)

CASE 4.—Trooper E., wounded 9th September, 1900. Entrance 3 inches directly above tip of left mastoid process; no exit. Twitchings right arm; convergent strabismus; pupils equal, contracted and inactive; comatose. Aperture examined; hole in skull size of Mauser bullet, with clean edges; some splinters of bone removed. Died four days after.

Post mortem.—Inner table more fractured and depressed; track through ant. of left occipital, and bullet lodged in right temp. sphenoid lobe, resting on petrous bone. Both lateral ventricles filled with blood clot.—(Civil Surgeon GREEN.)

Penetration—No signs of brain injury—Bullet lodged—Not extracted—Operation—Recovered.

CASE 5.—Trooper M., Canadian Contingent, admitted 13 General Hospital 5th April, 1902, with small scab over frontal bone, due to gunshot wound. No brain symptoms—seemed perfectly well. Wound probed; probe passed into skull; dry gauze dressing. Six days after temperature rose and brain symptoms appeared; restless; quite unaccountable for his actions. Next day trephined; spicules of bone removed; dura found lacerated; drained. On 17th day brain symptoms again appeared, and he was explored day following. Pus under scalp above right ear evacuated; it was found to be issuing through a fracture here, from abscess in brain 3 inches deep; trephined, and abscess

drained. Completely recovered in two months; invalided; X-rays showed bullet at base of brain.

This man returned to Canada 4th September, 1902, from Royal Victoria Hospital, Netley.—(Civil Surgeon MALCOLM.)

CASE 6.—Trooper T., wounded 20th July, 1901, at 30 yards range; admitted 26 Stationary Hospital next day. Left mastoid process shattered, base skull fractured, and bullet lodged in muscles of neck. Abundant discharge of cerebro-spinal fluid from ear. Pieces of bullet were removed from neck, and some pus beneath cervical fascia was evacuated. Case did well; transferred convalescent eight weeks after wound.—(Captain EVANS, R.A.M.C.)

Penetration—No signs of brain injury—Bullet lodged—Extracted—Recovered.

CASE 7.—Private C., wounded 5th February, 1902; admitted 26 Stationary Hospital next day. Entrance at post. super. part of left parietal; no exit. Edges of wound jagged and contused; brain protruding; semi-coma; right hemiplegia, motor and sensory; paralysis right face; aphasia. Trephined following day; two trephine discs and some splinters removed; wound in dura enlarged; mid. meningeal tied; irrigation; dura sutured; no drain; no bullet found. After operation, control over sphincters returned; became quite conscious, and could say "Yes" and "No" intelligibly, but had signs of cerebral irritation—crying out, and rolling head. About 3½ months later invalided to base; could walk with assistance; arm in sling; could play cards.—(Lieutenant HARDING, R.A.M.C.)

Penetration—Paralysis—Aphasia—Bullet lodged—Not extracted—Abscess—Operation—Died.

The final details of this case are as follows:—

Arrival Netley 5th June, 1902. Condition then is said to be the same. X-rayed. Numerous small particles of metal seen scattered through the brain substance. Temperature normal or sub-normal. Has the usual signs of cerebral irritation, but no fits. Died suddenly 16th July, 1902.

Post mortem (29 hours after death).—On removing skull, brain substance protruded over motor area on left side, and large cyst-like swellings could be felt in the brain. Lateral ventricle on right side dilated, and contained considerable amount of fluid. On the left side a round, fluctuating swelling projected into the lateral ventricle. Opened and found to contain 3 ozs. greenish pus. Wall of abscess thick and firm, and could be shelled out of brain easily; five other abscesses of similar character, varying from size of hazel-nut to that of an egg, occupied upper portion of temp. sphenoidal, anterior part of occipital, and posterior part of parietal lobes. Embedded in brain substance near anterior and lower portion of posterior cornu of left lat. ventricle were many small pieces of lead, none larger than ⅛ inch diameter, also a small fragment of bone about ¼ inch long. All these were embedded in fibrous tissue.

CASE 8.—Private F., wounded 24th January, 1900; admitted 4 Stationary Hospital next day. Entrance at post. part right parietal; no exit. Conscious, but drowsy; no paralysis; vision impaired; brain substance oozing. Operation following day; depressed edges removed; one piece of bone removed from brain. No improvement; died 12 days later. No *post mortem* made.—(Records, 4 Stationary Hospital.)

Penetration—No paralysis (vision affected)—Bullet lodged—Not extracted—Operation—Died.

CASE 9.—Trooper McC., wounded 28th November, 1900; admitted 2 General Hospital five days later. Entrance small, to left of occip. protub.; scalp here swollen, and bullet felt underneath, and seen by skiagraph. Slight headache—the only symptom. Flap turned down; Mauser bullet, bent at an angle of 45 degrees at its middle, with envelope torn and stripped, found loosely embedded in bone and removed; no fissuring from aperture; trephined; several loose pieces of bone removed from surface of dura; latter uninjured; perfect recovery. *Vide* Fig. 4.—(Lieut.-Colonel SYLVESTER, R.A.M.C.)

Penetration—Bullet lodged—Operation—Extracted—No signs brain injury—Recovered.

Penetration—No paralysis (cerebral irritation)—Bullet lodged—Operation—Bullet extracted—Recovered.

Case 10.—Boer prisoner, B., wounded at long range, 2nd June, 1903; admitted 9 General Hospital five days later. Entrance small and circular, 4 inches above and slightly post. to right auricle; no exit. Continued to ride for 300 yards to farm after being hit. Quite conscious, but with cerebral irritation—very restless; severe pain in head; pupils contracted and equal; temperature, 101° F. Trephined morning after admission; small round aperture in bone, with slight furrow leading to it, and two or three fissures; a good deal of splintering inner table and two discs removed; small hole in dura closed with lymph, probed—no discharge.

Symptoms disappeared; seemed perfectly well a fortnight later. Three weeks later severe pain in back of head, with vomiting. X-rayed; bullet seen under skull opposite side, 3½ inches above post. border of auricle. Trephined again here; dura opened and bullet extracted, some yellowish fluid escaping; dura stitched, and bone replaced. Temperature and vomiting for three days, but sent to camp quite recovered in a month.—(Captain Cameron, R.A.M.C.)

Penetration—Paresis—Bullet lodged—Operation—Bullet extracted—Died. (Lat. ventricles damaged.)

Case 11.—Private A., wounded accidentally by Lee-Metford on range, 9th July, 1903. Entrance on Reid's ant. vert. line, left side, 2½ inches from upper end; no exit.

Fell down when hit, asking if he "was killed"; 15 minutes afterwards got up and walked half a mile with assistance; vomited; right paresis and anæsthesia—face and extremities; pupils dilated, but reacting; quite conscious.

"Probe passed easily downwards and forwards for 3 inches." X-rays showed bullet lodged in right post. occipital region.

Trephined entrance, and removed splinters and blood-clot; probe passed along track detected bullet; failed to remove latter with forceps; trephined over site, 2¾ inches behind ext. aud. meatus, and 1¼ inches above Reid's base line; an elevated fracture found here, with small hole in dura; bullet extracted from brain ¾ inch deeper—had rebounded back after fracturing skull. No improvement; oozing of blood and serum into dressings; died fifth day.

Post mortem.—Two ounces of blood and serum escaped from sub-dural space, but "no sign of meningitis"; lat. ventricles perforated, contained blood and clot—"not dilated." Small hæmorrhages in many situations in brain substance and on the surface. Brain extensively pulped.—(Captain Morgan, R.A.M.C.)

Penetration (shell)—Fragment lodged—Operation—Died.

Case 12.—Lieutenant P. D., wounded 27th December, 1899; admitted Ladysmith same day.

Punctured fracture 2 inches to left of occipital protub.; hole in skull ⅓ inch, irregularly square, with firm sides; no appearance of depressed bone; right pupil contracted, does not respond to light; left, normal; breathing good; pulse 60, slightly jerky and irregular. Removed piece of detached bone ⅓ inch square. Next day slight paresis right arm; both pupils slightly dilated, but responding to light. Died fifth day.

Post mortem.—Post. half left cerebrum smashed into pulp; left ventricle opened; right hemisphere also wounded; several fragments of bone and squarish piece of shell ½ inch by ¼ inch found in pulp.—(Records, Ladysmith.)

TABLE 4.—Penetrating Fractures of the Skull (12 Cases).

Symptoms present.	Paralysis.	Aphasia.	Jacksonian epilepsy.	Coma.	Abscess of brain.	Hernia cerebri.	Operation on bone.	No operation on bone.	Total.	Percentage.	Bullet lodged within the skull.	Bullet extracted.	Bullet not extracted.
Recovered	1	—	—	—	—	—	4	1	5	41·6	4	3	1
Died	4	1	—	3	1	—	6	1	7	58·3	5	1	4
Total	5	1	—	3	1	—	10*	2	12	—	9	4	5
Percentage of cases in which the above conditions were present ..	41·6	8·3	—	25·0	8·3	—	83·3	16·6	—	—	75·0	44·4†	55·5†

* Of the cases operated on 60·0 per cent., and of those not operated on 50·0 per cent, died.
† Of the cases in which it lodged.

In the above table the heading "Operation" refers to operative procedures for the purpose of removing or elevating loose or depressed fragments of bone, and is exclusive of those carried out for extraction of lodged bullets; 83·3 per cent. of penetrating fractures required the operation of trephining, or such modification of it as is usually sufficient for the purposes named, and of these severe cases 60 per cent. died.

"Operation" does not include extractions of bullets.

Death rate for operations.

In every case, except one, in which penetration was due to actual contact of the skull by a bullet, the missile lodged, nine cases in all. Penetration in one of the two exceptional cases was through the base of the skull; the bullet struck the side of the condyle of the lower jaw, forcing it through the glenoid fossa and into the brain, and in the other it fractured the mastoid process and lodged in the neck, the bullet itself, in neither case, entering the cranial cavity. Of the nine cases in which the bullet lodged within the skull four recovered and five died. The bullet was extracted in four cases, of which one died. Of the five cases in which the bullet was not removed by operation four died and one recovered, but one of these fatal cases lived long enough to reach Netley, where he died suddenly a little over five months after the date of the wound (*vide* Case 8). The other case which returned to England with a bullet still within the cranial cavity recovered completely and returned to his home in Canada (*vide* Case 6).

Bullets lodged in all but three.

Exceptions.

The death which followed extraction of the bullet in one of the above cases probably had no connection with the operation for that purpose; the general injury to the skull and brain was already so severe that recovery was hardly to be expected. (*See post mortem* in Case 12.)

PERFORATING GUNSHOT FRACTURES OF THE SKULL.

(61 Cases.)

Judging from the number of cases of which notes are at present available, it would appear that the proportion of gutter fractures and of complete perforations of the skull were about the same. Of the total 133 fracture cases 45·1 per cent. were gutters, and 45·8 per cent. were perforating fractures, a ratio which will probably prove about correct for the whole war. But with regard to the comparative frequency of the two types of injury, it should be remembered that probably all the gutter fractures reached the field hospitals for treatment and observation, while not nearly all the perforating fractures did so, a considerable proportion of them dying on the field.

Proportion of gutter and perforating cases about the same as seen in field hospitals.

The amount of injury caused both to the bones of the skull and to the brain substance in the perforating cases varied very considerably, and, as might be expected, depended almost exclusively on the velocity of the bullet at the moment of its passage through the skull. When produced at short ranges the damage to these structures, and especially the pulping of the brain substance, was so extensive that the cases died immediately or within

Injury to bone in perforating cases.

a few hours, so that but few of them reached the field hospitals. This was in accordance with previous experience, which shows that these cases, and particularly when the bullet track implicates the posterior and middle fosse, are almost uniformly fatal; the deeper these perforations are, that is the further they are from the vertex, the graver is the prognosis, in consequence of the greater likelihood of fracture of the base of the skull further adding to the dangers of the case. At quite short ranges large portions of the calvarium may be completely blown away; but cases of this kind are usually accidental or suicidal.

Injuries to posterior and middle fosse very fatal.

Bullet tracks close to base very fatal.

It is of interest to consider the cause to which these severe injuries may be due; it is therefore suggested that it is probable that the old theory of "hydraulic effect," which must be so much discounted when put forward as explaining the production of the so-called "explosive effect" seen to be produced in the limbs by modern projectiles at short ranges, and where bone is fractured, may have much to do with the occurrence of cases of very extensive injury to the skull and brain. Unlike the condition of the limbs in this connection, the skull is full in the sense that nothing can be suddenly added to its contents without causing its rupture with great violence, due to the hydraulic or wave action communicated to the practically fluid brain substance by the bullet. The contents of the inelastic calvarium is suddenly added to by the bulk of the bullet, with the result that the natural sutures are separated, extensive fractures of vault and base are produced with fissures running in all directions, and the brain matter is pulped throughout its entire extent. If this explanation be accepted as correct, it would also serve to account for the rapid decrease of the severity of gunshots of the head as the range increases, for the importance of the time element must here be acknowledged to be great. Even at ranges of over 150 yards the general destruction to brain and bone has very greatly diminished, and this would be due to the lessened rapidity with which the slower travelling bullet enters the cavity of the skull, and to the consequently diminished hydraulic effect produced within it; for it is certainly true that, as a rule, the injuries caused at and over 150 yards are much less extensive; fissuring is often slight and confined to the regions about the two apertures, and the brain substance is pulped only in the immediate proximity of the bullet track. These are the cases which reach the field hospitals for treatment; the majority of the others die where they fall.

"Hydraulic effect" may have some influence as regards severity of the bone damage.

Rapid decrease of injury to brain and bone with increase of range.

While the general rule above mentioned, that the extent of the injury decreases with increase of range, holds good, it is also true that at extreme ranges, over 1,800 yards, fractures of greater severity than might be expected are seen to occur. There are two reasons for this: (*a*) At long ranges the bullet is travelling at a tangent to the most perpendicular section of its trajectory; and (*b*) it has by this time, in consequence of loss of velocity, taken on a wobbling motion on a centre at about its shoulder. The result of both these conditions is that it strikes against an object with a more extended surface, that in fact its energy is expended over a larger area. It is probably due to these facts that injuries of a greater extent than the known lessened velocity of the bullet would lead one to expect are sometimes produced in the skull, as well as in other situations, at long ranges. It will readily be perceived that the wobbling motion of the bullet and its tangential position on its trajectory when that line most nearly approaches the perpendicular, tend at one time to counteract each other, and at another to increase the obliquity with which the bullet strikes an object. To this fact it is probably due that all long-range fractures are not of the more severe kinds; that some of them appear to follow the general rule of a steady decrease in the degree of comminution seen in them, and that others do not.

Probable explanation of severe cases at long ranges.

Perforating gunshot fractures of the skull, naturally, present two apertures, which may be close together or far apart, and they may be divided into two classes according to the distance which separates the entrance from the exit holes. Civil Surgeon L. G. Irvine, who was attached to the General Hospital, Pietermaritzburg, has sent to the War Office an excellent report on his surgical experiences while doing duty in that hospital.

Civil Surgeon L. G. Irvine's report on head cases.

Referring to perforating gunshot fractures of the skull, he divides them into "Superficial" and "Deep Perforating Fractures"; in the former the two apertures are close together, and in the latter they are far apart. In the

superficial fracture the arc of the vault of the skull subtended by the line joining the two apertures is small; in the deep fracture this arc is large. Mr. Irvine states that of these two types of perforating fractures, he considers the superficial fracture the more fatal, and points out that this is in consequence of the greater amount of damage done to the grey matter of the brain in these cases. This was so, no doubt, in the particular series of cases which came under his personal observation; but that a general conclusion that a superficial perforation of the skull and brain is less fatal than a deep one should be drawn from the results seen in 12 cases—four superficial and eight deep—is very doubtful. It should be remembered that all the cases observed by Mr. Irvine had lived long enough to reach the Maritzburg General Hospital, and could not, therefore, have been cases of the severest types. It is evident that the symptoms of paralysis are more likely to be well marked in superficial cases, in consequence of the more extended interference with motor areas, but it is probable that centres of more immediately vital importance may be interfered with when the bullet traverses the brain at a deeper level, and closer to the base of the skull, a condition which certainly tends to an increase of the gravity of the injury.

Superficial perforations may be more fatal than the deep ones.

Motor areas may be extensively injured in superficial cases.

Unfortunately this is a question which the full statistics of the war is not likely to determine, because other medical officers have not classified their head cases under these categories; but it would have been an interesting point to have had settled.

The following notes bring out, as concisely as possible, the salient points of these cases:—

Case 1.—Trooper E., admitted to 14 General Hospital 22nd July, 1901. Entrance to right of mid-line of head behind parietal eminence; exit above and behind mastoid process same side; both septic. Left hemiplegia; intellect, clear; temperature, 102° F.; dressed. Discharge continued offensive. Four days after flap raised, disclosing a smashing up of parietal bone for 3 inches; all loose bone removed; gauze drain. Much oozing, followed by coma and death same evening.

Perforation—Septic—Paralysis—Operation—Died.

Post mortem.—Laceration of brain in wound area, with suppurative meningitis. Two large pieces of bone driven ½ inch into brain.—(Lieutenant Parry, R.A.M.C.)

Case 2.—Private P., admitted Spearman's Hill 22nd January, 1900, two days after a gunshot wound through right upper parietal region. Entrance and exit clean; partially conscious; marked paralysis left arm, and paresis left leg; temperature, normal; partial control of bladder and rectum. Four days later violent convulsions left arm, total loss of consciousness, and deviation of eyes to left. Explored; small splinter of depressed bone removed. Convulsions ceased on awaking from anæsthetic. Recovered.—(Major Caldwell, R.A.M.C.)

Perforation—Paralysis—Coma—Jacksonian epilepsy—Operation—Recovered.

Case 3.—Private B., admitted 9 General Hospital 11th March, 1902, for gunshot wound back of head, caused by accident same day. Quite unconscious; temperature, 100·2°; pulse, very weak. One wound at base of occipital bone, near mid-line; another 3 inches above this. Scalp much singed; brain exuding from both wounds. Scalp shaved; wounds dressed. Next day discharge very offensive; fractured pieces of bone, and hernia cerebri removed. Following day could distinguish light from darkness; temperature, 100° F. Could count fingers a week after; temperature, normal; remembers nothing of the accident. Improved till 2nd April, 1902, when he became partially comatose, with vomiting, and temperature 104°. Improved again, and seven weeks after admission was up and walking with assistance; double optic neuritis—bilateral homonymous hemiopia of left fields. Invalided.—(Major Watson, R.A.M.C.)

Perforation Septic—Blindness—No paralysis—Hernia—Operation—Recovered.

Case 4.—Captain E. T., wounded 30th April, 1900; admitted Bloemfontein two days later. Entrance over ext. ang. process left frontal; bullet

Perforation—Operation—Recovered. (Loss of both eyes).

passed through both orbits, destroying eyeballs, and traversing cranial cavity at ethmoid; exit through upper part of right eyelid; brain substance exuding into right orbit. Both globes removed; right conjunctiva sutured; left drained. No rise of temperature; all wounds dry when invalided three weeks later.—(Lieutenant SMITH, R.A.M.C.)

Perforation—Aphasia—No paralysis—Operation—Recovered. (Eyeball removed.)

CASE 5.—Corporal W. D., wounded 11th December, 1899; admitted to General Hospital a few days later. Entrance upper left frontal region, close to hairy scalp; exit in left orbit, disorganising globe. No paralysis, but speech considerably affected.

Trephined five days after injury; much depression of inner table found at entrance, which was elevated and removed. Speech returned. Good recovery. Left globe removed.—(Civil Surgeon ROBERTS.)

Perforation—No paralysis—No operation—Recovered. (Vision lost.)

CASE 6.—Corporal C., wounded 18th February, 1900, at 450 yards range; admitted 2 General Hospital a few days later. Entrance small, 1½ inches behind and a little below ext. ang. process frontal bone; exit ¼ inch above and behind left ext. ang. process. States that he saw with right eye for half an hour, and with left for one hour after injury; totally blind since; much headache; proptosis, most marked on right; conjunctivitis both eyes, and œdema of right lid; pupils dilated, not responding to light. Headache disappeared, but vision had not improved when invalided.—(Major LOUGHEED, R.A.M.C.)

Perforation—Septic—Paralysis—Aphasia—Jacksonian epilepsy—Operation—Recovered.

CASE 7. Private P. C., wounded by Mauser at 100 yards range, 22nd October, 1900. Semi-conscious, and did not speak for three days. Admitted to 12 General Hospital five days after injury. Entrance 1 inch postr. to centre vertical line drawn from mastoid apex and 4 inches above mastoid apex; exit 3 inches above ext. occipital protuberance and 1 inch to left of median line. No depressed bone felt between. Right hemiplegia and paresis right face; right knee jerk exaggerated; Jacksonian epilepsy; ataxic aphasia. Trephined entrance wound; dura, blue from clot beneath, was incised, and 2 ozs. clot removed; brain then pulsated; dura sutured, but drainage tube put it. Next day had two fits, and became violent, requiring chloroform; no fits after. Wound closed; paralysis disappeared; speech recovered; invalided quite well.—(Major LOUGHEED, R.A.M.C.)

Perforation—Paralysis—Operation—Recovered.

CASE 8.—Private J. D., wounded 11th December, 1899; admitted Orange River two days later. Entrance small, circular, with fissuring over right parietal eminence; exit much larger, irregular with jagged edges, 2½ inches above centre of right eye-brow. Pupils dilated, active; deafness; complete motor paralysis left leg and partial left arm; sensation impaired; signs of central irritation. Large flap turned down; much broken-down brain and clots removed from entrance, also 3¼ inches depressed bone, besides smaller pieces; many small fragments removed from exit. Two days after op. movement began to return in leg, and when invalided "sensation greatly improved, also power over leg; some improvement in arm."—(Hospital Records).

Perforation—No symptoms—Operation—Recovered.

CASE 9.—Private J. A., wounded 11th December, 1899; admitted Orange River, two days later. Entrance 2 inches above inner corner right orbit; exit 4 inches above ext. aud. meatus same side. Brain oozing from exit wound; only headache. Many loose pieces of bone removed; no fissure between entrance and exit holes. Had epileptiform seizure next day, but no others, and felt very well when transferred to base.—(Hospital Records).

Perforation—Paralysis—Aphasia—Jacksonian epilepsy—Operation—Recovered.

CASE 10.—Private J. D., entrance in occipital bone, a little behind left lambdoid suture; exit close behind left coronal suture, 1 inch from mid-line; brain oozing from latter. Headache; partial right hemiplegia—sensation impaired; aphasia—unable to protrude tongue; pupils widely dilated; some

rise of temperature, and next day many epileptiform fits—head and eyes turned to right. Loose pieces of bone removed from both wounds, after which convulsions continued for two days, and urine and fæces were passed invol. Latter ceased in a week; paralysis and speech improved; sensation not much better; pupils still dilated when he left for base.—(Hospital Records).

Perforation—Paralysis—Aphasia—Jacksonian epilepsy—Operation—Recovered.

Case 11.—Private E. J., wounded 3rd November, 1901; left with Boers. When brought in was semi-conscious; pupils dilated; pulse 48; speechless; passed urine invol.; right hemiplegia; no loss of sensation; clonic convulsions right side. Wound on left side of head 4 inches above, and 2½ inches behind ext. ang. process frontal bone; another 4½ inches behind. Trephined; brain oozing out; large number fragments removed from extra-dural space and from brain; cortex much lacerated; irrigated. In a week's time could speak a little; regained control over bladder and rectum, and paralysis improving. On discharge (3rd May, 1902), all paralysis had disappeared, but headache and giddiness remained.—(Captain McDermott, R.A.M.C.)

Perforation—Paralysis—Operation—Recovered.

Case 12.—Lance-Corporal M. F., wounded by Lee-Metford, 26th October, 1901, at 1,500 yards range; admitted 12 General Hospital two days later. Entrance 1½ inches to left of mid-line, and 2¼ inches above occipital protuberance; exit in right parietal, 2 inches from mid-line, and over fissure of Rolando, 2 inches from its upper extremity; aseptic. Conscious; drowsy; headache; moaning; complete left hemiplegia—no loss of sensation; control over both bladder and rectum; temperature 99·6°; left knee reflex absent. Trephined next day. At entrance three large and five small loose fragments removed; dura blue, incised and clots removed; a little brain also came away; fracture without depression, downwards and outwards in vault. At exit, piece of depressed inner table removed; dura lacerated; splinters removed from brain. Wounds remain aseptic, and temperature normal; steady improvement. On 26th day reflex normal; fair movement in arm and leg; no headache; central functions normal.—(Major Lougheed, R.A.M.C.)

Perforation—Coma—No operation—Died.

Case 13.—Officer wounded, 24th February, 1900; admitted Maritzburg next day. Moribund; comatose; Cheyne-Stokes respiration. Died day after.

Post mortem.—Mauser bullet had traversed base of right mastoid process; fissured petrous bone; entered skull cavity at angle of lateral sinus; exit to right of occipital protuberance. Both apertures circular and ½ inch diameter. Extensive comminution of post. fossa. Great destruction right cerebellum—brain matter and blood exuding from exit wound, and considerable hæmorrhage from lateral sinus. Range probably fairly close.—(Civil Surgeon Irvine.)

Perforation—Coma—No operation—Died. (Close range.)

Case 14.—(Name not given.) Wounded at Willow Grange, at 30 to 50 yards. Entrance small, just to left of occipital protub.; exit right upper frontal region, large, lacerated and star-shaped scalp wound. Brain matter escaping; not much bleeding. No comminution at entrance; at exit vault much fissured, and comminuted over area 4 inches diameter; fragments separated, yielding on pressure, and one of them elevated.

Semi-conscious; struggling; shouting. Died within seven hours.—(Civil Surgeon Irvine.)

Perforation—Paralysis—Operation—Recovered.

Case 15.—(Name not given). Wounded 15th December, 1899. Both wounds in scalp small; entrance in mid-line, 1¾ inches behind mid point between glabella and occip. protub.; exit upper frontal region, 1½ inches from mid-line and 3 inches above orbit. Hæmorrhage at time of injury; conscious, but restless and excited for 24 hours; complete paralysis left arm, partial left leg and face, with drop-foot. Flap turned up included both wounds; apertures in skull small, exit slightly larger; a fissure between them oozing blood; brain matter escaping from exit; loose spicules removed; trephined

over fissure; dura opened and plugged. A month later, normal movement in arm, increased power in knee and hip, but drop-foot persisted; speech slow; reads novel with interest.—(Civil Surgeon IRVINE.)

Perforation—Coma—Operation—Died.

CASE 16.—(Name not given.) Wounded 27th February, 1900; admitted Maritzburg four days later. Entrance at ant. inf. angle left parietal and corresponding angle of frontal, from which one fissure ran forwards into orbital plate, and two backwards through parietal—one to parietal eminence, and one lower towards exit; exit at lambdoid suture midway between post. angles of parietal. Both roughly rectangular, and larger than usual—may have been caused by larger bullet, or at short range. Comatose; curled up in bed, restless, and resenting interference. Wounds explored; loose spicules removed; anterior meningeal ligatured. Remained unconscious; right hemiplegia; constant twitchings right arm and leg; died 12th day; wounds aseptic.

Post mortem.—Great disorganisation brain; lacerated track 5 inches by $2\frac{1}{2}$ inches in parietal and occipital lobes, just above Sylvian fissure.—(Civil Surgeon IRVINE.)

Perforation—Paralysis—Hernia—Septic—Operation—Died.

CASE 17.—Boer prisoner wounded 27th February, 1900; admitted Maritzburg a fortnight later. Wounds septic, entrance in mid-line directly above ext. aud. meatus—rectangular hole in skull $1\frac{1}{2}$ inches by $\frac{1}{2}$ inch; exit to right of mid-line, 2 inches by $1\frac{1}{2}$ inches; bridge of bone between necrosed; hernia size of small tangerine orange at exit. Conscious; irritable; complete paral. left arm, and both legs. Hernia removed, and 40 per cent. solution formalin applied. Decided improvement in paralysis a month after, when convulsions set in, and continued at intervals till he died, nearly six months after being wounded.—(Civil Surgeon IRVINE.)

Perforation—Opera ion—Recovered. (Aphasia.)

CASE 18.—(Name not given.) Oval entrance and exit; fissuring between; over left motor area. Explored; loose fragments, and extra-dural clot removed. Convalescence marked by agraphia, which gradually lessened, and by slow cerebration when invalided a month later.—(Civil Surgeon IRVINE.)

Perforation—Coma—Fits—Operation—Died. (Left ventricle opened.)

CASE 19.—(Name not given.) Wounded 14th February, 1900; admitted Maritzburg next day. Bullet passed transversely; entrance $2\frac{1}{2}$ inches behind and $1\frac{1}{2}$ inches above right ext. aud. meatus; exit 3 inches above left meatus. Some general convulsions. Explored entrance; removed loose bone and clots. Died fourth day.

Post mortem.—Holes in skull circular, $\frac{1}{3}$ inch in diameter; small spicules in track near entrance; track 1 inch in diameter, led through left lateral ventricle; encephalitis; hæmorrhage at base.—(Civil Surgeon IRVINE.)

Perforation—No paralysis—Aphasia—Operation—Recovered.

CASE 20.—Private T., wounded at 500 yards range, 23rd February, 1900; admitted Maritzburg two days later. Entrance just below, and to right of occip. protub.; exit $1\frac{1}{2}$ inches above, and behind ext. aud. meatus—both alike, small and circular. Stupid, but conscious; amnesia verb.; very irritable; no paralysis; temperature 101° F. Explored exit the fourth day; loose fragments removed; 1 oz. brain matter exuded; brain then pulsated; one fine fissure seen running back; entrance not touched. Next day all signs irritation had passed; sensible; temperature normal. Healed by first intention, and 35 days later amnesia had nearly passed off, and he was quite intelligent.—(Civil Surgeon IRVINE.)

Perforation—Coma—Operation—Died. (Left ventricle opened.)

CASE 21.—Boer A., wounded night of 2nd August 1901, at 300 yards range, by Lee-Enfield; admitted 2 General Hospital at 3 p.m. next day. Entrance size of sixpenny piece, at post. inf. angle right parietal; exit twice as large, at centre of upper margin left parietal. Unconscious;

left pupil widely dilated, and eye turned outwards. All loose bone removed, and sharp edges cut away; drained. Died next day at 2 a.m.

Post mortem.—A fissure gaping to extent of $\frac{1}{8}$ inch connected apertures; fissures also from each forwards, through parietal and frontal, nearly meeting above nose, and backwards behind for. magnum, through parietal and occipital. Brain much disorganised, admitting two fingers in track.—(Lieut.-Colonel SYLVESTER, R.A.M.C.)

CASE 22.—Corporal H., accidently shot at two or three yards range. Entrance small ($\frac{1}{4}$ inch), just above and behind left mastoid process; exit through left orbit. Frontal bone on that side blown away; whole skull shattered into loose fragments; brain reduced to blood stained, almost fluid mass. Lived nearly one hour.—(Lieut.-Colonel WESTCOTT, R.A.M.C.) — Perforation—Coma—No operation—Died. (Close range.)

CASE 23. Private H. C. admitted three days after Mauser wound. Entrance at ant. inf. angle left parietal; exit in opposite occipital region. Semi-conscious, but could not be roused. In a few days coma disappeared, but amnesia and loss of memory remained; nervous depression and vertigo; no motor paralysis. Well enough to return home.—(Lieut.-Colonel WESTCOTT, R.A.M.C.) — Perforation—Coma—Aphasia—No operation—Recovered.

CASE 24.—Trooper E., wounded at short range, 28th July, 1901. Explosive effect in marked degree. Entrance at junction of frontal with left parietal; exit through right temporal. Upper part of skull raised in large fragments. Whole of right hemisphere reduced to blood-stained pulp.—(Lieut.-Colonel WESTCOTT, R.A.M.C.) — Perforation—Coma—No operation—Died.

CASE 25.—Trooper E. admitted 22nd July, 1901. Entrance a little behind right parietal eminence; exit above and behind right mastoid process—large septic wound. Conscious, and intelligent; left leg completely, left arm partially, paralysed; temperature raised. Four days after explored; loose bone removed—parietal very much fractured. Twitchings left arm; pulse feeble; coma; died same evening.—(Lieut.-Colonel WESTCOTT, R.A.M.C.) — Perforation—Septic—Paralysis—Operation—Died.

CASE 26.—Private C., wounded 18th February, 1900; admitted 6 General Hospital nine days later. Entrance below right malar; exit 1 inch below, and to right of occip. protub. Unconscious for a few minutes after being shot; much hæmorrhage from right aud. meatus; deafness right ear; facial paralysis. Both wounds now healed; some pain over right ear; 16th day "doing well."—(Civil Surgeon SKEVINGTON.) — Perforation—Paralysis—No operation—Recovered.

CASE 27.—Private G. admitted 4 Stationary Hospital 16th December, 1899. Entrance small, clean punched, just above left parietal eminence; exit in left frontal, with extensive fissuring. Unconscious; pupils equal and active, respiration and pulse slow; right facial, but no other paralysis; twitching right arm. Exit explored; several large pieces of bone removed; large clot removed from beneath dura; gauze drain. Next day much improved; conscious, but facial paralysis continued. Quite well when seen five months later.—(Lieutenant SIMSON, R.A.M.C.) — Perforation—Coma—Jacksonian epilepsy—Operation—Recovered.

CASE 28.—Lieutenant M. admitted 17 General Hospital 19th December, 1901. Entrance inner angle left orbit, fracturing nasal, upper max., and orbital bones; exit large, through frontal—brain penetrated. Unconscious, stertorous breathing; wound of thigh also; died that day.—(Major SEXTON, R.A.M.C.) — Perforation—Coma—No operation—Died.

CASE 29.—Lance-Corporal A. admitted 4 Stationary Hospital, 23rd February, 1900. Bullet passed across skull horizontally from side — Perforation—Coma—Operation—Died.

to side. Unconscious; many depressed fragments removed; one piece, ½ inch square, had been driven into brain. Died fifth day.—(Civil Surgeon Owen.)

Perforation—Coma—Operation—Died.

Case 30.—Sergeant H. admitted 4 Stationary Hospital, 5th February, 1900. Entrance 1½ inches above and behind right mastoid proc.; exit 1 inch above left supercil. ridge. Unconscious; breathing stertorous; left hemiplegia; "irritation signs" right arm and leg. Trephined entrance; many small pieces of bone removed; much disorganised brain, blood, and cerebro-spinal fluid escaped. Could move left hand and forearm that evening, but remained unconscious. Died third day.—(Civil Surgeon S. Copley.)

Perforation—Coma—Jacksonian epilepsy—Operation—Died. (Clot in lateral ventricle.)

Case 31.—Trooper B., wounded 7th February, 1901; admitted 16 General Hospital three days later. Entrance small, ½ inch above and behind right ext. aud. meatus; exit large and irregular, 1 inch in front of parietal eminence; complete left hemiplegia; eyes turned to left; pupils equal and active; unconscious; pulse 40 and full; facial convulsions. Flaps turned down over each wound; extensive fissuring, depression, and comminution of right parietal—fissures extending to frontal and occipital; trephined; depressed pieces and large extra-dural clot removed; dura opened and further clot let out; brain much disorganised; dura sutured. Rallied and became conscious, but died suddenly next afternoon.

Post mortem.—Large ante-mortem clot in right ventricle firmly attached.—(Lieutenant Smith, R.A.M.C.)

Perforation—No paralysis—No operation—Recovered. (Almost blind.)

Case 32.—Private S., wounded at 700 yards range, 22nd July, 1900. Entrance 3 inches above and 1½ inches behind tip of left ear; exit corresponding point right side. Recovered consciousness after three days, when vision was lost, except for bare perception of light. No paralysis. Transferred to base 29th day; vision not improved perceptibly.—(Civil Surgeon Ingall.)

Perforation—No symptoms except loss of vision—No operation—Recovered. (Vision improving.)

Case 33.—Trooper T. admitted 13 General Hospital, 5th April, 1902. Bullet passed transversely through occipital lobes; wounds small and healed rapidly. Total blindness; no other symptoms. Three weeks after, vision slowly improving. Was invalided 62nd day.—(Civil Surgeon Mansel.)

Perforation—Coma—No operation—Died.

Case 34.—Private W., wounded 1st April, 1902; admitted 20 General Hospital three days later. Entrance ½ inch diameter, irregularly circular, in left parietal, near border of temporal; exit 1 inch diameter, irregular in frontal to right of mid-line, near coronal suture. Unconscious; stertorous breathing; pupils dilated; brain protruding through exit. Died same day.

Post mortem.—Both wounds large and irregular; anterior half of vault very extensively comminuted; left frontal convolutions greatly disorganised; large quantity of extra and sub-dural hæmorrhage; small piece of mantle of bullet, and many pieces of bone in brain.—(Major Waite, R.A.M.C.)

Perforation—No paralysis mentioned—Operation—Recovered.

Case 35.—Private J., wounded 15th December, 1899; admitted 4 Stationary Hospital 16th December, 1899. Entrance, Mauser, in left parietal eminence; exit in left frontal region. Semi-conscious; several pieces of bone removed, as well as a large blood clot from beneath dura. Successful result; sent to base.—(Lieutenant Simson, R.A.M.C.)

Perforation—Coma—Operation—Died.

Case 36.—Major R., wounded 21st July, 1901; admitted 26 Stationary Hospital three days later. Entrance 2 inches behind, and above left ext. aud. meatus; exit on opposite side, almost in same position. Quite unconscious; "pressure symptoms marked." Trephined entrance; five large splinters bone and much clot removed; large branch of mid-meningeal tied. "Pressure

symptoms relieved," but complete aphasia remained; meningitis set in four days after. Died six days after operation.

Post mortem.—Bullet on entering had glanced round vault of skull; Brocas convolutions on both sides broken up; meningitis was more or less limited to dura covering these regions.—(Captain P. Evans, R.A.M.C.)

Perforation—Septic—No paralysis—Hernia—No operation—Recovered. (Melancholic.)

Case 37.—Trooper McC, admitted 14 General Hospital 24th June, 1901. Entrance small, 4 inches above left ear; exit circular; 2 inches in diameter, 3½ inches from root of nose, in mid-line, with hernia size of walnut protruding. Septic; headache; quite conscious, but morose; no paralysis; loss of control over sphincters; pupils irregular, but reacting. Hernia disappeared under pressure; wounds healed; recovered control over sphincters; able to walk with assistance. Transferred to Maritzburg ten weeks after with melancholia.—(Major Eckersley, R.A.M.C.)

Perforation—Coma—No operation—Died.

Case 38.—Private N., admitted 4 Stationary Hospital 6th February, 1900, for bullet wound of temple, which passed down the deep structures of neck, to emerge at the shoulder. Unconscious; never rallied, nor regained consciousness; died two days later.—(Civil Surgeon Hall Owen.)

Perforation—Paralysis—Aphasia—Operation—Recovered.

Case 39.—Private M., wounded 11th December, 1899; admitted 1 General Hospital 12 days later. Entrance 3½ inches behind, and 1½ inches above ext. angle left orbit; exit 2 inches behind entrance, and 2 inches from mid-line. Never lost consciousness, though he found himself suddenly deprived of speech. Was trephined at Orange River two days after injury. Wounds nearly healed now; motor aphasia; right facial paralysis; some weakness right arm and leg—mostly arm; pulse 50–60. Progress good; paralysis and aphasia improved; one month after wound: "usually finds the right words, but with great effort."—(Civil Surgeon Tyndall.)

Perforation—No paralysis—No operation—Recovered.

Case 40.—Private W., wounded 28th November, 1899, by Mauser, at 300 yards range; admitted 1 General Hospital 16 days later. Entrance 1 inch to right and ½ inch above root of nose; exit through right temporal, behind lobe of ear. Unconscious for 15 minutes after injury, then walked 200 yards to dressing station. Wounds now healed; thin serous discharge right ear; lacinating pain right temple; heavy, sleepy look; much general headache; pulse 60–64. When invalided one month later "was curious in manner and behaviour."—(Civil Surgeon Tyndall.)

Perforation—Septic—Paralysis—Operation—Recovered.

Case 41.—Private W., wounded 5th February, 1900. Entrance, Mauser, 1½ inches from mid-line, over right fissure of Rolando; exit 2 inches above occip. protub., and 1½ inches to right of mid-line. Flaps made and loose bone removed before admission 4 General Hospital, 26th February, 1900. Complete left hemiplegia, with paresis left face; wounds septic. Trephined entrance and exit holes in skull; in both pus exuded from diploe, and between bone and membranes; fragments of bone removed, some of them from ½ inch depth; fissure running from entrance to exit; trephined here also, elevating bone; drainage. Steady improvement; power in arm and leg gradually returning; latter slower when invalided two months later.—(Civil Surgeon F. R. Martin.)

Perforation—Septic—Paralysis—Operation—Died.

Case 42.—Private N., admitted 4 General Hospital, 27th February, 1900. Entrance, Mauser, small, just above right parietal eminence; exit large, at corresponding point left—direction transverse. Shouted, and wandered in speech, but answered rationally; paralysis all extremities; loss of control over sphincters; left pupil slightly dilated and fixed; large bed-sore over sacrum. Next day flaps raised over entrance and exit, and 25 fragments bone removed. Could raise arm to mouth after operation, but coma followed; died third day.

Post mortem.—No stellate fracture at entrance, but opening irregular; three fragments bone in track ½ inch to 1½ inches from surface. Larger, irregular exit, with three-starred fracture, extending for several inches. Track through brain large, and infiltration of blood and pus around.—(Major H. H. Johnston, R.A.M.C.)

Perforation—Coma—Operation—Died.

Case 43.—Private C., wounded 25th February, 1900; admitted 4 General Hospital five days later. Entrance and exit on opposite temples. Comatose. Trephined at once, both wounds; splinters and depressed bone, and extensive sub-dural clot removed. Sensation returned; pupils became equal, but he remained unconscious; died next night.

Post mortem.—Great laceration of brain; suspected Mauser at close range.—(Major S. F. Freyer, R.A.M.C.)

Perforation—Coma—Operation—Died. (Lateral ventricle damaged.)

Case 44.—(Name unknown, probably Boer.) Wounded 27th February, 1900; admitted 4 General Hospital three days later. Bullet track through left side of skull, from frontal to occipital regions. Comatose. Trephined at once, both wounds; many loose pieces bone removed. Remained unconscious; died five days after.

Post mortem.—Tunnel ½ inch diameter through left hemisphere and lat. ventricle; softening and inflammation surrounding brain; no depressed bone.—(Civil Surgeon Stanley Copley.)

Perforation—Septic—Paresis—Operation—Abscess—Recovered.

Case 45.—Private E., wounded 25th August, 1901, at 1,000 yards range; admitted 4 General Hospital five weeks later. Entrance at inner part right eyebrow, just under orbital ridge; exit in left parietal; former healed, latter discharging pus.

Emotional; grip of right hand much weakened; pupils dilated. Trephined exit; hole size of shrapnel bullet, with linear fissure in front and behind; abscess struck allowing ½ oz. of pus to escape. Steady improvement; temperature, pulse, and respiration remained normal; arm recovered; pupils became normal; emotional condition disappeared, and only slight headache remained.—(Civil Surgeon Hardy.)

Perforation—Paralysis—Aphasia—Operation—Recovered.

Case 46.—Lieutenant H., wounded 15th December, 1899, at 400 to 500 yards range; admitted Maritzburg next day. Entrance 1¾ inches above occip. protub. in mid-line "fracturing vault and rupturing long. sinus"; exit 2¾ inches above right supra-orbital ridge, ½ inch to right of mid-line. Aphasia, amnesia, and right paraplegia. Trephined at once; sinus plugged; entrance cleared of *débris*. When transferred cerebration was perfect, but slight paralysis right leg remained.—(Civil Surgeon Johnston.)

Perforation—Coma—Operation—Recovered.

Case 47.—Lieutenant McC., wounded 27th February, 1900; admitted Maritzburg three days later. Entrance Mauser, over anterior part left parietal eminence; exit 1¼ inches to left of mid-line and 2 inches below occip. protub., coma and muttering delirium. Operation at once; many loose fragments removed from edges of entrance, and from brain substance; exit left untouched; post. branch mid. meningeal tied.

When invalided had still some aphasia, and amnesia, with slight int. squint, but could walk, and had sensation in right leg.—(Civil Surgeon Johnston.)

Perforation—Coma—No operation—Died. (Lat. sinus injured.)

Case 48.—Major Y., wounded 24th February, 1900; admitted Maritzburg next day. Entrance opposite angle of right lat. sinus; exit at occip. protub.—ordinary Mauser wounds. Unconscious; Cheyne-Stokes respiration; died 17 hours after.

Post mortem.—Right lat. sinus injured; whole post. fossa comminuted; extreme laceration, and disintegration right cerebellum; much hæmorrhage at base.—(Civil Surgeon Johnston.)

CASE 49.—Burgher Trooper B., wounded 15th March, 1902; admitted Heidelberg next day. Entrance left cheek, below, and to outer side of orbit; exit in right frontal, after passing through left eye—latter totally disorganised. Restless, shouting, and singing loudly. As much loose bone as possible removed, or elevated; extensive laceration frontal lobes; drained. Hernia formed, and three weeks after operation rigors set in, with Cheyne-Stokes respirations; died four days subsequently.

Post mortem.—Large suppurating cavity in right orbit and antrum; purulent lymph in patches over left meninges; frontal lobes much "corroded."—(Captain W. E. HARDY, R.A.M.C.)

Perforation—No paralysis—Operation—Hernia—Died.

CASE 50.—Boer W., wounded 7th December, 1901; admitted two days later. Entrance left forehead, above eyebrow; exit similar situation right forehead—both small; brain matter protruding from exit. No paralysis; pupils equal and active. Operation; both openings cleared of loose bone; exit decidedly the larger; dura was perforated opposite each. Drowsy for three days, better afterwards; transferred to base fourth day.—(Civil Surgeon RICHARDSON.)

Perforation—No paralysis—Operation—Recovered.

CASE 51.—Captain R. G., admitted Johannesburg. Entrance above right pinna; bullet passed out through corresponding orbit. Proptosis and chemosis of right globe. Very irritable, with loss of self-control. Transferred to Howick 7th November, 1900. Wound healed; patient bright and cheerful, but suffers from pain above right superciliary ridge; sleeps well. Marked proptosis of right eye, with dilated pupils; inflamed conjunctiva; hæmorrhage in vitreous, and loss of vision of right eye. Invalided. Passed by a Medical Board at home on June 11th, 1901, as "fit to rejoin his regiment, being in good health."—(Hospital Records.)

Perforation—No paralysis—Vision lost in one eye—No operation—Recovered.

CASE 52.—During the fighting near Tugela River a soldier was shot in the forehead, and was admitted to 4 General Hospital, Mooi River, a few days later. Entrance (normal Mauser) at root of nose, exactly in mid-line, between int. ang. processes of frontal bone; exit at base of occipital protuberance, exactly in mid-line. Both wounds were very small, and healed by scab. The man had "no symptoms whatever." He was up and about for the week or two he remained in hospital, and apparently he went back to the front on discharge. Unfortunately, owing to pressure of work at the time, we did not keep notes of this unique case.—(Major S. F. FREYER, R.A.M.C.)

Perforation—No paralysis—No operation—Recovered.

Detailed notes of 52 cases of perforating fractures of the skull are given in the foregoing pages. The principal symptoms present, as well as the numbers of recoveries, deaths, &c., are shown in Table 5; and nine additional cases, of which the notes were incomplete but the results known, have been added to it.

TABLE 5.—Gunshot Perforating Fractures of the Skull (61 Cases).

Symptoms present.	Paralysis.	Aphasia.	Jacksonian epilepsy.	Coma.	Abscess of brain.	Hernia cerebri.	Operation.	No operation.	Total.	Percentage of deaths and recoveries.
Recovered	17	9	5	3	2	2	26	11	37	60·6
Died	22	0	2	18	0	2	16	8	24	39·3
Total	39	9	7	21	2	4	42	19	61	—
Percentage of cases in which the above conditions were present	63·9	14·7	11·4	34·4	3·2	6·5	68·8	31·1	—	—

Of 42 cases in which operations were done, 38·0 per cent. died, and 42·1 per cent. of those not operated on also died.

Paralysis and coma fatal symptoms.

In considering the above table, and the mortality rates which are shown for cases in which paralysis or coma occurred immediately on receipt of the wounds or supervened later, it is evident, as might be expected, that these symptoms are indicative of extensive brain injury; when paralysis was present in this series of cases, 56·4 per cent. of the cases proved fatal, and of those in which coma was a symptom as many as 85·7 per cent. died. Abscess of the brain only occurred in two cases, and both recovered; whereas of four cases of hernia cerebri 50 per cent. terminated fatally. Jacksonian epileptiform seizures were more or less marked in seven cases, but this symptom usually ceased or diminished immediately after operation or within a few days.

Jacksonian epilepsy usually disappeared after operation.

Results of operation satisfactory.

The results of operative interference in these cases were on the whole, considering the severity of some of the injuries, satisfactory. Operations were performed in 42 cases (68·8 per cent. of the total), with recoveries in nearly 62 per cent.; while no operations were done in 19 cases (over 30 per cent. of the total), with 57·8 per cent. recoveries. It is probably a fair inference to draw that if the percentage of cases in which no operations were performed had been less, the good effect of surgical interference would have been better shown by an even higher ratio of recoveries. The effects of operation were sometimes apparent in an immediate diminution in the degrees in which such signs as coma, paralysis, and those of brain irritation were present; and in those cases which eventually recovered, always in a progressive improvement in the general condition and decrease of the more important symptoms. In fact, the necessity of operation in gunshot fractures of the skull, and the good results to be expected from it, were special features of the surgical experience afforded by this war.

Operation necessary in majority of gunshot injuries of skull.

THE TREATMENT OF INJURIES OF THE HEAD.

Means to be employed.

The means to be employed in the treatment of gunshot and other injuries of the head should be directed towards keeping the patients at rest and undisturbed in a darkened room, obtaining and maintaining an aseptic condition of the scalp and of the wounds, and the use of operative interference at an early date when indications showing its necessity are apparent, that is when the bone is implicated even to a slight degree. The whole scalp should be shaved and rendered thoroughly sterile and "surgically clean" by the usual means, and the action of the bowels should be attended to by the administration of laxatives or, if coma be a symptom, calomel or cloton oil. These things, of course, "go without saying," but the matter of real importance in these cases is the employment of surgical interference for the elevation and removal of depressed and loose fragments of bone.

Previous experience of operation interference.

Operation for gunshots of the skull, having afforded such bad results during the Peninsular War, fell so much into disrepute amongst military

surgeons, that it was hardly resorted to at all during the wars of the nineteenth century. Even as lately as the Franco-Prussian War of 1870–71, operations on the skull in these cases were seldom performed; and then with but little good result. It has been, in fact, only since antiseptics came into use in war that they have been justified by the results obtained by means of them. Practically all the deaths which occur in head cases in war hospitals, at a later period than two or three days after admission, were, and indeed still are, due to septic meningitis, and to the two complications so commonly resulting from sepsis—hernia and abscess of the brain. In pre-antiseptic days all the cases became septic, therefore the death-rate was high, whether operations were performed or not, but especially so when they were performed. But while suppuration was not nearly always prevented during the Boer War by the methods of treatment used, it was so far kept in check by the free use of antiseptics that surgical infective disease (septicæmia, pyæmia, &c.) was reduced to a degree never before seen in any war except, perhaps, the Spanish-American War which immediately preceded it, and thus the fatal complication of meningitis less often supervened in gunshots of the skull, the general death-rate was reduced, and operative interference was not only more often justified but more frequently followed by success. So much so that it is hardly going too far to say that even the most severe cases of gunshot fracture of the skull, excepting, of course, those who are evidently so extensively injured that no treatment is likely to be of use, should be given the chance of recovery offered by operation. In South Africa some most unpromising cases recovered after operation sufficiently, at all events, to be invalided home, and some few marvellous cases of apparently complete recovery took place as well.

Septic meningitis usual cause of death.

Suppuration kept in check by use of antiseptics, and septicæmia reduced.

The following table affords a means of comparing the death-rate, as well as other important details, in gunshot injuries of the head treated in the pre-antiseptic days of the Civil War in America, and those due to modern methods of treatment; especially is a comparison of the results of surgical interference in the two cases deserving of notice. No doubt the number of cases in the Boer War of which the necessary particulars are obtainable is small, but it is probable that, on the whole, the results shown in this table indicate a fair average for the campaign :—

Table 6.

TABLE 6.

War of the Rebellion, United States America.

——	Cases.	Died.	Remarks.
		per cent.	
Injuries of the head, including scalp wounds.	13,000	21·3	
Fractures and contusions of the skull ..	4,350	59·2	
Operations for the elevation or removal of bone.	674	44·5	Of the 4,350 cases, 13·1 per cent. were operated on.

Boer War.—A Series of 151 Cases in which the Treatment and Results are known.

——	Cases.	Recovered.	Died.	Death-rate.	Remarks.
				per cent.	
All gunshot injuries of the head	151	107	44	29·1	Of the 151 cases, 66·8 per cent. were operated on.
Fractures and contusions of the skull.	133	89	44	33·1 (nearly)	Of the 133 cases, 75·1 per cent. were operated on.
Operations for the removal or elevation of bone.	101	67	34	33·6	

Operations on skull in Civil War in America and in Boer War.

From the above table it is apparent that, in the American Civil War, the death-rate of cases in which the bones of the skull were injured was 59·2 per cent., while operations were only performed in 13·1 per cent. of them; and that, in the Boer War, judging from the particular series of cases noted, the death-rate of similar cases was 33·1 per cent. nearly, and that operations were undertaken in 66·8 per cent. of all the cases, and in 75·1 per cent. of fracture cases.

Many suppurating cases recovered.

With reference to what has already been said regarding the less fatal effects of suppuration observed in head cases in the Boer War, in consequence of the free use of antiseptics in their treatment, of 141 cases in which the presence or absence of suppuration is mentioned this condition had supervened in 41, or 29 per cent. Of these 65·8 per cent. recovered; while it is certainly true that, in former wars, suppuration in gunshot injuries of the skull was looked upon as an extremely fatal complication, usually followed by meningitis and death.

Cases requiring operation easily recognised.

Neither the recognition of the cases requiring operation nor the operation itself is difficult. It is hardly going too far to say that, as a general rule of surgery, it should be understood that all gunshot injuries of the head in which there is evidence of actual contact of the projectile with the bones of the skull, require operative interference to give them the best chance of recovery. Beyond all doubt, all cases of evident fracture of the skull—gutters, penetrations, and complete perforations—require it whether cerebral symptoms be present or not. Only in cases where a mere graze of the outer table has occurred, or where linear fissures without depression have been produced, which are not accompanied by signs of cerebral injury or of intra-cranial hæmorrhage, can there be any doubt as to the necessity for operation. But not even in these apparently simple cases should there be any doubt. The marked feature of gunshots of the head is the small amount of visible injury apparent outside as compared with the real damage which may have been produced within. A considerable amount of the bullet's energy, and in a peculiarly localised way, may be expended in causing a graze of the outer table or a linear fracture, and it is well known how liable the inner and unsupported table is to extensive fracture and depression towards the dura and brain, while there is little evidence of injury to the outer table. Some surgeons may be inclined to await the onset of symptoms in this class of case before proceeding to operate, and perhaps their view may be supported by a considerable number of instances in which recovery has taken place without any untoward complication occurring; but fewer mistakes would be made if they were all operated on.

Even linear fissures often require operation.

Use of a trephine comparatively seldom necessary.

The term "trephining" is usually employed in works on surgery to denote operations on the skull for the purpose of elevating or removing depressed or loose fragments of bone; but in gunshot cases the use of the trephine is not required in a large proportion of them, as there is usually an aperture in the skull sufficiently large to admit the lower blade of Sir Victor Horsley's gouge forceps or of Hoffmann's similar instrument, and under these circumstances, of course, no trephine need be used. When, however, this is not the case a disc must be removed in the usual way, and a ½-inch trephine-hole will be ample to permit of the use of either of the gouge forceps referred to above. With a gouge forceps to hand it is seldom necessary to use the trephine at two situations on the same side of the skull. Grazes of the skull and linear fractures, when operated on, always require the trephine, and gutters sometimes; but penetrating and perforating cases never, because the surgeon can enlarge the apertures in these cases to any extent he pleases by means of the gouge forceps. (*Vide* Fig. 2).

A gouge forceps usually sufficient.

The incision in the scalp.

In raising the scalp for the purposes of operation on the skull, the incision should be down to the bone through all the tissues, including the pericranium, and it should be semi-lunar, not stellate in shape. The base of the flap should be towards the blood supply of the particular part of the scalp interfered with, that is, usually downwards with the convexity upwards, for obvious reasons as regards its vitality, and in order to have more or less sound skin over the site of operation in the bone; the pericranium should be raised with the flap. In gutter cases, and in superficial perforating cases, the flap should be made to include both apertures in the scalp; but when the apertures are far apart separate flaps must be made to expose each. All

May include both apertures.

hæmorrhage from the scalp wound must be controlled by means of ligature or pressure forceps before the rest of the operation is proceeded with.

Removal of bone in gutter cases.

In gutter fractures the floor of the trough in the bone is usually formed of the inner table in a condition of marked comminution; in these cases, although there may be no actual aperture in the skull, it is easy to remove comminuted bits so as to be able to enter the blade of the gouge forceps and extend the opening to any extent necessary. When this is not the case a ½-inch trephine disc should be removed from one end of the gutter in the bone, the further steps of the operation on the skull being carried out with the gouge forceps.

Removal of loose fragments.

The greatest gentleness should be used in removing fragments of bone, lest further damage be done to the dura or brain. Thin plates of the inner table will be found displaced side-ways under the edges of the "gutter," and should be searched for and extracted in those directions in which least opposition is offered to their removal. When all have been removed, any sharp corners or points of bone remaining on the edges of the fracture, and especially on the inner surface, should be cut away with the gouge forceps and the edges made smooth and unirritating to the dura which will come in contact with them.

All this has reference to "gutter" fractures, but it is equally applicable to operations on other kinds of cases.

Damage to dura to be avoided.

In penetrating and complete perforating cases, the apertures in the dura mater will usually be found to correspond exactly with those in the bone, and care must be taken in enlarging the latter that the blade of the forceps is passed in outside of the dura, between it and the skull; that, in fact, the edge of the dura should be separated from the skull in entering the forceps.

Minimum size of aperture to be made.

In both these types of fracture the apertures should be enlarged sufficiently to admit, at least, the little finger, for the purpose of exploring the outer 2 inches or so of the bullet track in the brain for fragments and spicules of bone driven in; no other instrument than the finger is at all likely to indicate the presence of these foreign bodies, and it is of the utmost importance that they be removed.

Removal of spicules from the brain.

They are of little weight, and do not penetrate far into the brain, so that exploration of a couple of inches of bullet track should usually be sufficient for their detection. They can readily be removed with a sinus forceps without injury to the brain.

Large fragments may be depressed.

When the aperture of entrance is not circular and clean-punched, and when fissures extend from it, considerable areas of bone may be found depressed; these should be elevated to their original level by the lever action of any instrument suitable for the purpose which will pass beneath them. Sometimes the depressed piece becomes so wedged against the edges of the sound bone that this cannot be done; it will then be necessary to free the entangled edges by means of the bone forceps, to permit of its elevation, or some of it may have to be cut away to enable it to be raised.

Exploration of both apertures.

Deep perforating fractures will require exploration at both apertures: on the entrance side for the extraction of spicules from the brain substance, as well, probably, as other fragments; and on the exit side, where the extent of fragmentation and fissuring is likely to be greater, for the removal of pieces of bone driven outwards into the tissues of the scalp, these pieces being sometimes of considerable extent.

Replacing of trephine discs and of fragments.

The advisability or otherwise of replacing the trephine discs and other fragments of bone must be considered in these cases. It is well to replace them if possible, because if they do not act as foreign bodies, but preserve their vitality, they close the apertures in the skull, support the brain, and prevent union between the dura and pericranium. But this procedure should only be carried out in aseptic cases; in suppurating cases replaced pieces die and come away, or have to be removed later on.

Not in suppurating cases.

Fragments and trephine discs which it is determined to replace should be kept in warm (100° F.) saline solution until they are required, or, as suggested by Mr. Watson Cheyne, they may be pushed in under the scalp, clear of the site of operation, and left there bathed in the normal fluids of the tissues, and at the normal temperature, while the rest of the operation is being performed. No sharp and uneven pieces likely to irritate the dura should be employed for this purpose. If the case remains aseptic, pieces of bone replaced in this way usually become consolidated with the skull, and serve the purposes intended of them.

Intra-cranial hæmorrhage.

Hæmorrhage, either intra- or extra-dural, is a common occurrence in gunshot fractures of the skull; it may occur immediately on receipt of the injury, or the signs produced by it may appear slowly later on, and is likely to be indicated by paresis or paralysis of certain muscles or groups of muscles, in consequence of pressure on certain motor areas of the cortex; if extensive, it usually produces coma. An extra-dural clot should be removed by means of a suitable spoon-shaped instrument, accompanied by gentle irrigation with normal solution, boracic lotion, or warm water which has been boiled. If only the edge of the clot becomes visible on opening the skull, the aperture may require enlarging in the proper direction to permit of its removal.

Intra-dural clot.

The presence of intra-dural clot when there is no aperture in the membrane is usually recognisable by a blue discoloration seen through the dura, combined with more or less paralysis and coma. In these cases the dura should be incised, and the clot removed as in the other cases. If on removal of the extravasated blood the hæmorrhage is found to be still going on, the vessel must be looked for and tied by passing a thin chromic gut ligature with a well-curved needle through the dura around the vessel on the proximal side of the opening in it. In aseptic cases the dura should, if possible, be closed by suture, but in suppurating ones it is advisable to omit this, so that discharge may not accumulate beneath it. Before closing the operation wound in the scalp the site of the operation should be well irrigated with one of the fluids already mentioned; then the scalp wound should be accurately closed by suture, and dressed with cyanide gauze wrung out of warm boracic lotion or other weak antiseptic, and an ample covering of cyanide wool. Aseptic cases require no drain, and those cases which do are better drained through the bullet aperture than through the operation wound.

Vessels may require ligature.

Dura to be sutured, if possible.

On these lines, or with such modifications of them as the conditions of individual cases seemed to require, gunshot injuries of the head were treated in South Africa with the results, as regards deaths, recoveries, &c., shown in the tables already given. As previously mentioned, no general conclusions, from a statistical point of view, should be drawn from the results obtained in the series of cases noted, because these had reached stationary hospitals for treatment, and were, therefore, cases which were somewhat more likely to recover, and were placed under more favourable circumstances as regards recovery than those which could not be moved from the more immediate front. No doubt many cases were too severely injured to bear transport to the rear; many cases, also, died in field hospitals within the first 24 hours after admission; so that it is highly probable that, when the records of the field hospitals become available, the very satisfactory results shown in this series of cases will not be borne out by the full statistics of the war. The change from large- to small-bore rifles, and the employment of modern surgical methods of treatment in the last war in America, only succeeded in reducing the death-rates in gunshots of the skull from 59·2 per cent. in the Civil War of 1861–65 to 52·2 per cent. in the late Spanish-American War, and it can hardly be expected that the results will prove to have been much better in the Boer War when the full numbers are known.

Statistics in tables in this report not correct for whole war.

Good effects of operative interference in Boer War very marked.

The evident good effects of operative interference were for the most part very satisfactory, sometimes even in most severe cases; the symptoms, no matter what their character, rapidly improved after operation. The frequency of Jacksonian epileptiform attacks diminished; sometimes no more occurred, and sometimes only a few at long intervals and of less pronounced severity, and eventually they ceased altogether. Signs of cerebral irritation immediately diminished, and soon disappeared. Coma was relieved, and gradually passed off. Paralysis was the symptom which was least rapidly affected by operation, except when it was due to blood-clot which could be removed; but paralysis also frequently appeared to diminish in consequence of operation, though in many cases some still remained when the men were sent home. It is not suggested that all the cases which were operated on recovered, but th relation of cause and effect between operation and amelioration of the patient's condition was very apparent.

Results of our experience in Boer War.

Our experience, then, in South Africa permits it to be laid down as a rule of military surgery that, in the treatment of gunshot injuries of the bones of the skull, the means to be employed are (1) those most effective towards securing an absolutely aseptic condition of the scalp and of the

wounds, and (2) operative interference at the earliest time the patient's condition warrants it.

Abscess and Hernia of the Brain.

The treatment of these two very fatal complications of gunshot fractures of the skull may, in certain connections, be discussed together: abscess is the direct result of suppuration in the wound, and hernia frequently depends on the presence of an abscess in the brain.

Signs of abscess of brain may appear early or late.

Cerebral abscess as a complication supervening on compound fracture of the skull may develop before the wound has healed, or at a period as late as some months after the receipt of the injury, and occasionally even after more or less complete recovery has apparently taken place. In the former case it is due to direct infection in the wound, and in the latter to irritation usually set up by bullets lodged in the cranial cavity or to spiculæ of bone or other foreign bodies driven into the brain substance. When suppuration occurs in the wound and is followed by cerebral abscess, the rather vague symptoms which may be supposed to indicate what is taking place usually begin to show themselves in from two to four weeks.

If early, in from two to four weeks.

Signs of abscess.

Probably the first signs to become apparent are drowsiness and slowness of cerebration, combined with headache, rigors, and vomiting; the pulse becomes slow, as does the respiration also; the temperature is sub-normal, and the pupils dilated and inactive; optic neuritis and a steadily deepening condition of coma develop, and, unless surgical interference can be employed to relieve the cause of these symptoms, the case comes to a fatal termination after some days, but with a slowly forming abscess life may be prolonged for 15 days or more. It should, however, be remembered that the symptoms of abscess are always liable to be mixed with those of some degree of meningitis which, naturally, may accompany its formation.

The site of the abscess.

The position of abscess of the brain in gunshot cases, as in fractures due to other causes, is usually not difficult to ascertain, as it is commonly situated in the immediate neighbourhood of the injury and close to the surface. Once the symptoms of abscess develop, or when there seems to be a probability of the existence of this complication, definite steps should be immediately taken to clear up the diagnosis, for no other means of treatment than that by operation can be successful. A hypodermic needle, 3 inches long, should be passed into the brain at the site of wound and different directions, until the abscess is reached or until it becomes apparent that none exists. Care should be taken that the point of the needle is kept steady in its original direction, and not allowed to damage the brain by any movement from side to side while the piston of the syringe is being withdrawn, and the tension within the syringe should be kept up while the needle is being removed, in order that, should its point have passed beyond the abscess cavity, the pus may show in the syringe when it again enters the abscess during its withdrawal. On recognition of the abscess, the brain over it (and the dura, if not already open) should be incised, the cavity gently irrigated with warm boric lotion, and a drain, reaching well into the cavity but not long enough to bear on its far wall, put in. The wound and the exposed surfaces of the brain and dura should be freely irrigated with boric lotion, dried, and dusted with iodoform or diluted double cyanide powder before applying the usual dressings. How long the drain should be kept in must be made to depend on the continuance of discharge; if removed too early the original symptoms will again show themselves and the tube must be replaced. It sometimes happens that only the side of the abscess cavity corresponds to the edge of the opening in the skull; in this case the latter must, if necessary, be slightly enlarged by means of the gouge forceps in order to make certain of free drainage.

Treatment of abscess.

Abscess developing at a late period.

Besides the class of case just referred to, abscess of the brain may supervene at what may be termed the remote period, many weeks, or even months, after the wounds have healed, and sometimes when complete recovery appears to have taken place. The cause of this development, as already stated, is usually the presence of foreign bodies in the brain substance, and the signs indicating it are similar to those mentioned above. The treatment, too, is practically the same, but the difficulties of diagnosing the position of the abscess are much greater. It is, of course, a fair presumption that it will be

found somewhere along the bullet track or in its neighbourhood, but it may not be so. If the bullet has lodged, the direction of the bullet track may not be known; moreover, the bullet may have glanced off some portion of the inner surface of the skull, the petrous portion of the temporal, for instance, and be lodged in any part of the cavity.

X-rays would, of course, show the position of the bullet which might be the cause of the abscess; they might also show fragments of bone in the brain, and in this way some indications might be given, but not very trustworthy ones. Localising symptoms might be present in consequence of interference with certain motor and sensory areas, and these might be definite enough to point to the site of the abscess. If not the brain should be explored at the entrance wound, and at the exit as well, if necessary, in the same way as in the other cases, except that the use of a trephine may be required under such circumstances.

Hernia cerebri.

Hernia of the brain is due to a combination of the two factors, an aperture in the skull and an increased intra-cranial pressure; it therefore happens that, as abscess of the brain is a common cause of increased pressure,

Often due to abscess.

the two conditions are frequently found together, the hernia depending on the presence of the abscess. The whole of the protruding tumour is not always formed of brain matter, a large portion of it frequently being composed of more granulation tissue.

The cause, then, of hernia cerebri being as stated, the symptoms which accompany it, leaving out of consideration the visible tumour, are usually those of abscess and meningitis, which have already been mentioned.

Treatment of hernia.

The treatment of this complication must, in the first instance, be directed towards the discovery of an abscess by an exploratory operation, and ensuring its free drainage, and, in the second, by endeavouring to obtain as nearly as possible an aseptic condition of the tumour by the use of dry dressings and dustings with iodoform, diluted double cyanide or other antiseptic powders. Pressure should not be applied, nor should the tumour be removed by operation, as has been recommended. As the abscess drains and the intra-cranial pressure diminishes the tumour will recede, the cause of its protusion having been removed.

A method of treatment for hernia cerebri, which is apparently new, is recommended by Civil Surgeon L. G. Irvine, viz., painting the tumour with a

Use of Formalin.

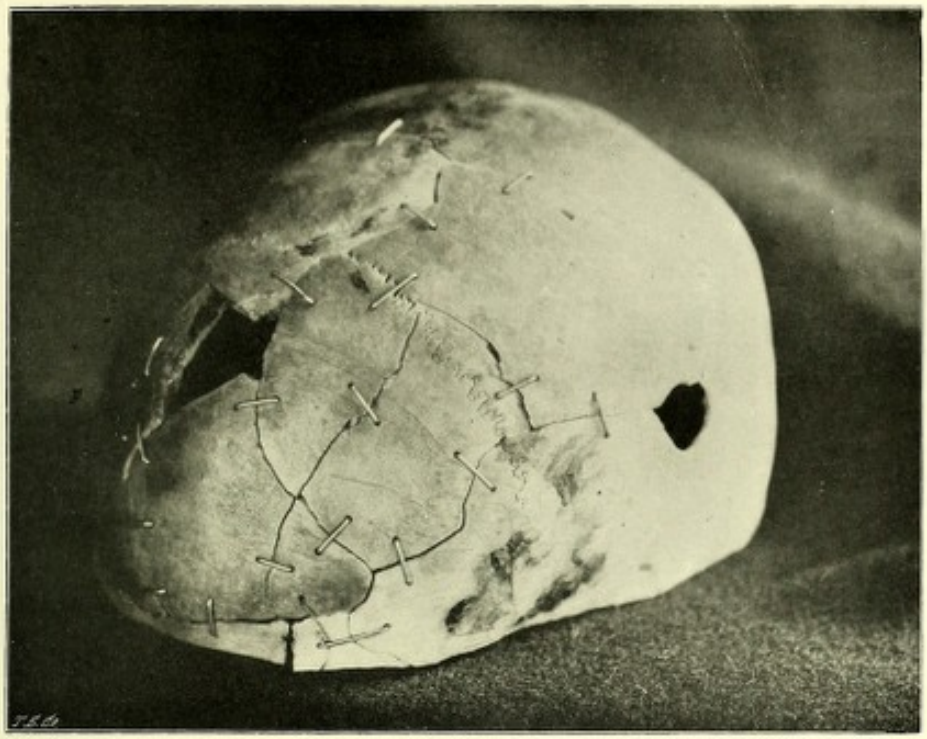
40 per cent. solution of Formalin every second or third day. This produces a dry, horny crust on its surface which can easily be removed, when the formalin is again applied. Presumably, this procedure is carried out in addition to the treatment by incision and drainage of the abscess to which the hernia may be due, or on failure to ascertain its locality.

Hernia a rather fatal complication.

On the whole, hernia cerebri is a rather fatal complication of gunshot fractures of the skull, but perhaps not so much in consequence of the mere mechanical protusion of the brain matter as of the conditions which accompany it and to which it is due.

The following table gives the more important details regarding the series of 167 cases of injuries of the head noted in the foregoing pages:—

Exit.



Entrance.

FIG. 1.

Fracture of Skull; range, a few yards.

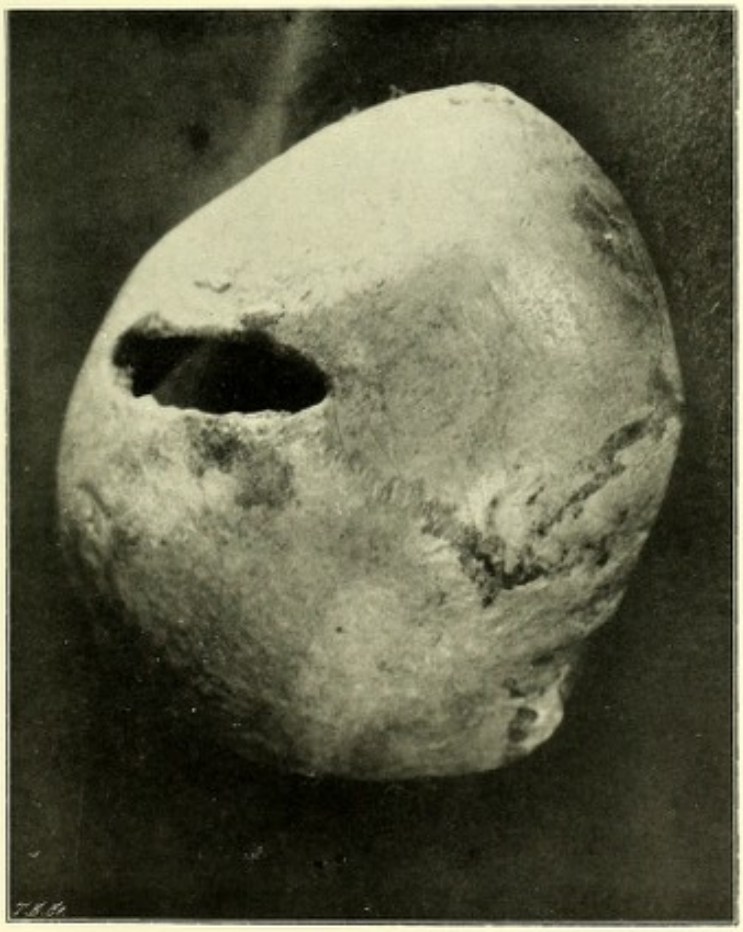


FIG. 2.

Gutter Fracture of Skull; patient died five months after receipt of injury.

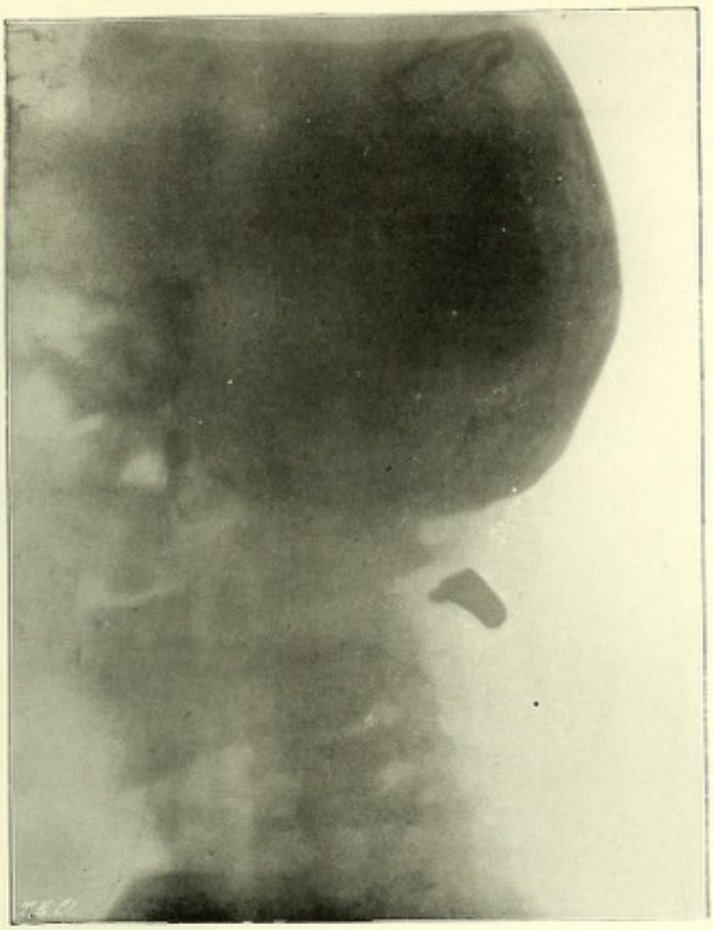


FIG. 3.

Deformed Mauser lodged in Muscles of Neck.

FIG. 4.

Deformed Bullet fixed in Disc removed by Trephine.

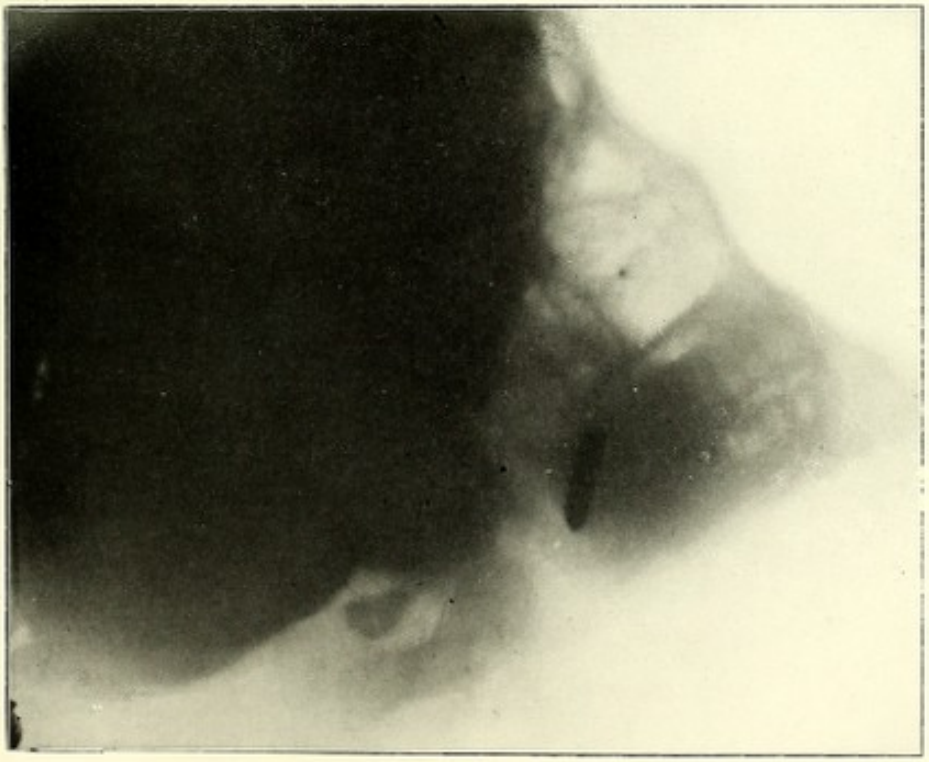


FIG. 5.

Mauser lying on Maxillary Ramus; entry through malar on same side.—(By L. SELLS.)

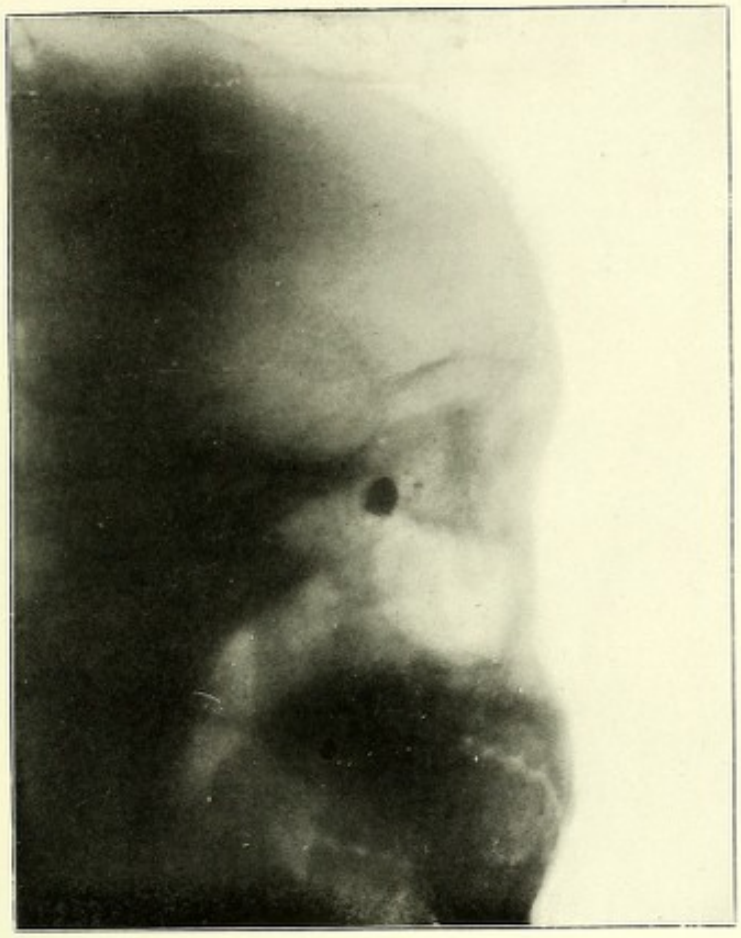


Fig. 6.
Buckshot in Orbit.—(Skiagraphed at Netley.)

Fig. 7.
Mauser Bullet lying obliquely at the Base of the Skull, anterior to the right mastoid process. Entry at the Left Temporal Fossa.

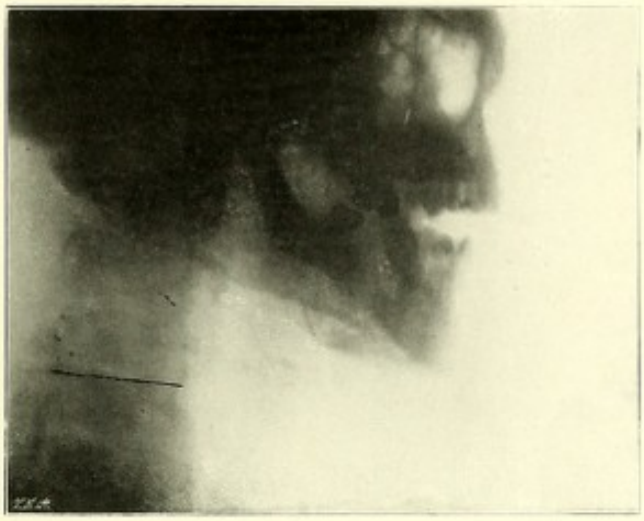


FIG. 8.

Bullet entered at Inferior Angle of Masseter. Exit through floor of mouth upwards; fracture maxilla obliquely and from below; wire *in situ*, showing attempt to approximate the larger fragments.

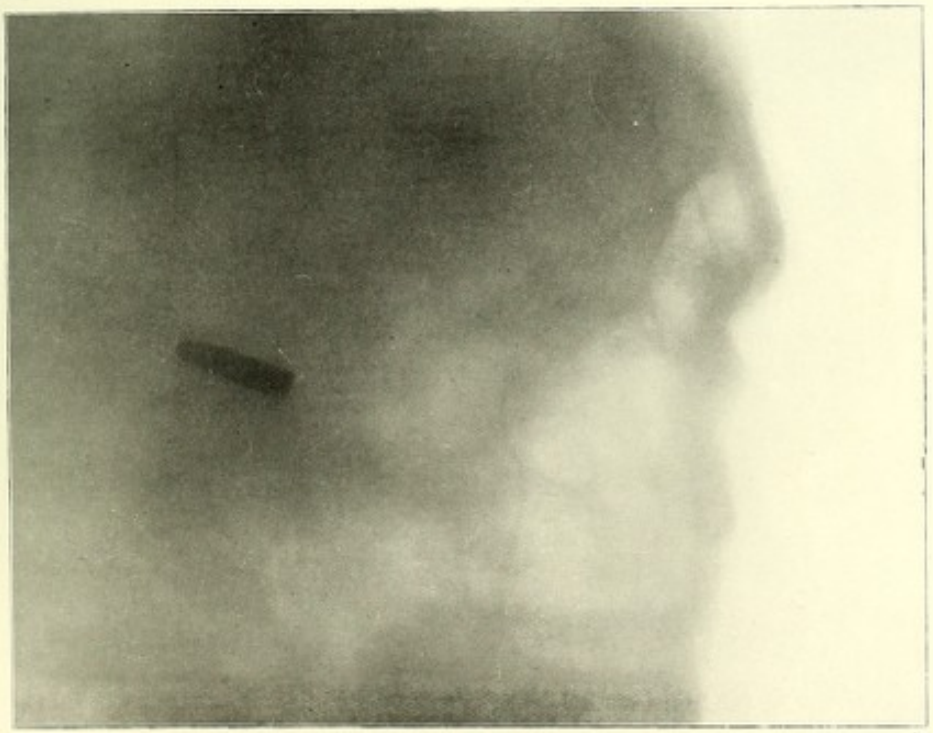


FIG. 9.

Mauser lodged in Temporal Fossa: had entered at opposite side.—(L. SELLS.)

TABLE 7.

Injuries of the Head.

—	Cases.	Recovered.	Died.	Death-rate.
				per cent.
All injuries of the head: accidental and gunshot.	167	115	52	31·1

Gunshot Injuries of the Head.

—	Cases.	Recovered.	Died.	Death-rate.
				per cent.
Gunshot injuries of the head: scalp wounds, contusions, and fractures.	151	107	44	29·1

All Injuries of the Head: Accidental and Gunshot (167 Cases).

—	Cases.	Recovered.	Died.	Death-rate.
				per cent.
Operation on the skull ..	113 (= 67·6 per cent.)	74	39	34·5
Abscess of brain	14 (= 8·3 „)	9	5	35·7
Hernia cerebri	12 (= 7·1 „)	7	5	41·6
With coma	39 (= 23·3 „)	7	32	82·0

Table 8 shows the fatality of gunshot injuries of the head classified according to the regions of the skull in which they occurred; the comparatively high death-rate in frontal cases was due to the fact that nearly all of them happened to have been produced at short ranges.

TABLE 8.—Gunshot Injuries of the Head (regionally classified).

—	Number of cases.	Contusions.		Gutters.		Penetrations.		Perforations.		Totals.		Death-rate.
		Recovered.	Died.	Recovered.	Died.	Recovered.	Died.	Recovered.	Died.	Recovered.	Died.	
												per cent.
Frontal	38	5	0	10	4	2	1	13	3	30	8	21·0
Upper parietal	59	4	0	31	5	1	1	15	2	51	8	13·5
Temporo-parietal ..	29	2	0	4	0	4	2	3	14	13	16	55·1
Occipital	23	2	0	6	3	1	1	6	4	15	8	34·7
Totals	149	13	0	51	12	8	5	37	23	109	40	26·8

This table includes only the cases in the detailed notes in which the site of the injury was given, as well as a few others in which it was known, viz., 149 in all.

SECTION II.

By the Editor.

GUNSHOT INJURIES OF THE SPINE.

Severe damage to vertebral bones usually fatal in former wars.

The cases of gunshot injuries of the spine seen in the Boer War formed a particularly interesting class from many points of view. In former wars practically all the cases in which the vertebral bones, other than merely their outlying processes, were fractured proved fatal. This statement cannot with accuracy be made with regard to spinal cases in the late war. The larger bullets of former times were, in consequence of their size, so much more liable to cause such extensive fractures of the vertebral bones that the probabilities of injury and depression of the bony walls of the spinal canal, and consequent lesion of the cord itself, were much greater than is the case when the injuries are the results of the modern projectile of small calibre. Snider and Henry-Martini bullets, and others of as great diameter, fracturing the pedicles, laminæ, or bodies of the vertebræ, usually produced such extensive damage to these parts that gross lesions of the cord, laceration or compression either from hæmorrhage or depression of bone, almost always accompanied them, and recovery in this class of case seldom took place. But in bones such as the vertebræ, where cancellous tissue largely predominates, the modern small-arm bullet is unable to expend much of its energy in producing destructive effects, the result being that exceptional cases (and they are even now exceptional) where the vertebral bones are traversed by them without gross lesion of the cord are more numerous. Hence it may be that gunshot fractures of the spinal bones—*qua* fracture—when the very fatal effects of concussion observed in the Boer War do not result, are less fatal than they used to be. Assistant Surgeon G. A. Otis, the author, with Surgeon D. L. Huntington, of that grand and exhaustive surgical record, "The Surgical History of the War of the Rebellion," stated that in that war "only a few examples were recorded in which the transverse or spinous processes alone were injured in which more or less complete recovery ensued, and fewer still when the bodies of the vertebræ were implicated." But in the Boer War a considerable number of cases—considerable, that is, for an exceptional occurrence—were experienced in which more or less recovery took place, although other portions than the transverse and spinous processes were traversed by small-bore bullets.

Less fatal when due to small-bore bullets.

Concussion of the cord.

One of the most interesting conditions due to small-bore bullets to which the experiences of the Boer War drew the attention of surgeons was that of concussion of the cord. In former wars, where the older weapons of larger calibre were employed, cases of injury to the spine in which signs of serious damage to the cord were at first present, but rapidly passed away, were considered to have been cases of "concussion." In these cases the bullets had evidently passed close to the spinal column, but without, in the vast majority of instances, actually implicating the vertebral bones. But in the Boer War a considerable number of cases of concussion of the cord, or, at least, of cases in which all other conditions than concussion of the cord were evidently absent, were observed in which fatal results followed. In many cases in which there were, during life, all the signs of complete transverse lesion of the cord, *post-mortem* examinations showed degeneration of the cord into a "custard-like material" incapable of any conducting power, while, at the same time, it was evident that the cord itself had not suffered any direct injury either from contusion or compression. In some of these cases the transverse or spinous processes were found fractured, and in others the bodies of vertebræ had been grooved or tunnelled, but in none of the cases now being referred to had the bony walls of the vertebral canal itself been fractured or depressed, nor had intra or extra-dural or intra-medullary hæmorrhage

Effects of severe concussion on the cord;

the bony walls not being broken;

occurred to account for the symptoms. By the process of elimination, then, in the absence of fracture of the wall of the canal and of hæmorrhage in any situation, no other conclusion remains but that the changes found in the cord on *post mortem* must have been due to the vibratory concussion communicated to it by the passage of the bullet at a high rate of velocity.

and no hæmorrhage being produced.

So many cases of this kind have been recorded after *post-mortem* examination in South Africa, and by surgeons whose capability of correct observation cannot be questioned, that this cause of fatal changes in the cord must be admitted. Mr. Makins refers to it in his "Surgical Experiences in South Africa"; Mr. Stonham gives a case in which it occurred in a Boer prisoner who died on the 52nd day; Colonel Lougheed details several cases; Civil Surgeon L. G. Irvine says in his report dealing with spinal cases, "that mechanical concussion is capable of producing grave injury to nerve tissue seems to be the inference to be drawn from certain cases" which were seen seen by him; and, finally, Messrs. Bowlby and Wallace, of the Portland Hospital, in the surgical section of "A Civilian War Hospital," mention some fatal cases of gunshot of the spine in which no fracture had occurred, attributing the deaths to concussion of the cord, but not referring to its degeneration into the "custard-like material" mentioned by other surgeons.

Evidence of concussion effects.

Mr. G. Lenthal Cheatle published in the "R.A.M.C. Journal" for October, 1903, a valuable paper on four cases of gunshot injuries of the lower and mid-dorsal spine, two of which are interesting with reference to the effects of concussion, for in both of them there were present during life all the symptoms of complete transverse lesion of the cord, while the *post mortems* in both cases showed that "no penetration of the vertebral canal had occurred, and apparently no damage had been done to the spinal cord or membranes which could possibly account for the serious nature of the clinical signs" (*see* Figs. 10 and 11 at end of Section). Mr. Cheatle does not mention any macroscopic changes in the cords in these cases, but he reports that, under the microscope, "there could be seen profound changes within the ganglion cells situated in the anterior and posterior horns of the grey matter" in that part of the cord opposite to the vertebræ which were actually struck. One of these men died 18 days and the other 17 days after being wounded; while in the cases reported by others in which the "custard-like" degeneration was found on *post mortem* the men had lived from 48 days to two months after being wounded. It is therefore allowable to suggest the possibility that, if Mr. Cheatle's cases had lived longer, naked-eye appearances of cord degeneration similar to those found in the other cases might have been found in them also. In both series of cases the symptoms were alike—those of transverse section of the cord; in one, profound changes were to be seen microscopically after an interval of 18 days; and, in the other, after the lapse of from one to two months, degeneration of the cord had advanced to such a degree that the term "custard material" aptly described it, and, of course, all nerve tissue had disappeared, and all conducting power had been lost.

Mr. Cheatle's cases.

This question of the possibility of the production in the spinal cord of the degenerative changes above mentioned by the vibration and concussion due to a bullet at high velocity, without the occurrence of hæmorrhage or compression or other gross lesion, is not one of merely academic interest; it is one of vital importance when treatment by operation comes up for consideration. Operation in cases of gunshot of the spine is only undertaken for the elevation or removal of depressed bone, or for the removal of intra- or extra-dural blood clot, or of a lodged bullet; while degeneration of the cord, once produced, is an irreparable condition. If, therefore, the surgeon were able to recognise with certainty the cases in which hæmorrhage or depression had occurred—which he is seldom able to do—and if he was sure that by operation he could remedy these conditions, he would still be aware that the probabilities were strongly in favour of the existence of such damage to the cord from concussion that his operation, successful so far as the blood clot, or depressed bone, or the lodged bullet was concerned, must be absolutely useless towards any permanent good to the patient. That the few laminectomies done in South Africa had so little good result was probably due to the presence of concussion changes, on which the operations had no influence whatever.

Degeneration of the cord from concussion an important question.

Operations on the vertebræ useless in cases of severe concussion.

Fig. 12 at end of this Section is a reproduction of a photograph of a spinal cord, now in the R.A.M. College Museum, in which degeneration into

"custard-like" material had taken place without injury to the vertebra or hæmorrhage inside or outside the dura. The specimen was sent home by Colonel Lougheed.

While, therefore, the actual bone damage produced by the small-bore bullet on the spinal bones may be less than that resulting from the larger projectiles, the effects of severe concussion of the cord due to the new bullet at a high rate of velocity are so fatal that the death-rates in spinal cases are not found to be as much reduced as might have been expected. In the Spanish-American War they gave a death-rate of 75 per cent. higher than that of gunshot of any other region of the body, and in the Boer War they showed a death rate of 59·5 per cent. in the cases noted.

Laminectomy might be useful if concussion effects are absent.

On the other hand, if skiagraphs show fracture of the vertebræ or lodgment of a bullet in the spinal bones, and the symptoms of the case are those which usually indicate compression of the cord, either from depressed bone or hæmorrhage, or by the bullet itself, the inference is that the missile could not have been travelling at the high velocity which is probably necessary for the production of severe concussion symptoms, and that therefore this kind of injury being absent, operative interference for the removal of the condition producing the compression would be less unlikely to be followed by success.

Diagnosis.

But the difficulties in forming a differential diagnosis as to the conditions in a case of gunshot of the spine, in which symptoms of partial or complete section of the cord are present, are for the most part practically insuperable.

Signs due to slight concussion may soon disappear.

Cases in which the signs depend on slight concussion alone commence to improve within a few hours or days, and usually run a favourable course towards complete recovery, but in the early stages of such cases it is impossible to recognise them as being of this kind. Cases which do not soon improve may be instances of severe concussion, of gross lesion of the cord by the bullet or by fractured bone, or of medullary or extra-medullary hæmorrhage of either kind, inside or outside the dura.

Signs due to severe concussion.

The symptoms presented by cases of severe concussion—cases of such severity that the degeneration of the cord, already so frequently mentioned, are found on *post mortem*—are similar to those of complete transverse lesion. There are, of course, complete paralysis of motion and sensation in the parts supplied by the section of the cord below the site of injury, followed by the trophic changes with which surgeons are so well acquainted, and leading to the inevitable end, the delay in the occurrence of which is usually only the more prolonged as the injury is low down.

Injuries high up.

Injuries of the cord at or above the third cervical vertebra are almost immediately fatal, in consequence of interference with the phrenic nerves as well as with the nerve-supply of the external muscles of respiration.

Below fourth cervical vertebra and in upper dorsal region.

In lower dorsal and lumbar regions.

Cases of similar injury to the cord below the fourth cervical vertebra and in the upper dorsal regions are equally fatal, but the end is more delayed, and is usually due to lung complications; whereas in injuries of the lower dorsal and lumbar regions life may be prolonged indefinitely, and death is almost always due to exhaustion consequent on septicæmia from trophic bedsores, cystitis, and diseases of the urinary organs, or to an ascending myelitis which eventually reaches regions of the cord the functions of which are necessary for the continuance of life. In two cases of the latter class, which lived for over a year after the receipt of their wounds, additional pain and difficulty were experienced from the formation of small vesical calculi which became impacted in the urethra, causing retention of urine, and which were difficult to remove.

Vesical calculi in spine cases.

Other cases of gunshot of the spine are seen in which, although neither complete or even partial transverse section of the cord, nor that degree of concussion which proves equally fatal, has occurred, yet symptoms which indicate these very grave conditions are present, and sometimes, for a time at least, in as marked degrees. These may be cases of slight concussion, of intra-medullary hæmorrhage, of pressure on the cord from depressed bone, of hæmorrhage within or without the dura, or from a lodged bullet.

Other lesions of the cord.

Differential diagnosis practically impossible.

But the differential diagnosis between these various conditions, the signs of which are so similar, are extremely difficult, if not quite impossible. Cases of slight concussion can only be recognised as such when and because the symptoms accompanying them rapidly begin to disappear. When the symptoms persist, they may depend on any, or on a combination, of the other

conditions; and when the signs of transverse lesion are complete, the vast majority of the cases prove fatal sooner or later, as the situation of the injury is high up or low down in the vertebral column.

Concussion effects probably present in all cases of severe lesion.

Cases in which there are such lesions of the cord itself as may be produced by depressed bone, hæmorrhage of any of the three kinds, or by lodgment of the bullet, must, except perhaps in the latter case, be complicated more or less by the effects of concussion; and, indeed, in some of them the latter may be the condition of gravest import in consequence of the degenerative changes so likely to occur. When, on the other hand, the bullet has lodged in the spine, the inference is strong that it was travelling at too low a rate to produce severe concussion. Cases in which the symptoms depend purely on hæmorrhage or on depression of bone must be very rare; but some were met with where fractures of the neural arches had occurred without visible degeneration of the cord being found on *post mortem*—that is, where concussion effects were not apparent.

When bullet lodges, concussion unlikely to be severe.

Medullary hæmorrhage.

Intra-medullary hæmorrhage is usually accompanied by signs of gross lesion of the cord, but while the motor paralysis may be complete the anæsthesia may not be so, but may be confined to certain areas below the level of the injury, while in others sensation may be more or less perfect; absence of pain and hyperæsthesia is also a sign of hæmorrhage within the cord.

Signs of pressure.

Any of the local conditions producing pressure are usually accompanied by irritative signs, pain, hyperæsthesia, and twitchings and contractions of muscles; and in cases of extra-medullary hæmorrhage the paralytic symptoms, motor and sensory, may improve for a time, to return later in consequence of myelites originated by the pressure and injury to which the cord has been subjected. Mr. Makins describes a case (No. 96 in his "Experiences in South Africa") in which he believes the symptoms were due to pure extra-medullary hæmorrhage; the bullet traversed the lower dorsal region. "On the second day after the injury, the lower extremities became drawn up, the knees and hips assuming a flexed position, and this was followed shortly by the advent of complete motor and sensory paraplegia, accompanied by retention of urine. Two days later, gradual and rapid return of both sensation and motor power set in, and in 14 days no trace of the condition remained." Cases of this kind were very rare, and they are distinguished from those of slight concussion only by the later onset of the paraplegic signs.

A case of extra-medullary hæmorrhage.

Lesions of the cord.

While this report might rightly be taken as dealing only with the actual experiences of the Boer War as found noted in the records of the various injuries seen in the campaign, yet, although the records of spinal injuries do not furnish instances in which all the classical signs and symptoms of lesions of the cord are detailed, it may be well to refer to them briefly and in general terms.

Signs of gross lesions of the cord.

In cases which are, or from any local condition amount to, instances of complete transverse lesion, the marked symptoms immediately noticed are always those of absolute paraplegia below the level of the injury, usually accompanied by those of shock in a marked degree, and frequently by a zone of hyperæsthesia at the upper limit of the anæsthetic area.

Of complete transverse lesion.

The deep reflexes are totally and permanently lost, while the superficial ones, though absent at first, may reappear, or some of them may do so. Trophic changes soon make their appearance, affecting the skin and its appendages and the deep organs, more especially the bladder and kidneys.

Intra-medullary hæmorrhage seldom occurs in large quantity, but even a little of it is sufficient to produce irreparable damage to the cord, and usually to initiate those secondary changes in the cord which, sooner or later, must bring the case to a fatal termination. The signs which distinguish it from other kinds of injury to the cord are (*a*) that the paraplegia may not be complete, more especially as regards the loss of sensation, which is patchy and irregularly distributed over the skin surface below the level of the extravasation, and (*b*) the absence of pain and signs of spinal irritation.

Of intra-medullary hæmorrhage.

Compression of the cord, whether it be due to extra or intra-dural hæmorrhage, depression of the bony wall of the vertebral canal, or to the lodgment of a bullet within the canal, is indicated by pain and hyperæsthesia, but more particularly by signs of spinal irritation, such as cramps, flexions of the limbs, twitchings and contractions of

Of compression.

muscles, &c., and in some cases the paraplegia, both as regards motion and sensation, may be incomplete and patchy. In these cases, granting the absence of the effects of severe concussion, more or less improvement may take place, which may either be permanent or only temporary, deterioration frequently occurring in consequence of secondary myelitis.

Signs vary in the different regions.

The symptoms of total transverse lesion of the cord, of course, vary in accordance with the region in which it is situated; when in the lower lumbar segment, where the cauda equina only is implicated, the paraplegia is only partial, both as regards motion and sensation in consequence of the possible escape from injury of some nerves in the leash. Most of the muscles of the leg and gluteal region are paralysed, and sensation is lost over the distribution area of the sacral plexus. The bladder symptoms are, at first, retention of urine, followed by incontinence from distension and overflow. When the injury is in the dorso-lumbar segment, there is complete loss of motion and sensation in all parts below the lesion; with paralysis of the sphincters, incontinence of urine and fæces, and the bladder slowly diminishes in size while its walls become thickened.

Early bladder symptoms.

In mid-dorsal regions.

Mid-dorsal lesions show the same paraplegic signs, but have added to them paralysis of the abdominal muscles, permitting distension of the intestines with gas, and producing distressing symptoms from mechanical interference with the action of the heart and lungs. There is incontinence from distention and overflow of the bladder, and usually a zone of hyperæsthesia at the upper limit of the anæsthetic area. Sometimes reflex acts of micturition occur, but they are performed unconsciously.

In upper dorsal and cervico-dorsal regions.

With the injury in the upper dorsal region there is paralysis of the intercostals, and when in the cervico-dorsal, paralysis of the accessory muscles of respiration as well, so that respiration is entirely diaphragmatic; the arms are affected, and vomiting and more or less of a condition of priapism are common signs. The temperature in the parts below the lesion usually runs high at first; later it becomes subnormal. In cases of cervical injury the temperature occasionally runs to extreme degrees (110° F., or more); sometimes it is subnormal, but even if high at first it soon goes down.

Temperature in spinal cases.

The observations, so far available, made of the temperature of spinal cases in South Africa were by no means as full as could have been desired; in many cases no reference to it has been made. In one cervical case it was 95° F. on the second day. In eight dorsal and lumbar cases the temperature was from 100° F. to 103·8° F. at periods ranging from the day of receipt of the wound to the fifth day after it. The cervical case above mentioned was the only one in which a subnormal temperature was noted. The temperatures in spinal cases are only of special interest during the early days of their treatment; later they become raised, not in consequence of cord lesion, but from absorption from acute bed-sores.

Trophic changes.

Trophic changes always take place in the paralysed parts, and in gunshot cases those in the skin often appear with extreme rapidity, acute bed-sores beginning to develop in two or three days. They need not be referred to in detail, but acute bedsores occur quite irrespective of pressure, and no care in keeping the skin dry and clean, and to avoid pressure, will prevent their formation. They are the principal cause of death in cases of injury in the lower regions of the cord, either from the exhaustion and septicæmia resulting from them, or from direct infection of the meninges when they extend to the spinal bones in the lumbar and sacral regions.

Trophic changes in the bladder and urinary organs are also a frequent cause of death in these cases; ulcers form in the bladder, cystitis develops, and the kidneys fail to act effectively. The onset of cystitis, a most distressing condition, and one which contributes materially towards the fatal termination, is very variable as regards time, sometimes appearing early and sometimes as late as six weeks or more after the wound. No doubt it may, and often does, originate from the use of "surgically unclean" catheters, especially when it begins early; but, as a rule, no amount of care as regards cleanliness of instruments will prevent its development later in the course of the case when "residual urine" can hardly be avoided, and when ulceration results from trophic degeneration of the walls of the bladder and urinary tract.

The following more or less detailed notes are those at present available of spinal cases in the Boer War:—

Gunshot Injuries of the Spine.

Upper cervical region. Concussion of cord—No operation—Recovered.

CASE 1.—Captain G. L. P., wounded 27th February, 1900. Entrance at ant. border right sterno-mastoid, just behind angle of jaw; exit in mid-line of nape of neck between third and fourth cervical spine—both normal Mauser.

Paralysis of right extremities without anæsthesia, and paresis of left arm, and to less extent of leg, also without anæsthesia; right intercostals paralysed; loss of control over sphincters.

Symptoms steadily improved in following order: Bladder and rectum; left arm and leg; right arm and leg. On 13th day recovery of power was very marked; still some paresis right intercostals.

A year later Medical Board reported: "He has recovered to a considerable extent the use of the right leg, but it still drags in walking, and is liable to spasms when he is tired. He has little or no use of the right arm. It will be at least a year before he can be expected to recover the use of his limbs, if he ever does so."—(Civil Surgeon L. G. IRVINE.)

Lower cervical region. Concussion—No operation—Recovered.

CASE 2.—Private A. K., wounded 14th December, 1899, at 500 yards range; admitted 30 hours later.

Entrance over left malar bone on zygomatic process; exit close to angle of right scapula. Paralysis of motion and sensation both arms and left leg; incontinence of urine and fæces; tenderness over seventh cervical spine.

Bladder and rectum recovered first; then left leg—sensation before motion; next right arm and finally left arm had not completely recovered when invalided 69 days later.—(Civil Surgeon B. WOOD.)

The final report as to this man's condition, dated 31st December, 1903, is as follows: "At present he suffers from partial paralysis of the left upper extremity, with slight contraction of the fingers and forearm. He cannot raise his left arm, and the grasp of his left hand is very feeble.

"He did 'light work' for a year since his discharge, but had to discontinue it, and has been out of work for seven months."—(D. LENNOX, M.D., Surgeon Major.)

Lower cervical region. Laceration of cord—No operation—Died.

CASE 3.—Private E., wounded 20th June, 1901, at nine yards range; admitted 14 General Hospital same day. Entrance over upper part of right scapula; exit in left side of neck 1 inch below angle of jaw—both small. Quite conscious; complete paralysis of both arms and legs; breathing entirely diaphragmatic; sensation over upper part chest and back; temperature sub-normal; urine had to be drawn off. Two days later much oozing cerebro-spinal fluid from neck wound; very marked dyspnœa and cyanosis; died at 3.30 p.m.

Post mortem.—Bullet passed through spinal column between fifth and sixth cervical, destroying 1 inch of cord.—(Major E. ECKERSLEY, R.A.M.C.)

Lower cervical region. Laceration of cord—No operation—Died.

CASE 4.—Private E., shot accidentally by ·450 revolver at range of a few feet. Entrance 1½ inches to right of seventh cervical spine; exit 1 inch above left sterno-clav. joint; temperature, 103·4° F., on fifth day. Complete paraplegia, motor and sensory; sensation in arms, but motor power impaired; respiration entirely diaphragmatic; loss of knee reflex; priapism and retention of urine; speech thick. Cystitis developed; died 35th day.

Post mortem.—Bullet entered through right lamina first dorsal, and emerged between pedicles of sixth and seventh cervical; cord almost completely divided; "custard" substance occupied 1 inch.—(Major LOUGHEED, R.A.M.C.)

Lower cervical region.

CASE 5.—Private H., wounded 1st April, 1902; admitted 20 General Hospital. Complete paralysis below level of sixth cervical vertebra. Drowsy,

Laceration—No operation—Died.

but answered on being roused; temperature, 95°; pulse, 48; respirations, 12 per minute—laboured and diaphragmatic. Died two days later.

Post mortem.—Bullet passed through sixth cervical laminæ and cord, completely disorganising latter; no effused blood within meninges.—(Major WHAITE, R.A.M.C.)

Upper dorsal region. Concussion of cord—No operation—Died.

CASE 6.—Private T., wounded 28th November, 1899, at 800 yards range, whilst lying prone; admitted 2 General Hospital five days later. Entrance in centre left axilla; exit over spine right scapula—both small and circular. Paraplegia; no zone of hyperæsthesia; troublesome cough, with hæmoptysis at first. Temperature 102° F. on fifth day. Cystitis developed, with bed-sores, fever, rigors, and profuse sweats. Died 48 days after injury.

Post mortem.—"Custard" condition of cord for 1½ inches opposite fourth dorsal vertebra; membranes adherent; "slight clot in spots"; "bullet entered and passed out between pedicles; no bone was found fractured or depressed."—(Major LOUGHEED, R.A.M.C.)

Three cases of concussion of cord—No operation—Died.

CASES 7, 8, and 9.—Major Lougheed had three other cases similar to this one. All had paralysis, and died.

Post mortem showed in none of them any depressed bone or hæmorrhage pressing on cord. The disintegration of cord at seat of injury was considerable in all, and in all the "custard" condition was found. He adds:—"It would seem that a Mauser bullet passing through the spinal canal is quite sufficient to disintegrate the cord, without even lacerating it, and thus to completely interfere with its conducting powers. Operative measures are useless in such cases."

Concussion or compression (?)—No operation—Recovered.

CASE 10.—Lieutenant P., wounded 6th November, 1900; admitted Kroonstad eight days later. Entrance (Mauser) 1½ inches above outer end of middle third of right clavicle; exit over left scapula 1 inch from its lower angle—both healed. Legs paralysed, though not completely; no loss of sensation; severe "girdle" pains; slight loss of power over rectum, but bladder acts normally; left arm partially paralysed. After a year he recovered complete power in his lower limbs. He is now (8th March, 1904) serving, but is still troubled with obstinate constipation; also his left hand is weak, ankle clonus is present on both sides, and the patella reflexes are exaggerated.—(Major S. F. FREYER, R.A.M.C.)

Upper dorsal region. Slight concussion of cord—No operation—Recovered.

CASE 11.—Private W. P., wounded 13th April, 1901, and carried with column for a fortnight till admitted 12 General Hospital. Entrance ½ inch to right of second dorsal spine; exit 2 inches above centre of clavicle, same side—both small and circular. Complete paralysis both legs, motor and sensory; loss of knee reflexes; anæsthesia from 1 inch below nipple line; aphonia—could only whisper; perfect control over sphincters. Slight motion in left leg 17th day, and sensation 20th. All symptoms gradually cleared up; invalided. In August wrote, "Quite well, and returned to duty from Netley."—(Major LOUGHEED, R.A.M.C.)

Lower dorsal region. Concussion of cord—No operation—Died.

CASE 12.—Private H., wounded 15th December, 1900. Entrance, Mauser, left shoulder; no exit. Complete paraplegia, with anæsthesia below umbilicus; temperature 100° F. on second day; zone of hyperæsthesia from umbilicus to costal arch; paralysis of sphincters. Cystitis developed; died 29th day.

Post mortem.—Bullet entered spinal canal between bodies 9th and 10th dorsal vertebræ, and then passed between body of latter vertebra, damaging its right upper surface and post. common ligament, leaving hæmorrhagic track. Post. common ligament not lacerated; small patch of ecchymosis on dura at point opposite bone injury; here also on pia there was slighter ecchymosis—just apparent. Cord somewhat softened for ½ inch, but no naked-eye myelitis; no loss of substance in cord or membranes.—(Civil Surgeon L. G. IRVINE.)

CASE 13.—Private W. H., wounded 8th April, 1902, by Lee-Metford at 30 yards range. Horse killed under him—fell off and could not stand; admitted 12 General Hospital five days later. Entrance 3½ inches from 12th dorsal spine in 11th left interspace; exit 5 inches from mid-spine in 10th right interspace. Lower dorsal region. Concussion—No operation—Recovered.

Immediately wounded severe pain in both feet and calves; this, most intense over dorsal surfaces and external malleoli, lasted three weeks; no motor paralysis; knee jerks normal; no difficulty in micturition, some tenderness on pressure over 12th dorsal spine—no fracture detected, nor ecchymosis. Could walk three weeks after injury; knee jerks much exaggerated; soon returned to duty.—(Major LOUGHEED, R.A.M.C.)

CASE 14.—Private M. F., knocked over by bursting shell; no external marks of injury. Both legs completely paralysed from hips. Transferred to 4 Stationary Hospital. No further record.—(Major HEWSTON, R.A.M.C.) Concussion—No operation—Transferred.

CASE 15.—Imperial Guide, wounded 13th March, 1902; admitted 14 General Hospital six days later. Entrance between eighth and ninth ribs right ant. axillary line; exit 1 inch to left of second lumbar spine proc. Mauser, healed. Lower dorsal region. Concussion of cord—No operation—Recovery.

Paralysis right leg; pain in both feet; retention of urine; blood clots drawn off. Recovered.—(Major E. ECKERSLEY, R.A.M.C.)

CASE 16.—Private J. F., wounded 11th December, 1900; admitted seven days later. Had two Mauser wounds thus:—

No. 1. On right side. Entrance 2 inches from spine, between 11th and 12th ribs; exit mid-axillary line between seventh and eighth ribs. No. 2. Entrance just to right of fourth lumbar vertebra, exit just above crest of ilium 2 inches from ant. sup. spine. Paralysis right lower extremity; mæmaturia, retention of urine and obstinate constipation. Developed acute cystitis; died 33rd day. There was slight return of movement in extremity during last fortnight. No *post mortem* recorded.—(Civil Surgeon E. HENSMAN.) Lower dorsal and lower lumbar regions. Concussion (?)—No operation—Died.

CASE 17.—Trooper F. M. J., wounded 13th May, 1900, at 500 yards range. Entrance (Mauser) in sixth interspace right mid-axillary line; exit 2 inches to left of fourth lumbar spine. Lower dorsal region. Concussion—No operation—Recovered. (Paralysis improving.)

Paralysis of right lower extremity; slight weakness of left, wasting of muscles, severe pain and loss of knee jerk right side; no loss of sensation; sphincters normal; hæmoptysis and hæmothorax. Pain had ceased, and slight power of motion had returned in right leg three months later.—(Civil Surgeon J. C. HIBBERT.)

CASE 18.—Private T. C., wounded 27th June, 1900, at 350 yards range. Entrance midway through upper arm, then through fifth intercostal space mid-axillary line; no exit; was extracted from under skin between fourth and fifth lumbar vertebræ close to left of spinous processes. Lower dorsal or lumbar region. Concussion—No operation—Recovery.

Was in crouching position when wounded. Complete paraplegia; "no sensory phenomena." Next day some return of power, which has gradually increased; able to flex and extend left leg, to rotate both legs inwards and outwards and to flex and extend toes; temperature rises 1-2 degrees every evening; invalided and sent home. He was discharged the Service four months later, having improved considerably, but being quite "unfit," from paresis of both legs.—(Civil Surgeon DAVIDSON.)

CASE 19.—Private A. B., wounded 18th February, 1900, at 500 yards range; admitted 23 days later. Entrance (Mauser) 2½ inches to left of spine on level with iliac crest; no exit; bullet removed from right thigh 2½ inches Lower dorsal region. Concussion—No operation—Recovered.

below great trochanter. Incontinence of urine and fæces, cystitis. Regained full control over bladder and rectum by 47th day.—(Civil Surgeon J. H. Pegg.)

Upper dorsal region. (?) Laceration of cord—No operation—Recovered (with paralysis).

Case 20.—Private F. P., wounded 28th November, 1899, at long range; admitted 2 General Hospital a few days later. Entrance 1½ inches to left fourth dorsal spine; exit over centre right clavicle 1½ inches diameter; clavicle fractured.

Much pain back of neck and head; sensation lost up to level of seventh rib in front and eighth behind; complete paralysis lower limbs; upper intercostals acting, but breathing mostly diaphragmatic; cremasteric reflex present; patellar and plantar absent; no zone of hyperæsthesia. Urine drawn off; bowels not acting; temperature 101° at night; frequent vomiting. A month after 20 ozs. serum aspirated from left pleura. No improvement in paralysis. Invalided. Eventually he was sent home from Netley, at his own urgent request, eight months after receipt of wound. No improvement had taken place; had complete paraplegia, incontinence of urine and bedsores over sacrum.—(Major Lougheed, R.A.M.C.)

Mid-dorsal region. Laceration of cord—Operation—Died.

Case 21.—Private McN., wounded 28th November, 1899, at long range; admitted 2 General Hospital four days later. Entrance over right seventh rib, 2 inches behind post. axillary line; exit small, just below centre of spine left scapula. Paralysis. Next day laminectomy over first to third dorsal spines; no damage to laminæ or pedicles found. No improvement; died seven weeks later.

Post mortem.—Cord partly divided, and in "custard" condition for nearly 1 inch, opposite third dorsal vertebra; membranes adherent to cord at site; back and sides of vertebra tunnelled and grooved.—(Civil Surgeon Hanwell.)

Mid-dorsal region. Laceration of cord—Operation—Died.

Case 22.—Sergeant C., wounded 26th October, 1900, at 50 yards range; admitted 12 General Hospital same day. Entrance small and circular 1 inch to right of mid-sternum, in first intercostal space; exit also small, ½ inch to right of fifth dorsal spine. Severe hæmoptysis lasting three days; complete paralysis up to level of nipples; breathing diaphragmatic; retention of urine and loss of control over rectum; right hæmothorax. Bedsores and cystitis followed. Laminectomy 15th day; perforation found in fifth lamina, and hole in dura beneath, from which softened cord exuded; dura adherent to cord; no pus or blood. Two days later coughed up half pint of pus and died.

Post mortem.—Wound through right lung, with small cavity; pus in bronchus. Side of body fifth dorsal vertebra tunnelled; "custard" condition of cord for 1 inch; membranes adherent; "little hæmorrhage" at site.—(Major Lougheed, R.A.M.C.)

Upper dorsal region. Laceration of cord—No operation—Died.

Case 23.—Private McE., wounded 1st January, 1902, at 500 yards range; admitted 12 General Hospital same day. Entrance in post. inf. triangle left neck, 2 inches above centre of clavicle; exit near inf. angle right scapula, over sixth rib and 5 inches from mid-spine. Motor and sensory paralysis both sides, up to second rib; lost knee jerks; no priapism; loss of control over rectum; retention of urine; bedsores and cystitis followed. Died 17th day.

Post mortem.—Bullet tunnelled left pedicle second dorsal vertebra, fractured lamina third, and crossed canal, emerging under third right lamina and fracturing fourth, as well as transverse process and four ribs. (*See* Figs. 13 and 14.) Hæmorrhage in substance of cord opposite second and third dorsal vertebræ, 1 inch long; membranes adherent; some "custard" substance.—(Major Lougheed, R.A.M.C.)

(?) Lower dorsal region. Laceration (?) of

Case 24.—Private W., admitted 4 Stationary Hospital 26th February, 1900. Entrance 2 inches below and 1 inch outside right nipple; exit left side

second lumbar vertebra. Paraplegia. Improvement for first week, after which he became gradually worse, and died 13th day. No *post mortem* recorded.—(Civil Surgeon HALL.) cord—No operation—Died.

CASE 25.—Boer prisoner K., admitted 17 General Hospital, April, 1901, for shrapnel wound. Entrance right scapula; bullet extracted at left sixth intercostal space, mid-axillary line. Complete paraplegia; much dyspnœa and cyanosis; overflow of urine—3½ pints drawn off. Temperature, 103° F. on third day. Died day following. Mid-dorsal region. Laceration of cord—No operation—Died.

Post mortem.—Comminuted fracture vertebral column in mid-dorsal region; hæmothorax and left pneumonia.—(Lieutenant J. W. LEAKE, R.A.M.C.)

CASE 26.—Trooper C., 7th N.Z.M.R., wounded 1st January, 1902; admitted 18 General Hospital nine days later. Entrance, 1½ inches below and 3½ inches outside right nipple; exit, 2 inches inside angle of left scapula. Complete motor and sensory paralysis below umbilicus—sphincters involved. "Temperature at times ran high." Bedsores formed; urine septic. Transferred to 14 General Hospital four months later in good general health; sores healed, but still paraplegic.—(Major MALLINS, R.A.M.C.) Mid-dorsal region. (?) Laceration of cord—No operation—Recovered (with paralysis).

CASE 27.—Trooper W., admitted 17 General Hospital 2nd September, 1901, with gunshot wound spine in mid-dorsal region. Complete paralysis below injury, including bladder and bowel. Mid-dorsal region. Laceration of cord—Operation—Died.

Laminectomy eighth day; found complete transverse section of cord between sixth and seventh dorsal vertebræ. Wound healed; bedsores and cystitis developed. Report states bladder and rectum regained normal power, and some sensation returned as case progressed towards inevitable end. No *post mortem* recorded.—(Captain R. HUNTER, R.A.M.C.)

CASE 28.—Private M. McK., wounded 9th October, 1901; admitted Aliwal North same day. Entrance oval, 1 inch below inf. angle right scapula; no exit. Immediately on receipt of wound felt pain in arms, and could not move legs; paralysis, motor and sensory, below ninth ribs; reflexes abolished; zone of hyperæsthesia; emphysema from nape of neck to right iliac crest; tympanitis; priapism; paralysis of sphincters; temperature, 100°; pulse, 100; respiration, 28 on day of wound; upper chest moving in respiration. Lower dorsal region. No operation—Recovered? (with paralysis).

Progress bad; left by hospital train for Base a fortnight later. No further record.—(Major ELDERTON, R.A.M.C.)

CASE 29.—Private J., wounded 28th November, 1899, by Mauser at 300 yards range; admitted 2 General Hospital five days later. Entrance, seventh right intercostal space, 4½ inches from spinous process; no exit. "Usual symptoms of complete lesion of cord about level of 12th dorsal"; bedsores very deep; died in about a month. Lower dorsal region. Laceration of cord—No operation—Died. Bullet lodged.

Post mortem.—Bullet entered spinal column from right side, between last dorsal and first lumbar vertebra, and was found embedded in the cord substance, with its nose projecting at post. surface of dura; cord in "custard" condition.—(Major LOUGHEED, R.A.M.C.)

CASE 30.—Private T., wounded 27th February, 1900, by Mauser at 300 yards range; admitted 2 General Hospital. Entrance, ½ inch to right of dorsal spine; no exit. "Usual paralytic symptoms of cord lesion about eighth dorsal vertebra." Died 81 days later. Lower dorsal region. Laceration of cord—No operation—Died. Bullet lodged.

Post mortem.—Bullet found lying in centre of cord, with its nose buried in back of eighth dorsal vertebra (*vide* Fig. 15); cord in "custard" condition for 1½ inches at site; no bone injury detected from outside canal.—(Major LOUGHEED, R.A.M.C.)

Lower dorsal region. Laceration (?)—No operation—Recovered (with paralysis).

CASE 31.—Trooper F. F., wounded at 600 yards range; admitted 24th December, 1899. Entrance (Mauser) in upper maxilla, ½ inch from inner canthus, just below left eyelid; exit, 3 inches to right of spine, at junction of dorsal and lumbar vertebræ. Complete paralysis from sixth rib downwards; subsequent cystitis and bedsores. Slowly getting worse when invalided to England 52nd day. Was discharged the Service six months later, no improvement having taken place.—(Civil Surgeon E. KER.)

Mid-dorsal region. Laceration (?)—No operation—Died.

CASE 32.—Trooper T., wounded 27th November, 1899; admitted 2 General Hospital six days later. Entrance (Mauser), left axilla; exit, over spine right scapula. Paralysis and loss of sensation from level of seventh rib downwards; constipation, retention of urine, and rapidly-spreading bedsores; cystitis; wasting of muscles of lower limbs; died 72nd day. No *post mortem* recorded.—(Civil Surgeon E. HENSMAN.)

Lower dorsal region. Concussion of cord—Laminectomy (not completed)—Died.

CASE 33.—Private McN., wounded 1st December, 1899, at 800 yards range; admitted five days later. Entrance (Mauser) in centre of spine left scapula; exit at angle of right scapula.

Paralysis below level of ensiform cartilage; total loss of reflexes—retention for 10 days, afterwards incontinence; bedsores; cystitis. Had hæmoptysis also for first three days, followed by pleurisy; laminectomy attempted fourth day, but fourth, fifth, and sixth dorsal spines found intact, and so operation not proceeded with; wound closed; died 48th day.

Post mortem.—Cord totally disorganised and in "custard" condition opposite seventh dorsal vertebra; no meningitis; no trace of bullet track.—(Civil Surgeon G. HANWELL.)

Upper dorsal region. Laceration—No operation—Died.

CASE 34.—Private W. B., wounded at 20 yards range; admitted 17th February, 1900, some hours later.

Complete motor paralysis of left leg, partial of right, great feebleness of both arms; diaphragmatic respiration; great hyperæsthesia all over body, necessitating anæsthetic for dressing. Put on water bed; died 47th day.

Post mortem.—Perforation of body of first dorsal vertebra; "penetration of bullet into cord."—(Civil Surgeon J. E. KER.)

Lower dorsal region. Laceration (?)—No operation—Died.

CASE 35.—Private J., wounded by Mauser, 1st December, 1899, at 500 yards range; admitted 40 hours later. "Wounded between last dorsal and first lumbar vertebræ." Paralysis, anæsthesia below umbilicus, and loss of reflexes. Died 41st day. No *post mortem* recorded.—(Civil Surgeon G. H. POOLEY.)

Mid-dorsal region. Compression of cord (hæmorrhage)—No operation—Died. Bullet lodged.

CASE 36.—Private McN., wounded 28th November, 1899, at 800 yards range, whilst lying prone; admitted 2 General Hospital four days later. Entrance 1½ inches below right acromio-clav. joint; no exit. No hæmoptysis; paralysed from umbilicus downwards. Cystitis developed, with vomiting, bedsores, rigors, and profuse sweats. Died 47 days after injury.

Post mortem.—Bullet had passed obliquely through bodies of seventh and eighth dorsal vertebræ, and lodged in left lumbar spinal muscles. Cord practically uninjured; small clot found between cord and post. surface body seventh dorsal vertebra; pus on membranes; had probably spread up from bedsores.—(Major LOUGHEED, R.A.M.C.)

Lower dorsal region. Compression of cord (hæmorrhage)—No operation—Died.

CASE 37.—Private H., wounded 17th March, 1901, by Mauser at 50 yards range; admitted 12 General Hospital next day. Entrance small and circular, 2 inches below, and 1 inch external to right nipple; exit over left 12th rib, 1 inch from mid spine. Motor paralysis both legs, but sensory only of right; zone of hyperæsthesia round upper abdomen; no priapism; loss of control over rectum, and retention of urine; right pneumothorax; no cough; patellar reflex absent; temperature, 100°. Cystitis developed; shooting pains in

both legs, and slight return of sensation in left; dyspnœa and jaundice. Died 30th day.

Post mortem.—Right lung much damaged, communicated through hole in diaphragm with large cavity in liver containing blood clot. Post. surface of body 12th dorsal vertebra deeply grooved; dura not torn or perforated; cord did not appear damaged from outside, but when arachnoid was stripped opposite groove in vertebra, a dark oval patch of partially absorbed blood clot, ¾ inch long, was found. From lower end and sides of this patch the fibres of cauda emerged.—(Major LOUGHEED, R.A.M.C.)

CASE 38.—Private McD., wounded 28th November, 1899; admitted 1 General Hospital a few days later. Entrance, left side, over seventh rib, 1 inch behind post. axillary line; exit, right loin, 2 inches outside ant. sup. iliac spine, and 1 inch above crest. Complete paralysis with anæsthesia to level of umbilicus; loss of control over sphincters. Sensation began to return in one week, and was quite normal in three weeks, when motor power also began to return (right sartorius and adductors). Entrance wound opened, became septic; cystitis and bedsores developed; died 48th day.

Lower dorsal region. Compression of cord (hæmorrhage)—No operation—Died.

Post mortem.—Abscess size of hen's egg in back of left lung; loin muscles infiltrated with fœtid pus. Beneath dura at commencement of "cauda" was a partly organised clot, 2 inches long, adherent to cord and dura; some splintering of 12th dorsal lamina which did not press on cord.—(Civil Surgeon THORNTON.)

CASE 39.—Private I., wounded 28th November, 1899, at 800 yards range; admitted eight days later. Entrance (Mauser) at junction of right clavicle with acromion; exit, left 10th intercostal space, 2 inches from spinal column. Paralysis and imperfect sensation of both lower extremities; retention of urine, cystitis, and bedsores. Shortly after admission he recovered partial power and sensation in limbs; died 47th day.

Lower dorsal region. Compression (from hæmorrhage)—No operation—Died.

Post mortem.—Extra-dural hæmorrhage; cord practically uninjured; septic meningitis extending probably from bedsore; cystitis and septic infection of both kidneys.—(Civil Surgeon E. HENSMAN.)

CASE 40.—Private F., admitted Maritzburg 17th December, 1899. Entrance left shoulder; no exit. Paraplegia.

A fortnight later could move left leg, and a month after being wounded could move toes right foot very slightly; gradual recovery of sensation right leg. No further notes. No later history to be obtained.—(No signature.)

Dorsal region. Probably slight concussion—Bullet lodged—No operation—Recovered.

CASE 41.—Drummer W., wounded 15th December, 1899, admitted Maritzburg next day. Entrance on upper part of left shoulder, 1 inch above spine of scapula and about 2½ inches from coracoid proc.; exit just behind right nipple. Patient says he found bullet half protruding and pulled it out. Total paralysis below chest. Three days later bedsores forming over sacrum. No further history to be obtained.—(Civil Surgeon W. STUART.)

Dorsal region. No operation—Result not known.

CASE 42.—Captain R. C. D., wounded 12th February, 1902. Entrance size of half-crown, in right post. axillary line, about 1 inch below level of nipple; part of bullet under skin at corresponding spot left side—extracted in four pieces. Some emphysema both sides, paraplegia; no sensation below umbilicus; paralysis of sphincters; cremasteric reflexes present; no visible deformity. On 14th day could feel and localise pin prick both legs; 16th, zone of hyperæsthesia at umbilicus; 28th, could move toes and legs a little; 46th, could flex knees and adduct and abduct thighs feebly—severe invol. twitchings.

Lower dorsal region. Laceration of cord—Half of bullet lodged—Operation—Recovered (with paralysis).

Eighty-two days after injury sensation was more or less perfectly returned except for a patch on upper and outer left thigh; ankle clonus present; superf. reflexes exaggerated; bedsores healed; paralysis of rectum; perfect control over bladder. Invalided. Med. Board London, 7th November,

states that laminectomy was performed at a surgical home by Sir W. Bennett, and half a Mauser bullet removed from cord; "has pain and severe muscular twitchings in legs, but is improving." On 7th May, 1903, a Medical Board reported, "paralysis lower limbs continued, but considerable movement right leg; left leg also improving—only toes and ankle movable."—(Lieutenant RICHARDSON, R.A.M.C.)

Further notes on Captain D.'s case by Sir Wm. H. Bennett, dated 14th December, 1903 :—

On 1st December, 1903, his condition was as follows :—"Sensation in both lower limbs nearly normal; co-ordination still defective, but much less so than it was a month ago. Walking with crutches easy; walking across room with a stick or the assistance of hand on chairs or table possible with comparative ease. Jactitation of limbs troublesome after prolonged exertion, but subsides at once upon resting; no pain. Functions of rectum and bladder quite normal. The progress towards improvement has been steady during the last four or five months. To the best of my belief, no case has been previously recorded in which improvement has followed to the same degree where a foreign body (half a Mauser bullet in this instance) has been embedded in the centre of the spinal cord for a long period and removed by operation. There is a reasonable hope that recovery may yet be nearly, if not quite, complete."

Upper dorsal region. Probably severe concussion of cord—No operation—Died.

CASE 43.—Boer prisoner, C., wounded 8th February, 1902. Entrance 2½ inches from right edge of sternum in fourth intercostal space; exit 1½ inches to left of fourth dorsal spine. Complete loss of motion and sensation below eighth rib in front and fifth behind; sphincters paralysed. Cystitis developed; died 52nd day.

Post mortem.—Cord soft and pulpy opposite fourth dorsal vertebra; meninges inflamed; no evidence of fracture.—(Lieutenant H. HIME, R.A.M.C.)

Upper dorsal region. Paralysis—Bullet extracted—Recovered (with paralysis).

CASE 44.—Private G. W., Manchester Regiment, wounded 21st October, 1903. Entrance below right clavicle; no exit, but X-rays showed bullet 2½ inches to left of vertebral column. Pain in vertebral region; paralysis of motion and sensation from 1 inch below nipple line; bladder over distended, urine drawn off; cough with hæmoptysis.

Cut down at level of fourth dorsal vertebra; found bullet at depth of 1½ inches, and removed it without difficulty—a ·450 large leaden bullet.

Transferred Maritzburg 6th day.—(Major BRUCE, R.A.M.C.)

Lower dorsal region. Operation—Died.

CASE 45.—A. B., a Boer prisoner, wounded through lower dorsal region; symptoms of complete transverse lesion of the cord in this position. No visible deformity of spinal column, nor hyperæsthetic zone. Laminectomy done on 12th day, laminæ of 9th and 10th vertebræ being removed; no fracture of neural arch found. The dura bulged into opening and was very tense. No hæmorrhage outside dura, but this membrane was dark in colour as though hæmorrhage had taken place beneath it. Dura opened; no clot found. The cerebro-spinal fluid escaped evidently under great pressure. No clot or injury to cord to be seen. Dura sutured and wound closed. The man was allowed to recover from the chloroform while still lying half over on his face; he spoke rationally and appeared to have recovered completely from the anæsthetic, but died immediately he was turned on his back preparatory to moving him from the table to his bed.—(Notes by Surgeon-General STEVENSON.)

Lumbar region. Concussion of cord—Operation—Recovered Bullet lodged.

CASE 46.—Boer prisoner, H. C., wounded 18th December, 1901, by Lee-Metford, at 1,600 yards range; admitted 12 General Hospital 29 days later. Entrance just external to left sacro-iliac joint behind; no exit; X-ray negative. Had acute pain and numbness in left leg and thigh for half an hour, but walked short distance. Both knees drawn up and rigid;

pain when extended; no paralysis or anæsthesia; sphincters normal; right knee jerks absent; nightly temperature, 101°. Eleven days later left knee jerk almost lost. Explored entrance; removed many large sequestra from region of left sacro-iliac joint, and part of inter-articular cartilage; tunnel passed upwards and to mid-line—no bullet found. Two months after operation wound healed; could walk, with full movement of hips; knee jerks still absent.—(Major Lougheed, R.A.M.C.)

Lumbar region. Concussion—No operation—Recovered.

Case 47.—Private E., wounded 23rd December, 1899, at 60 yards range; admitted 16 hours later.

"Through buttocks and sacrum." Complete paralysis of legs for nearly a week; pain in sacrum with some slight weakness in legs if he walked too far when invalided 26th day. Had completely recovered four months later, and returned to duty with his regiment.—(Civil Surgeon Ker.)

Upper lumbar region. Concussion—No operation—Recovered.

Case 48.—Private C., wounded on 6th February, 1902, medium range. Bullet (Mauser) entered ½ inch to left of spinous process of first lumbar vert.; exit 1 inch to right of ensiform cartilage; probably passed through stomach and liver. No abdominal symptoms noted. Almost complete paralysis and loss of sensation below site of injury (could just perceptibly move left toes). Bladder and rectum paralysed. Bedsores rapidly formed, but healed in four months. Sensation began to return in one month, and motion in four months; could then slightly flex knees; after seven months could move both legs well at the hip and knee joints, but no power over movements of feet. After 15 months could get about on crutches. Had severe pain in toes of both feet a month after wound.

Condition on 22nd June, 1904, 2-$\frac{4}{2}$th years after wound; still uses two crutches, but can walk a short distance with the aid of two sticks. Has good power over muscles controlling hip and knee joints, but practically none over those of ankles or toes. Sensation on right side to within 4 inches of ankle, and on left it is almost normal. Muscles of both legs and thighs much wasted, but not flabby; a good deal of thickening and enlargement of right knee. Has good power over bladder, but urine sometimes passes involuntarily; still has severe pain in toes at night and requires narcotics. General health excellent.—(Notes by Surgeon General Stevenson.)

The Treatment of Gunshot Injuries of the Spine.

Treatment similar to that of fracture-dislocation seen in civil hospitals.

The general surgical principles which govern the treatment of these cases in war are quite similar to those applicable to that of cases of fracture-dislocation in civil practice.

The avoidance of any prolonged transport of these patients is most important, movement being likely to produce or cause the recurrence of hæmorrhage; but often the exigencies of a campaign make this impossible. Absolute rest in bed; the use of morphine subcutaneously for the relief of pain, which is sometimes excessive; the attempt to postpone the occurrence of cystitis by extreme care for the cleanliness of the catheters used; the treatment of the cystitis when it appears by washing out the bladder at least twice a day with warm boric solution; the thoroughly antiseptic treatment of the trophic sores and pressure sores which form; and, occasionally, the consideration of the possibility of good effect to be obtained from operative interference, are the principal matters for the surgeon to keep before his mind.

General treatment.

Cystitis often an early symptom; The reason for this.

Cystitis is, perhaps, more likely to appear early in cases due to gunshots and treated in war hospitals than it is under other circumstances, because the patients are, from the necessities of the case, liable to be left on the field for long periods before being brought to the field hospitals, and the consequent over-distension of the bladder which may result from the primary condition of retention of urine may be extreme and produce damage to the bladder walls; and also in consequence of the general difficulties of aseptic work and of the sterilisation of instruments frequently met with on active service. The

Importance of sterile catheters.

retention should be relieved as soon as possible, and no catheter the aseptic condition of which is doubtful should be used. The best instrument for this purpose, when no stricture is present, is the soft-rubber Jacque's catheter, as it stands boiling with impunity. It should be boiled each time after use, then thoroughly washed in 1–20 carbolic lotion and kept in spirit until again required, being washed out with boric lotion before being used. In those cases in which there is complete incontinence and constant dribbling away of urine as it is secreted, the soft catheter should be left in the bladder, and the urine collected in a urinal, or led by means of a rubber tube to a vessel beneath the bed, in order to avoid moisture about the patient, which is so likely to hasten the formation of bedsores.

Efforts to keep bedsores aseptic.

Every effort should be made to keep bedsores as nearly aseptic as possible; they should be dusted with boric acid and iodoform, or with dilute double cyanide powder, and dressed in the usual way, but with a freer use of wool in order to lessen the effects of pressure. But no matter what care is taken in this regard these sores will become more or less septic. The

Anæsthetics sometimes required during dressings.

necessary movement of the patients, and the tenderness of the ulcers in some cases, cause great pain and distress during the renewal of dressings, and an anæsthetic may have to be employed each time they are changed.

Laminectomy.

Operative interference in these cases has never been very successful in its results. The reasons why it is even less likely to be so in cases of spinal injury due to small-bore bullets, in consequence of the probable presence of concussion effects, have already been alluded to. The indications for operation are the existence of the signs of spinal irritation and pain due to depressed bone, meningeal hæmorrhage, or the lodgment of a bullet in the vertebral canal, conditions under which it is conceivable that operation might be useful. Some of the conditions on which the symptoms depend might be shown by the use of skiagraphy; otherwise, the symptoms arising from them are so vague and uncertain that the procedures carried out amount merely to exploratory operations for the purpose of ascertaining the existing conditions and for remedying them, if possible.

As will be seen from Table 9, operations on the vertebral bones were performed in 7 of the 48 cases noted, with only two recoveries. In one of the latter (Case 45) it appears to have been undertaken for the removal of dead bone from the sacrum and neighbourhood of the sacro-iliac joint, the vertebral canal not being opened; the case was, in fact, not a "laminectomy."

The second case (No. 42) which recovered was operated on by Sir Wm. Bennett seven months after the receipt of the wound, and "half a Mauser bullet removed from the centre of the cord" in the lower dorsal region. This was a very unusual case; for although the cord had, of course, suffered a considerable lesion from the bullet, and all the signs of complete transverse section were present at first, improvement in sensation was noticed on 14th day, and in motor power on 28th day. The improvement continued after the operation, and was still going on at the time of Sir Wm. Bennett's last report, nearly two years after the injury occurred.

The following are the important details of the five operation cases which died :—

(1) Operation on fifth day—no damage to laminæ or pedicles. *Post mortem*: Cord partially divided; body of vertebra tunnelled.
(2) On 15th day—laminæ fractured, dura perforated, softened cord issuing.
(3) On eighth day—complete transverse section of cord found.
(4) On fourth day—posterior neural arch found uninjured; bone not interfered with; wound closed. *Post mortem*: "custard" condition of cord; no hæmorrhage; no trace of bullet track.
(5) On 12th day—no fracture of neural arch; dura opened to remove clot; none found. No *post mortem*.

Case No. 45 in the notes was a particularly interesting one, and affords an object-lesson for future guidance. On exposing the vertebra no fracture was found, but the laminæ were removed to ascertain if hæmorrhage had

occurred; there was none extra-durally, but the discoloration of the dura, which was uninjured but very tense, was such that intra-dural clot was suspected. The membrane was then opened for its removal, but none was found. A very considerable amount of the cerebro-spinal fluid escaped, evidently under high pressure, before the dura was sutured, and this was apparently the cause of the man's sudden death when he was turned on his back before removing him to bed, the explanation, presumably, being that the natural water jacket (or most of it) in which the brain and spinal cord are suspended having been allowed to escape, such a change in their condition occurred that they were unable to carry on their functions.

Danger of escape of cerebro-spinal fluid.

The lesson to be learned from this case is very apparent—the danger of allowing any considerable escape of cerebro-spinal fluid when it is found necessary to open the dura during the operation of laminectomy, and the advisability of keeping the head and upper part of the body dependent when the spinal dura must be incised, as recommended by Watson Cheyne and Burghard at page 291, Part IV, of their new work, a "Manual of Surgical Treatment," 1900.

Results of laminectomy in Boer War.

If "laminectomy" for gunshot of the spine may be correctly defined to be an operation undertaken *during the early days* of a case for the purpose of removing any of the causes of pressure on the cord, then none of the operations of this kind performed during the Boer War were successful. In one of the cases which survived (No. 46) the spinal canal was not opened at all, and in the other (No. 42) the operation was performed seven months after the wound, and considerable improvement had already taken place by that time. Of course, this case was one of "laminectomy" properly so-called, and a most satisfactory one as well, but it can hardly be placed in the category of procedures ordinarily referred to under that term.

Injuries of other parts complicating those of the spine.

Many of the spinal cases were, no doubt, complicated by wounds to other important parts—in the abdominal and pleural cavities and in the neck; but these additional injuries need not be alluded to in this section. They help to increase the death-rates in a class of injury very fatal on its own account, but they are common in all gunshots of this region.

The following table supplies the important details and the results observed in the 48 cases noted:—

TABLE 9.—Gunshot Injuries of the Spine (48 Cases).

Nature of Injury, &c.	Region of Spine Injured.						Total.		Percentages.	
	Cervical.		Dorsal.		Lumbar.					
	Cases 5	Died 3	Cases 41	Died 25	Cases 2	Died —	Cases 48	Died 28	Died 58·3	Recovered 41·6
With fracture of vertebral canal..	3	3	13	10	—	—	16	13	81·2	18·7
Concussion of cord .. .	2	—	15	7	2	—	19	7	36·8	63·1
With hæmorrhage	—	—	5	5	—	—	5	5	100·0	—
With direct lesion of cord by bullet	3	3	13	9	—	—	16	12	75·0	25·0
Bullet lodged	—	—	5	3	1	—	6	3	50·0	50·0
Condition of cord not ascertained	—	—	8	3	—	—	8	3	37·5	62·5
Operation, exclusive of extraction of bullet	—	—	7	5	—	—	7	5	71·4	28·5
Recovered, more or less completely	2	—	16	—	2	—	20	—	—	41·6
Died	—	3	—	25	—	—	—	28	58·3	—
Death-rates..	60·0 per cent.		60·9 per cent.		—		—		58·3	—

Remarks on Table 9.

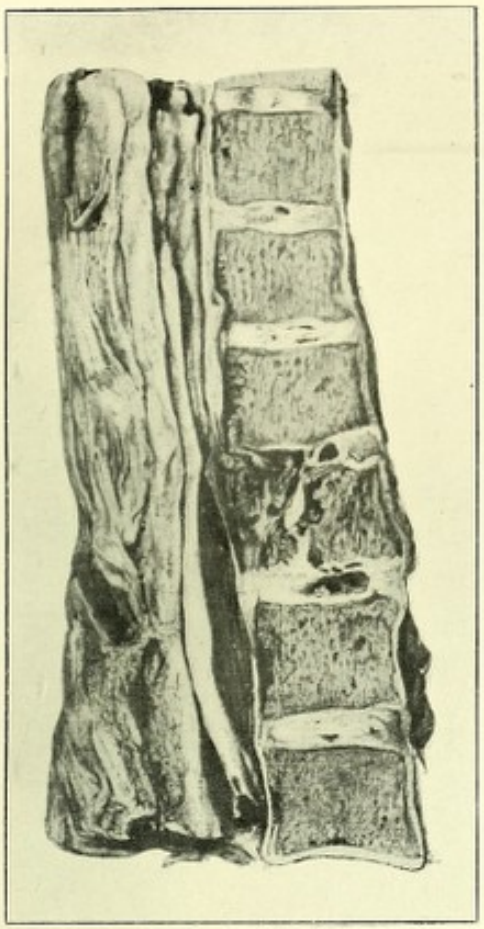
From the above table it will be seen that of the 48 cases noted, injuries of the dorsal region were the most fatal, the death-rate being 60·9 per cent. as compared to 60 per cent. for the cervical region. This reversal of the usual

ratios is, of course, due to the small number—only five—of cervical cases recorded, and that two of them were cases of slight concussion and recovered. In five of the 41 dorsal cases extra-medullary blood clot was found on *post mortem*, but it was impossible to determine what part the hæmorrhage played in producing the fatal result, because all of them showed conditions of the gravest character towards causing death, such as abscess of the lung, severe injury of the liver, and septic meningitis from extension of the infection from bedsores.

While the general mortality of the 48 cases was 58·3 per cent., that of those in which fracture of the neural arch or actual lesion of the cord (taking the two injuries together) had occurred was a little over 78 per cent.

Prognosis as regards life favourable when bedsores heal and cystitis disappears.

In cases where the injury is fairly low down, and when the bedsores heal and the cystitis disappears, life may be indefinitely prolonged, although the functions of the cord below the lesion are not recovered—that is, although the paralysis is complete, or almost so, and the loss of sensation is present over a wide area. In some of these more or less improvement may be hoped for as time elapses (*vide* Case 48).



Illustrating Mr. G. La Cheatle's Cases.

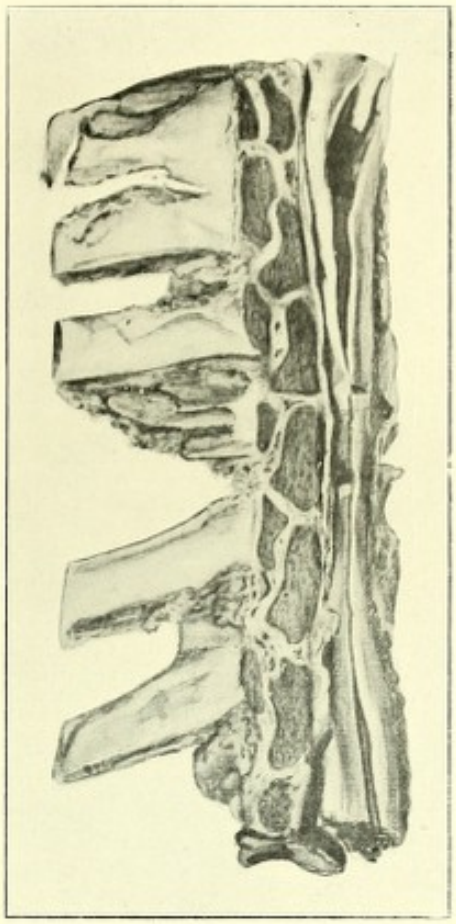


Fig. 10. Fig. 11.

Fig. 12.

Spinal Cord from Colonel Loughred's Case ; cord replaced by "custard material" ; no sign of bone injury.

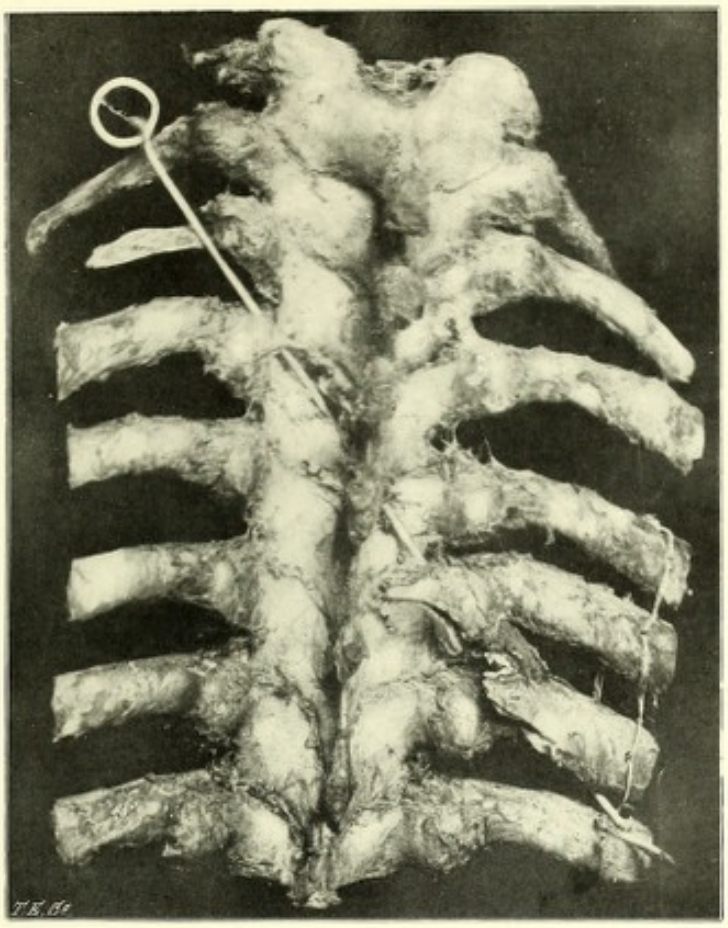


FIG. 13A.

Entrance left post. inferior triangle of neck ; exit near inferior angle of right scapula ; had motor and sensory paralysis to 2nd rib.—(Colonel LOUGHEED's Case.)

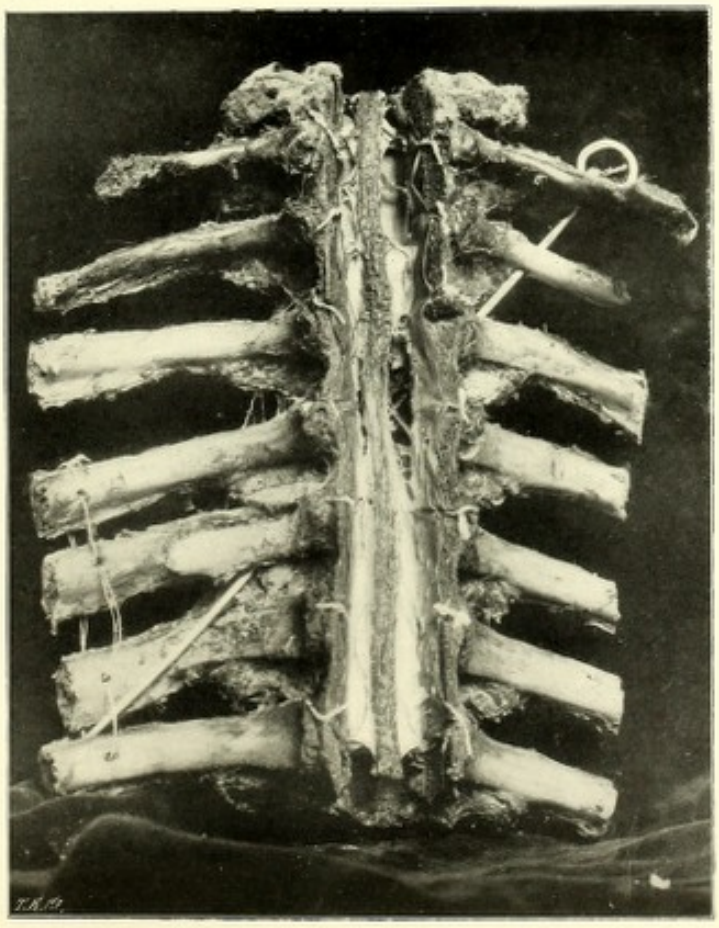


FIG. 14B.

Same Case, showing Cord.

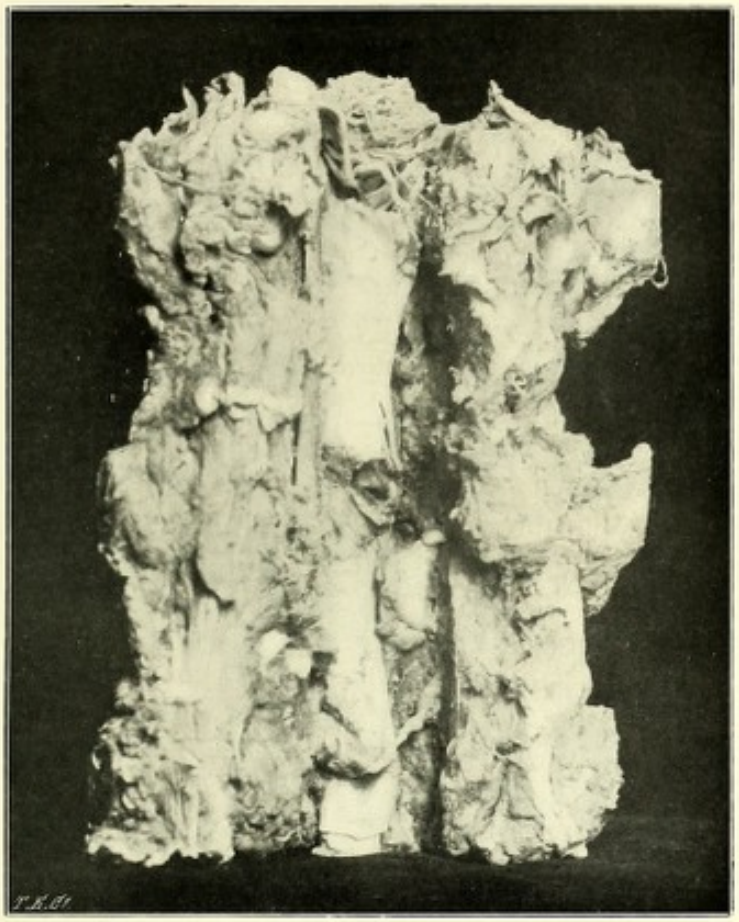


FIG. 15.
Mauser Lodged in Cord opposite 8th Dorsal Vertebra.—(Colonel LOUGHEED.)

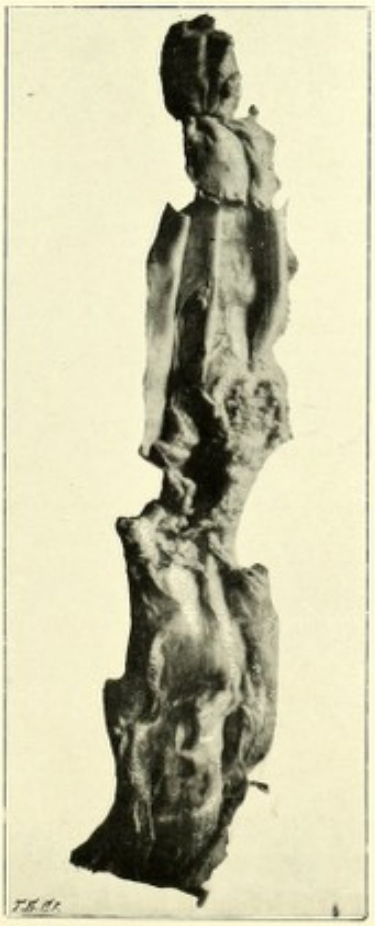


FIG. 16.
Bullet Grooved Cord at 10th Dorsal Vertebra.—(Colonel LOUGHEED.)

SECTION III.

By the Editor.

(Notes of Cases collected by Lieut.-Colonel Mallins.)

GUNSHOT WOUNDS AND INJURIES OF THE ABDOMEN.

Gunshot wounds and injuries of the abdomen may conveniently be divided into two principal classes—(A) Non-penetrating wounds and contusions, and (B) Penetrating wounds.

(A.) Non-penetrating Wounds and Contusions.

(14 Cases.)

Class A.

Of this class of abdominal injuries there were, so far as records of them show, comparatively few instances met with in the Boer War, and in many of these, judging from the notes given below, the diagnosis of non-penetration of the abdominal cavity was more than doubtful. In previous wars the majority of this class of injury has been due to kicks from horses or contusions produced by the wheels of gun carriages or wagons of various kinds; but in the Boer War no abdominal cases appear to have been the results of such injuries. The 14 cases recorded here were all due to projectiles of one kind or another. The diagnosis of non-penetration in these cases was always made to depend on the site and direction of the bullet track, and on the fact that the symptoms which followed did not justify a diagnosis of implication of the peritoneal cavity; but, as will be apparent from the notes, the correctness of the diagnosis of escape of the peritoneum may be open to question in some of the cases.

Contusions usually due to kicks from horses, &c.

All cases noted in Boer War due to bullets.

A very fatal class of injury.

This class of injury was by no means free of risk in other wars, in consequence of the probability of the occurrence of rupture of the solid and hollow viscera, and of the fact that the tears produced in a viscus from contusion is almost certain to be of such extent—much greater than those due to bullets—as to give rise to profuse extravasation in the one case, or to severe internal hæmorrhage in the other. Of all the cases seen in the American War of the Rebellion, 5·3 per cent. died, and of those complicated by rupture of the contained viscera 58 per cent. died.

All trivial cases except one.

Of the 14 cases seen in the Boer War one died, it being the only one in which any definite signs of internal lesion supervened. This case (No. 7) was, so far as I can ascertain, unique, for it was the result of a mere graze of the abdominal wall close to the umbilicus by a small-bore bullet. The cuticle was removed over an area of 1 inch by ¼ inch, but the true skin was not opened, while immediately beneath the site of contusion there were two ruptures in the ileum of considerable extent, giving rise to extravasation and general peritonitis, and death after a few days. Fig. 17 at end of this Section shows the abrasion of the cuticle and the ruptures of the ileum; the specimen is now in the R.A.M. College Museum.

Reasons why exploration is advisable in contusion cases.

As regards the treatment of Case No. 7, and of others of a similar nature due to different causes in which signs of peritonitis follow, it is probably correct to say that they all require an exploratory operation immediately definite symptoms develop. The difficulties of doing aseptic work in the field, and especially in South Africa, which will be referred to later on, should not be permitted to deter surgeons from performing laparotomy in cases of this character. So many penetrating small-bore bullet wounds of the abdomen recovered without operation in the Boer War, and the deaths following

operative interference were so numerous that it soon became evident that, under the conditions which obtained in the late campaign as regards aseptic surgery, there was a greater danger of death following when operations were immediately performed than when merely expectant treatment was employed; that, in fact, determining on non-interference was choosing the lesser evil.

Visceral lesions from contusion always severe.

But where solid or hollow viscera have been ruptured by contusion of the abdominal walls, and evidences of internal hæmorrhage or of peritonitis develop, these complications are so certain to prove fatal in consequence of the great extent of the local damage produced within the abdomen, that operation becomes the lesser evil, and should be proceeded with. Many cases of small-bore bullet wounds traversing the abdomen recovered without operation; but few, if any, of the cases of internal rupture from contusions fail to cause death, and recovery can hardly be expected unless the hæmorrhage can be controlled, the apertures in the intestine closed, and the peritoneum washed out by means of a laparotomy.

Moreover, the arguments against operation in bullet cases do not hold good in the latter class of injuries; for the peritoneal cavity is already in an extremely infected condition in consequence of the large amount of intestinal contents which has been extravasated through the larger apertures usually caused by contusions, and therefore the conditions of field surgery which are so often adverse to aseptic work need hardly be feared as being likely to add to it. Granting the correctness of this line of reasoning, the necessary conclusion follows that when symptoms develop—either of hæmorrhage or of peritonitis—after a severe contusion of the abdominal walls, operative interference should be immediately proceeded with irrespective of circumstances which are, in other cases, taken to preclude its employment. Chavasse puts the mortality following on rupture without external wound at 96 per cent. ("A System of Surgery, edited by Frederick Treves," p. 567); this enormous death-rate must surely be reduced by operation.

When symptoms follow in contusion cases exploration is justified.

The symptoms which occurred in the cases of non-penetrating wounds and contusions of the abdomen cannot be referred to here, because no details of value are given in the notes of cases; it would, in fact, appear that practically no symptoms supervened in any of them except the one which died. Of the 14 cases the mortality rate was 7·1 per cent.

Gunshot Wounds of Abdomen (Non-penetrating).

Flesh wound of parieties—No abdominal signs—Recovered.

Case 1.—W. B., wounded 18th February, 1900, at 600 yards range; admitted 3 General Hospital four days later.

Entrance left side of pelvis ½ inch below crest and 3½ inches behind ant. sup. iliac spine; no exit. Bullet removed from under skin 3¾ inches from mid-line of abdomen on a level with ant. sup. iliac spine.

Lying prone when shot; bullet pierced edge iliac crest, and some necrosis took place, but, except for "slight stiffness," was discharged quite well 41st day.—(Civil Surgeon A. Young.)

Flesh wound of parieties—No abdominal signs—Recovered.

Case 2.—G. B., wounded 25th May, 1900, at about 50 yards range; admitted 3 General Hospital eight days later.

Entrance ¾ inch above umbilicus and 1½ inches to right of mid-line; exit over eighth rib 5 inches from its sternal end. Bullet was deflected by a button—entrance and exit large (former ¾ inch by ½ inch, latter 1¼ inches by ¾ inch); both wounds discharging freely, otherwise no disturbance; sent to Cape Town next day.—(Civil Surgeon A. Young.)

Flesh wound of parieties—No abdominal signs—Recovered.

Case 3.—C. B., wounded 19th May, 1900, at 90 yards range; admitted 3 General Hospital 14 days later.

Entrance 1 inch to right and 1¼ inches above umbilicus; exit over eighth left rib, 5¼ inches diagonally from entrance. Kneeling when hit; both wounds large (entrance, ¾ inch by ½ inch; exit, 1½ inches by ¾ inch); both suppurated, but otherwise nothing serious; flesh wounds of both legs and right heel also; sent to Cape Town next day.—(Civil Surgeon A. Young.)

(?) Flesh wound of parieties—(?) No abdominal signs—Recovered.

Case 4.—Private P., wounded 16th February, 1900; admitted 4 Stationary Hospital next day. Entrance (shrapnel), circular with bruised edges, midway between left last rib and iliac crest; no exit. Abdomen hard and tender; complains of pain about umbilicus, but symptoms obscured by morphia; under anæsthetic track was found to pass towards lower end of kidney; no signs of injury to peritoneum or viscera; "did well"; sent to 4 General Hospital for X-raying.—(Civil Surgeon A. Nuthall.)

Flesh wound of parieties—No abdominal signs—Recovered.

Case 5.—G. H., wounded 21st February, at 350 yards range. Entrance (Mauser) right loin; exit below right costal margin at ninth rib. Simple flesh wound which "healed quickly and well."—(Hospital Records.)

Flesh wound of parieties—No abdominal signs—Recovered.

Case 6.—Wounded at Rhenoster Kop. Entrance (Mauser) 2 inches above Poupart's ligament and 1 inch to inside of right ant. sup. iliac spine; exit just below and outside pubic spine same side.

Abdomen rigid and painful; pulse rapid, and temperature 100° F.; swelling and induration in bullet track; glands in groin enlarged; no symptoms of penetration; had to remain in bed some weeks, but eventually returned to duty.—(Hospital Records.)

Mere contusion of abdominal parieties by Mauser bullet—Rupture of ileum—Died.

Case 7.—This was a peculiar case. The patient was struck by a Mauser bullet a little above the umbilicus, but in such an oblique direction that the skin was only grazed and the cuticle removed over an area 1 inch by ¼ inch in extent without injury to the true skin. Peritonitis set in and the man died on seventh day. On *post mortem* two ruptures were found in the ileum immediately beneath the point of impact by the bullet. The specimen is now in the museum of the R.A.M. College, and Fig. 17 is a photograph of it, showing the abrasion of the skin and the ruptures in the gut.

Flesh wound of parieties—No abdominal signs—Recovered.

Case 8.—Corporal T., admitted 3rd May. Entrance (Mauser) below ant. sup. iliac spine; no exit. "Bullet removed from deep abdominal muscles, just external to iliac artery. External cutaneous and anterior crural nerves damaged. The momentum of bullet was lessened by its passage through a plug of tobacco labelled 'Lucky Hit Tobacco.'" Recovered.—(Civil Surgeon J. W. Smith).

Contusion of abdomen by shell fragment—No abdominal signs—Recovered.

Case 9.—Corporal W. received a graze by a shell fragment over left lower quarter of abdomen, which appeared to have caused little inconvenience. He also had in addition a very severe shell wound of right knee-joint, fracturing femur, and a flesh wound of inner side of left thigh. After seven days he was transferred by convoy to Kroonstad, with little pain, and temperature 99°.—(Civil Surgeon W. Sheen.)

Flesh wound of parieties—No abdominal signs—Recovered.

Case 10.—Drummer L., wounded 11th February, 1902. Entrance ½ inch above crest of ilium and 4 inches from ant. sup. iliac spine; exit 3 inches above, in same vertical line.

Left on veldt nine hours; no abdominal distension or vomiting; slight impairment of movement. Kept quiet and on starvation treatment; good recovery; returned to duty.—(Captain H. Walton, R.A.M.C.)

Flesh wound of parieties—Extra-peritoneal abscess opened and drained—Recovered.

Case 11.—Private W., wounded 18th February, 1900; admitted 2 General Hospital about end of same month.

Entrance (Mauser) at outer and lower part of left buttock; exit at top of 12th right rib—bullet glanced off ilium and crossed spinal column in its course, fracturing second lumbar spinous process.

Exit wound soon closed but entrance suppurated; considerable pain in latter, and also above outer part of Poupart's ligament; fulness extending to umbilicus soon appeared; extra peritoneal abscess opened over Poupart's ligament and drained; wound healed; invalided after three months with limited movement of hip joint.—(Records 2 General Hospital.)

Contusion of abdomen by shell—Melena—Hæmaturia—Recovered.

Case 12.—Dr. McB. struck by an empty shell case, 28th November, 1899, which ricocheted from ground and hit his water-bottle, which was hanging over his epigastrium; fell from his horse on some large stones and lay unconscious for an hour.

Vomited much blood when he came to; melena and hæmaturia for two days; tingling down both legs for a week.

Admitted 2 General Hospital ninth day; walked much bent, with the aid of a stick; slight rigidity and pain on pressure in epigastrium; sensation normal in both legs; motor power very much diminished and knee jerk on same side lessened; no irregularity of spine, but pain on pressure over lumbo-sacral region, and rotatory movement caused much pain. Remained in this condition till 21st day, when while sitting on ground he was forcibly pulled backwards by another patient at play; suffered much pain, fainted, and was carried to bed; found now to have complete motor paralysis of both legs; sensation normal and knee jerks increased. "Next day at 1 p.m. complained of severe shooting pains in lower abdomen and both legs; five minutes later found he could move toes, and in an hour could flex his knees and extend and raise both heels off the bed." From that date he rapidly regained power in both legs and soon could walk quite straight. Recovered almost completely when invalided 80th day.—(Records 2 General Hospital).

(?) No penetration—No abdominal signs—Recovered.

Case 13.—Private D., wounded 12th February, 1900, at 100 yards range; admitted five days later. Entrance (Mauser) on most prominent part of right buttock; exit just above centre of right horizontal pubic ramus. Neuralgia of great sciatic with hyperæsthesia of sole of foot; slight rise of temperature. Slightly improved when invalided a month later.—(Civil Surgeon Stuart.)

Flesh wound—No signs of penetration—Recovered.

Case 14.—Corporal McC. admitted 10th June, 1900. Entrance (Martini-Henry) 1½ inches below right iliac crest and 1 inch behind ant. sup. spine; no exit.

Sinus passes backwards 6 inches to sacro-iliac joint on same side, where X-rays show bullet; suppuration two days after injury; intense sciatica on that side.

Two months later, when invalided, pain had disappeared, but sinus leading down to bullet remained.—(Civil Surgeon Rowell.)

(B.).—Penetrating Wounds.

(207 Cases.)

Wounds of one viscus only seldom seen.

In discussing the subject of penetrating gunshot wounds of the abdomen, on the notes of the details available of the 207 cases recorded in the Boer War, or, indeed, under other circumstances, it is almost impossible to differentiate the symptoms and the death-rates due to injuries of the various individual viscera. When, from the presence of certain symptoms and from the direction of the bullet track, injury of any particular viscus is assumed to have taken place, it is practically impossible to exclude the occurence of injuries to other viscera as well, or to recognise how far the symptoms and the mortality depend on the damage done to the viscus in question, and how far they may be due to wounds of other parts within the cavity in its neighbourhood or at a considerable distance from it.

Wounds of some special organs within the abdomen, as, for instance, the liver, the stomach and the kidney, commonly give rise to signs which are peculiar to themselves; but, on the whole, the symptoms produced by a penetrating gunshot wound of the abdomen must usually be those of injury to more than one portion of its contents. The one symptom which is common in most cases, when any symptom occurs, is, of course, peritonitis. With regard to the death-rates, it is still more difficult, without *post mortem* examination, to decide how far they are due to injury of particular organs, except that peritonitis or internal hæmorrhage are the causes of all the deaths which take place; and these may result from almost any penetrating wound.

In summing up, therefore, the notes of the cases, and specially with regard to mortality rates, the most useful method appears to be to refer to injuries of a particular viscus as being so when "it *seemed* to be the only one wounded," or when, "in conjunction with probable wounds of other viscera, it appeared to be the principal organ wounded," principal, that is, as regards its tendency to cause death. Wounds of particular viscera.

One of the most remarkable observations made in the war in connection with penetrating gunshots of the abdomen was the large percentage of cases in which no signs of visceral lesion were noted, viz., 22·3 per cent. But evidently the phrase "no signs of visceral lesion noted" refers to the absence of symptoms soon after, or, sometimes, for many days after the receipt of the wounds, for later in the course of 8 of these cases, operations had to be performed, with 3 deaths, as will be seen from Table 11; in fact, 3 out of the 4 deaths under this heading took place after operations had been performed, but they were all cases in which severe peritonitis had supervened. Penetration without symptoms.

Dividing Class B into three sub-sections will enable the discussion of these cases to be made more clearly :— Sub-division of Class B. Penetrating wounds.

Sub-section I, including all cases in which both the symptoms and the known direction of the track of the bullet strongly indicated wound of a particular viscus;

Sub-section II, including all cases which, judging from the direction of the track of the bullet, injuries of particular viscera were strongly indicated, but in which the symptoms were too indefinite to render perforation of a particular viscus undoubted; and

Sub-section III, including all cases in which no symptoms of visceral lesion were to be noticed.

The cases coming under these three sub-sections were by no means clearly distinguished from each other by well-defined limits; on the contrary, they shaded into each other, especially the two first, and to such a degree that Mauser bullet wounds of the abdomen became one of the curious enigmas of the Boer War. In some of the cases—and a large proportion, too—absolutely no signs of visceral lesion developed, although the missile evidently had traversed the anatomical regions occupied by certain viscera. In others, indefinite and ill-developed signs, only warranting suspicion of visceral injury, showed themselves; while in others the signs were so well marked that damage to the contents of the cavity was beyond question from the first. The cases shade into each other.

Most surgeons went to South Africa anticipating the production of such wounds of the hollow viscera by small-bore bullets traversing the intestinal area as would be practically certain to be followed by extravasation and peritonitis, and that those implicating solid organs would be complicated by severe internal hæmorrhage. With these preconceived ideas it was natural for them to conclude that laparotomy would afford the only hopeful means of treatment, as by it alone could the internal lesions be repaired, the peritoneum washed clear of infective matter, and hæmorrhage controlled. But it is safe to say that everyone was surprised by the occurrence of cases of the class above referred to, cases in which it was evident that the intestinal area or the situation of the solid organs was traversed and signs neither of peritonitis or hæmorrhage presented themselves. Pre-conceived ideas of the effects of penetration.

Sub-section I.—In this class it is convenient to include some cases which showed severe general symptoms, but in which the recognition of the particular viscus wounded was only made at *post-mortem* examination. There were 114 cases recorded under this sub-section, with 54 deaths. Cases presenting marked symptoms.

Sub-section II.—In this class there were 46 cases with five deaths, and, as in these cases diagnosis of the particular lesion was doubtful, a note of interrogation is placed in the marginal notes after the viscus supposed to be wounded. Cases with doubtful symptoms.

Sub-section III.—In this class there were 46 cases with four deaths—one apparently due to peritoneal infection from outside (Case 161), and three from peritonitis setting in suddenly during convalescence. Cases with no symptoms.

When the cases that died, which sooner or later developed general peritonitis, are removed from Sub-sections II and III, there still remain in these two classes together, 83 cases out of the total 207, which showed no

symptoms whatever, or in which the symptoms were so indefinite that, but for the direction of the bullet track, lesions of viscera would never have been suspected in them. Thus it happened that in as large a proportion as 40 per cent. of the 207 cases of penetrating gunshots of the abdomen, diagnosis of visceral lesion was impossible.

Mauser wounds.

This matter becomes still more interesting if Mauser wounds only are considered, excluding cases due to shell fragments and bullets of the larger types. Of these there were 183. Omitting the nine fatal cases which, although entered as coming under Sub-sections II and III, developed peritonitis and died, leaves 74 cases out of 183 Mauser wounds through the abdominal cavity in which damage to the contained viscera could not be diagnosed because no symptoms of such complications presented themselves; this means that 35·7 per cent. of penetrating Mauser wounds of the abdomen, judging from the absence of symptoms in these cases, appeared not to be complicated by perforation of the viscera.

The cause of apparent escape of intestines from injury.

While the cause of this apparent immunity of viscera to injury is mostly an academic question, it is also one of some practical interest. In former wars, when slower-travelling bullets were used, it was attributed to the fact that the loose attachments of most of the hollow viscera, their slippery surfaces, and the slight resistance offered by them, enabled them to slip aside without receiving injury. Many instances of this kind are referred to in the "Surgical History of the War of the Rebellion," although the evidence in favour of this explanation in the majority of them is far from being unequivocal, as is pointed out by the authors of that work.

But to take for granted, as has been done by some surgeons, that the same theory is sufficient to explain similar cases due to Mauser bullets is to assume too much. Dr. Parks, of Chicago, experimented on anæsthetised dogs by firing bullets of small calibre through their abdominal cavities in the intestinal area, and found perforations of the intestines in every case where the site of the bullet track led him to expect them.

Insufficiency of supposed slipping aside of intestines.

The theory that the intestines slip aside and so escape perforation, in those cases where symptoms do not arise, does not appear to fall in with the known characteristics—small diameter and high velocity—of the modern rifle bullet. If cases of the kind were the exception, and few in number, it might, perhaps, be admitted that this very unexpected and extraordinary state of things was present; but, on the contrary, in the Boer War cases of apparent immunity of the intestine, when penetration of the cavity was unquestionable, formed a large proportion of the abdominal cases met with. Indeed, so many cases of this kind were seen, and so many of them recovered without operation, that their occurrence became one of the main reasons why surgeons felt that operative interference was not warranted in abdominal cases until such symptoms had supervened as demonstrated the hopelessness of the cases unless operations were undertaken; that, in fact, the older theory that diagnosis of mere penetration justified laparotomy must be abandoned, and that the onset of symptoms must be awaited before surgical procedures were carried out. For this is certainly the outcome of our experience in the late campaign, at all events under the circumstances which existed in South Africa as regards the difficulties, often quite insuperable, of doing even fairly aseptic work on active service.

Some cases in this category *had* sustained visceral lesions.

It is significant also to observe that some of the cases which the surgeons who noted them considered properly placed in the category of "No signs of visceral lesion noted" were certainly not cases in which no lesions had occurred; no symptoms appeared during the early stages of their treatment, but complications supervened later, and, either during operations or at *post-mortem* examinations, apertures were found in the intestines. And, furthermore, it is not justifiable, in this connection, to lay much stress on the fact that, at some *post-mortem* examinations made a month or more after the receipt of the wounds, it is not definitely stated in the notes that perforations were discovered. In the hurry and pressure of field work it is likely that the examinations were hastily and incompletely made; suppurative peritonitis and adhesions were present, and even under the most favourable circumstances small perforations may be difficult to find after the lapse of so long a time, or they may have so healed as not to be visible, as happened in Case 161.

That signs of peritonitis do not almost immediately set in must, of course, depend on one of two things: (*a*) that apertures are not produced in the bowel wall, or (*b*) that extravasation sufficient to cause symptoms does not occur. Which is the most probable explanation is the moot question. The inference to be drawn from the argument that integrity of the intestine must be the only reason for the absence of symptoms is that all apertures in the bowel wall must cause extravasation sufficient to produce signs of peritonitis, but this may not be a sound conclusion to arrive at. The average size of a normal Mauser aperture in the intestine is quite minute—$\frac{1}{3}$ of an inch or less. No doubt there is a tendency to leakage, no matter how small the hole may be; but if any conditions can be suggested that would tend to assist this character of the opening (its minuteness) in limiting the amount of the extravasation, it is conceivable that it might be so small in quantity that general peritonitis need not necessarily follow. Many causes which must tend to limit the extravasation from normal Mauser holes are present in gunshots of the intestine—(1) the small size of the aperture; (2) hernia of the mucous membrane; (3) paralysis of the gut due to the injury, causing cessation of the onward movement of the contents; (4) closure of the holes from the effect of the cross-action of the contraction of the longitudinal and circular muscular coats; (5) escape of gas and consequent collapse of the gut; and, most important of all, (6) the rapid formation of adhesions sealing the apertures against adjacent coils. Furthermore, certain conditions are of importance in assisting these causes, or, rather, in permitting them to have the effect of limiting the amount of extravasation—(*a*) an empty state of the bowel, the wounded man not having had food or drink for some hours before being injured, and his not receiving any before arrival at the field hospital; and (*b*) that he has the good fortune not to be disturbed by being transported, either by stretcher or wagon, towards the rear soon after the receipt of his wound.

Perforation without leakage to any extent the true explanation.

In many of the cases in which no symptoms supervened, such remarks as "lay where he fell for several hours," "was not brought in for 12 hours," "was treated at first in a farm-house," are made, showing that many of these patients were not soon subjected to movement. Sir F. Treves* alludes to the bad effects of transport with regard to the abdominal cases at Spion Kop, saying that "they were, from a surgical point of view, hopeless, having been carried by hand and wagon over the difficult road between the top of the hill and the field hospitals." He* also states that he is "certain that the hole (in the gut) is closed almost directly by the apposition of other coils of intestine." There are notes of two cases of abdominal wounds sustained by officers of the Medical Service which are of special value in this connection; both patients were fasting when wounded, and refused to take water when offered to them, and both lay where they fell for many hours; both recovered and are still serving.

For adhesions to form rapidly between the adjacent coils of intestine, it may be said that some slight amount of extravasation is useful, for by means of the irritation set up by it, Nature is prompted to initiate the processes by which the adhesions are developed. Three or four hours (or even less) have been found sufficient for the formation of adhesions sufficiently firm to close apertures in intestines, and if, during that time, the patients are left undisturbed, these may be effective in closing off the general cavity of the peritoneum from any widespread infection. Unless these adhesions are broken down by movement, no symptoms will follow; or, if the infection has occurred to a somewhat greater extent, a localised peritonitis, or intra-peritoneal abscess, may be produced, and may be treated in the usual way by incision and drainage when its position becomes evident, with a good prospect of successful result.

While admitting the bare possibility of bullets of small calibre passing through the intestinal area without causing visceral lesion, it must be that the number of such cases would be represented by a very small fraction per cent. It is contrary to the results of experiment and to the known probable effects of a small bullet at its ordinary rate of velocity.

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* "Medico-Chirurgical Transactions," Vol. LXXXIII, May, 1900.

Mr. Cheatle's case (No. 74) has been put forward by him and quoted by many others, as proving the possibility of a bullet traversing the area of the small intestines without injuring them; but in reality it proves nothing of the sort. Careful examination of three bodies in the *post-mortem* rooms at St. Thomas's and St. Mary's Hospitals demonstrated to me and to the surgeons working there that, with the entrance and exit wounds in the situations fixed by Mr. Cheatle, the track of the bullet between the cæcum and sigmoid flexure had been almost entirely extra-peritoneal, through probably the body of the last lumbar or first sacral vertebra, and not amongst the intestines in front of these bones, and that this was the true explanation of the escape of these viscera, not that the bullet had passed amongst them without injuring them* (Figs. 18, 19, and 20). Such observations, too, in the notes of cases as "no perforations seen," and the like, are by no means convincing that perforations had not been produced; they sometimes heal quickly, and they are often overlooked at operations. It would truly be an extraordinary fact if, in the cases noted below, absence of visceral lesion were the true explanation of absence of symptoms, for this was noticed in 22·2 per cent. of them. It is a still more unexpected event that no leakage should take place from wounds in such large arteries as the axillary and superficial femoral, but Nos. 83, 84, and 126, under "Wounds of Arteries," are cases in point where no extravasation of blood was found when the vessels were seen at operations or on *post-mortem* examination.

The site of the bullet track the only evidence in many cases.

Some special organs afford special symptoms of having been injured—hæmatemesis in stomach cases, escape of bile in liver cases, occasionally; hæmaturia in kidney cases; hæmaturia and escape of urine in bladder cases. But many of these symptoms may be present in any case, with peritonitis common to all except where the large intestine, bladder, or kidney is wounded extra-peritoneally, and even in these the peritoneum may become infected by extension from the extra-peritoneal wound. The symptoms present, then, in any particular case are the sum of the symptoms due to injuries to the various viscera implicated in the bullet track; and, as in many of them no symptoms at all develop, it happens that the direction and site of the bullet track, combined with the known anatomical positions of the contents of the abdomen, are the only reliable signs indicating the probability of damage to any particular part within, and the probability may be taken as the highest possible when these conditions point to it.

Transverse and oblique wounds the most fatal.

The amount of damage a bullet traversing the abdominal cavity is capable of producing on the contained viscera depends largely on the direction in which it passes. Transverse, vertical, and oblique wounds are more dangerous than antero-posterior ones, because in them the perforation of the hollow viscera are certain to be more numerous, and injuries of the solid viscera are likely to be produced as well. This opinion has always been held, and the experience of the late war further corroborates its correctness. Sir Frederick Treves† evidently takes this view, for in dealing with the question of laparotomy on a campaign, he states that he "would exclude from operations all cases of transverse or oblique wounds above the umbilicus, because it is practically impossible to do all that is required" in these cases.

Internal hæmorrhage.

Internal hæmorrhage from omental or mesenteric vessels, or from solid organs, exclusive of mere hæmatemesis, hæmaturia, or melena, occurred in 25 cases—that is, in 12 per cent.; and of these 25 cases, 17, or 68 per cent., died. These figures by no means represent either the incidence of this complication or the death-rate really due to it for the total number of abdominal cases met with during the whole war; for it must be remembered that the cases from which they are derived had all lived long enough to reach field or stationary hospitals, whereas the majority of such cases, when medium or large vessels are wounded, die on the field before surgical aid can be given them.

Leakage from hollow viscera.

Extravasation of the contents of those hollow viscera which have a complete peritoneal coat did not, as already stated, occur to any marked degree in nearly all the cases where the bullet traversed the cavity of the abdomen, and its absence, or inconsiderable amount, is referred to frequently

* *See* "Journal of the R.A.M. Corps" for January, 1905.

† "Medico-Chirurgical Transactions," Vol. LXXXIII.

in the *post mortem* reports. But it was indicated by peritonitis, which was present more or less in 164 cases, or 79·2 per cent. ; and of these 164 cases, 59, or 35·9 per cent., died. But when those parts of the large intestine or of the bladder which are devoid of peritoneum were wounded, extravasation into the cellular tissue invariably occurred, giving rise to cellulitis and septicæmia, and usually causing death, showing, as Mr. Makins has observed, that extra-peritoneal wounds of the hollow viscera were more fatal than those in which the peritoneal surface was opened, exactly the reverse of what was formerly believed to be the case. In some few of these peritonitis did occur from extension of the infection from the extra-peritoneal wound to the neighbouring peritoneum.

With regard to the remaining 43 cases, in which peritonitis is not noted, it may be that any slight signs which developed in them were masked by the use of morphine.

Bullet lodged.

The bullet lodged in 41 cases, or the large proportion of 19·8 per cent. This is explained by the length of the bullet track in some of these cases, extending as it did from the upper part of the chest to the pelvis, and by the fact that it frequently passed through the pelvic and other bones. The missile, including a fuse-screw and a shrapnel bullet, was extracted in 19 cases, or 46·3 per cent., of the total cases in which it was retained. In two other cases, Nos. 105 and 114—one of which, 114, was quite a surgical curiosity—the bullet was passed or extracted through the urethra. Mr. Makins reports a third case in his "Surgical Experiences."

Laparotomy for Gunshot Wounds of the Abdomen.

Apparent necessity of operations in all cases.

On the supposition that all bullets which traverse the abdominal cavity produce visceral lesions, and peritonitis or internal hæmorrhage, the teaching, previous to the Spanish-American and Boer Wars, regarding the treatment of penetrating gunshot wounds of the abdomen, was that they could hardly recover unless laparotomy was performed, and the intestinal apertures closed, the hæmorrhage controlled by ligature, and the extravasated matter washed out of the peritoneal cavity. This conclusion was a perfectly logical one to derive from the premises—that penetration always included visceral lesion, and that visceral lesion always included extravasation and general peritonitis, or internal hæmorrhage, and death in either case, unless operative interference were undertaken in order to carry out the necessary procedures.

Experience proved operation not always required.

But practical experience in both the late wars has proved that the premises were incorrect, and, therefore, the conclusion wrong. It may be true that penetration does not always mean visceral lesion and the fatal complications and results above named; but it is unquestionably true that penetration does not always include such visceral injuries as must inevitably result in extravasation of the intestinal contents in such quantity as will certainly produce general peritonitis.

The majority of surgeons who went to South Africa during the early days of the war were convinced of the correctness of the old theory in this connection ; thus they naturally believed that laparatomy was the only means to employ on recognition of penetration in abdominal cases. They believed, in fact, that the same procedures should be carried out on a campaign as would certainly be employed on similar cases in a civil hospital at home. But it is here that the differences in the circumstances under which these cases have to be treated on active service and at home come in for consideration. A surgeon is not justified in exploring the abdomen, unless death is otherwise inevitable, if he cannot practically guarantee such aseptic conditions of the wound he makes, and of his hands and instruments, that he will be enabled to remove all infective matter already free in the cavity, and that his procedures will add none to that already present—in a word, that the wound will run an aseptic course. These conditions are to be obtained in a civil hospital ; the surgeon has unlimited possibilities as to assistance at such operations, as well as for nursing the cases afterwards ; the operations can be done deliberately and at leisure, not at a time of over-pressure of work with the hospital suddenly filled with wounded men ; the surgeon and his assistants who do them are

Circumstances of civil hospitals and war hospitals different.

not hampered by the knowledge that spending hours on operations on these men, the majority of whom will die in any case, entails the neglect of the treatment of others who will probably die or lose their limbs as the direct consequence of that neglect; and, besides, patients with abdominal injuries are fairly certain to reach the civil hospital for treatment within six hours of the accidents to which they are due.

Favourable conditions absent in Boer War. Water for lotions not obtainable.

None of these favourable conditions were present in South Africa, and seldom can be calculated on in any campaign; but the circumstances which were especially against the performance of laparotomy in the Boer War were those on which depended the impossibility of anything like really effective antiseptic surgery at the front, in the field hospitals, where these operations must be done to give good results. Thoroughly antiseptic work is impossible without a practically unlimited supply of the various antiseptic lotions, and this predicates an unlimited supply of water suitable for making them. This was where antiseptics failed to a large extent during the Boer War. Water suitable for lotions was seldom available; what could be obtained was nearly always muddy, and, therefore, would not pass through a Berkefeld filter; it was, on many occasions, unspeakably dirty and foul-smelling, contaminated with excreta of cattle and of human beings. Water from the rivers was bad, especially from the Modder, but that collected in "pans" was worse. Boiling was, for the most part, impossible, because fuel was scarce and seldom to be obtained in sufficient quantity even for cooking purposes. Under these circumstances, as might be expected, laparotomies failed to save patients on whom they were performed in as high a proportion as 69·2 per cent., and the cases which recovered were, with two exceptions, only those in which the manipulations which were required within the abdomen were of the simplest kind; of the 15 cases in which the intestines were repaired by suture or resection 73·3 per cent. died.

Laparotomy at stationary hospitals.

The difficulties as to water for lotions and for the sterilisation of hands and instruments did not, of course, exist at general and stationary hospitals; means were to be obtained there for operations under fair or good conditions as regards "antiseptic precautions." Accordingly it happened that the two successful resections (Nos. 36 and 45) out of the three noted below were performed at fixed hospitals—one by Dr. Neale at Estcourt, and the other by Mr. P. Luke at Kroonstadt. Both cases were treated under the most favourable conditions, Neale's six hours, and Luke's 12 hours, after the receipt of the wounds. The third resection was done at a field hospital, and died. Of the other six recoveries in which the abdomen was opened:—

2 were for suture of the intestine;
1 was for colotomy;
1 was for artificial anus; and
2 were for the purpose of irrigation and drainage of the cavity.

Most of these also were treated at fixed hospitals, and were not primary laparotomies.

Primary laparotomies practically abandoned.

Seeing the great mortality which followed operations on the abdomen, surgeons soon practically abandoned primary laparotomy in field hospitals; then many cases of evidently penetrating wounds were found to have recovered with little or no indication of visceral lesion, and soon it seemed to be the generally accepted opinion that no abdominal case required operation, certainly not as a primary laparotomy, and only at a later period if the symptoms present showed that recovery was hopeless without it; but by that time they were usually hopeless in either case, with or without operation. In consequence, then, of the impossibility of doing these operations under even fairly good antiseptic conditions and of their high mortality, as well as of the fact that many cases recovered without interference, it is evident that the old theory of the necessity of performing laparotomy in all penetrating gunshot wounds of the abdomen requires modification to the extent that operations are not justifiable unless such symptoms occur as point strongly to the onset of peritonitis, and not even then if means and materials for antiseptic work are not available.

Laparotomy for internal hæmorrhage.

On the other hand, operation for the control of internal hæmorrhage in abdominal cases is in a different position. When large vessels within the

abdomen are wounded, the cases, of course, do not reach the field hospitals. But when medium and small vessels are lacerated, death may not occur so rapidly, and cases of this kind do come under observation and may be amenable to treatment, and, naturally, this can only be carried out when the abdomen has been opened. Even the smaller vessels in the abdomen give rise to persistent hæmorrhage when torn; there is little or no tendency to clotting in their cut ends, nor can any tension be set upon them such as would tend to cause cessation of bleeding into the more resistant structures of a limb; even small vessels in this situation tend to bleed until a ligature is applied, or death takes place.

Hæmorrhage from Mauser wounds in solid viscera.

Hæmorrhage to any dangerous extent from Mauser wounds in solid organs seldom occurred, except occasionally in the case of the liver and the spleen; and wounds even in the latter organ do not, as formerly thought, always continue to bleed until death or operation puts an end to it. Sir F. Treves has recorded a case (No. 44) on which he operated and found a large amount of blood in the abdomen, the result of wound of the spleen, but the hæmorrhage had ceased; and another precisely similar case was published lately, but I am at present unable to give the reference.

Hæmorrhage for which operation is necessary.

The abdominal cases in which internal hæmorrhage occurs, and which may, nevertheless, come under observation in field hospitals, are usually those where the vessels of the omentum or mesentery, or of the hollow viscera, are implicated, and in these cases, as already pointed out, the loss of blood usually proceeds until death takes place unless controlled by operation.

These cases are in a different position to that of cases of merely suspected lesion to hollow viscera. Many of the latter recover without operation; very few, if any, of the former do. The logical conclusion to arrive at, then, is that in cases in which internal hæmorrhage is evidenced by the usual signs, and where its continuance is shown by a steadily increasing area of dulness in the flanks, operation for ligature of the wounded vessels and removal of the extravasated blood clot should be immediately undertaken; operation, under these circumstances, is the lesser evil, because without it the cases will surely die, and with it they may be saved; and this quite irrespective of the absence of anything like ideal means of antiseptic surgery which so often obtained in South Africa, and which will probably exist to a large extent in all campaigns.

Failure of laparotomy and its cause.

That the death-rate following all operations on cases of gunshot wounds of the abdomen in the Boer War should have been as high as nearly 70 per cent. is not astonishing, considering that, except in the early days of the campaign, they were not performed until it became apparent that omitting them meant abandoning the patients to certain death. Peritonitis had already set in and was often general in extent, and under these circumstances perforations are difficult to discover; the walls of the gut will not hold sutures when they are found; apertures may be overlooked, and the necessary manipulations are liable, or indeed certain, to break down adhesions which Nature, in her efforts to limit the peritonitis, has already succeeded in forming between the wounded portions of the cut and the uninjured coils next to them. The delay which necessarily took place before the majority of these operations were performed, and the impossibility of performing them in accordance with the modern surgical requirements, are sufficient to account for their marked want of success; while, on the other hand, the very satisfactory results obtained in the two cases of resection of 12 inches and 15 inches of small intestine indicate that the causes of the high death-rates were as above suggested, for they were done under exactly the reverse conditions—in stationary hospital, soon after the receipt of the injuries, and with means of antiseptic procedures available, in fact, under conditions more nearly corresponding to those ideal ones to be obtained in a civil hospital at home.

The conditions adverse to successful operations on the abdomen were present in a peculiarly marked and unexpected degree in South Africa; but, judging from the report of the Surgeon-General of the United States Army, they were equally so in the late Spanish-American War, and in future wars, though every effort will, no doubt, be made to diminish them, they probably will still so far prevail as to render laparotomy in war hospitals always an unsatisfactory operation.

This is, no doubt, taking a pessimistic view, but it is justified by the experience of the two late wars. To give favourable results, laparotomies must be performed early, and they must remain aseptic, that is, they must, practically always, be carried out in movable field hospitals, but these are places where it is impossible, so far as is at present apparent, to guarantee an aseptic course to any operation wound.

The following notes give all the available details of the 207 cases of penetrating gunshot wounds of the abdomen of which records are to be obtained at present. The cases are grouped under the various headings of "Stomach," "Small Intestine," "Large Intestine," &c., according as each organ appears to be the *only* viscus or the *principal* viscus likely to have been involved in the wound, in order to ascertain, if possible, why and to what extent perforation of any particular viscus produces symptoms and affects the death-rates. A marked contrast will be observed in these connections between wounds of the hollow and of the solid organs. But other striking results are also brought out by this method of classification, and these, with such remarks on treatment as may be required, will be reserved until the groups have been individually considered :—

Group 1.—*Stomach.*

Death-rate = 15·3 per cent.

The stomach is noted as wounded in 19 cases. In 5 of them it appeared to be the only viscus wounded ; of these one died ; in 8 others it appeared to be the principal viscus wounded—principal, that is, as regards its tendency to cause death—and of these also, one died. Thus, of the 13 cases in which the stomach alone was wounded, or where in conjunction with wounds of other viscera, it was the principal viscus wounded, all but two recovered. One of the fatal cases (No. 7) died of hæmorrhage, and the other (No. 13) of peritonitis after operation. These were all typical Mauser wounds ; and as no particular line of treatment was followed in the 11 cases which recovered, and as, with few exceptions, they were subject to the usual unfavourable conditions as regards enforced transport, &c., it may be assumed as evident that ordinary Mauser perforations of the stomach are not as fatal injuries as those produced by the older bullets were believed to be. This is probably due to the small size of the apertures and the thickness of the coats of the organ which tend to limit extravasation, assisted, no doubt, by the collapse of the viscus which takes place on the escape of the contained gas.

Some peritonitis in 84·6 per cent. ; hæmatemesis in 53·8 per cent.

Of the 13 cases, 11 had peritonitis in more or less marked degrees ; 9 cases suffered from vomiting and 7 had hæmatemesis.

Laparotomy was performed in one case (No. 13), which died ; in one case a circumscribed abscess containing bile and pus between the liver and diaphragm was open and drained ; this case (No. 4) recovered with a biliary fistula which was nearly closed when the man was sent to the Base.

Gunshot Wounds of Stomach.

Stomach (?)—Pain and flatulence—No operation—Recovered.

Case 1.—C. S., wounded 31st March, 1900, at 500 yards range ; admitted 3 General Hospital 21 days later. Entrance ½ inch to right of last dorsal spine ; exit 2 inches below right costal margin and 2 inches from mid-line of abdomen, both small (Mauser) and healed. Spent two days in hut where wounded ; was given medicine "to relieve pain and bowel movement." Has been troubled with flatulence, but except that he looks pale and weakly, has no other unfavourable signs. "Bullet must have perforated stomach."—(Hospital Records).

Stomach (?)—Vomiting, tenderness, and pyrexia—No operation—Recovered. Bullet lodged.

Case 2.—Private K., wounded 11th June, 1900, at 300 yards range ; admitted 4 Stationary Hospital six days later. Entrance just below xiphoid cartilage ; no exit, but probe passed downwards and to left for 1½ inches. Vomited at once on being hit, but was able to walk half mile to ambulance ; frequent vomiting for 24 hours ; no hæmatemesis ; out of danger on admission, but still lay most carefully on his back, to avoid movement ; decided fulness in epigastric and left hypochondriac regions, with tenderness on palpation.

The M. O. described his condition as one of "ridiculously good health, although there is an evening rise of temperature." Transferred 26th day.—(Civil Surgeon A. NUTHALL.)

CASE 3.—Private C., wounded 11th June, 1900, at 200 yards range; admitted 4 Stationary Hospital six days later. Entrance (Mauser) through xiphoid cartilage; exit 1 inch below angle right 12th rib, and 2 inches from spinous processes of vertebræ. Felt like "injured at football but lasting longer;" severe abdominal pain for four days, during which he had practically no food. Had a sharp attack of epididymitis left side the 20th day. Tongue clean, bowels acting, and condition good when transferred.—(Civil Surgeon A. NUTHALL.)

Stomach, liver, and kidney (?)—Abdominal pain—No operation—Recovered.

CASE 4.—Lieutenant S., wounded by Mauser. Entrance 2 inches below right costal margin; exit to right of spine at a rather higher level. "From position of wounds bullet must have passed through liver and stomach." Lay on field 24 hours without food or drink; drank eight waterbottlesfull when picked up; recovered.—(Records Imperial Yeomanry Hospital).

Stomach and liver (?)—No operation—Recovered.

CASE 5.—Private F., wounded 30th April, ——. Entrance seventh right intercostal space ant. axillary line; exit immediately above centre of crest left ilium. Vomited large quantity of blood two hours after being hit, but none since; "pleura, liver, stomach, colon and probably small intestine traversed." Convalescent in a month.—(Civil Surgeon J. W. SMITH.)

Stomach—Liver and pleura (?)—Hæmatemesis—No operation—Recovered.

CASE 6.—Trooper M., wounded 2nd May, 1902; admitted 16 General Hospital 18 hours later. Entrance ninth right intercostal space 3 inches behind nipple-line; exit seventh intercostal space a little behind left nipple-line—direction upwards and forwards.

Collapse; great pain over liver and stomach; constant hiccough and hæmatemesis, and trying to vomit; temperature 97·4°; liver dulness obliterated; dulness in both flanks; upper half abdomen motionless.

Morphia, rectal feeding, and ice to suck for 11 days. Bile-stained fluid collected between liver and diaphragm was evacuated by incision a month after wound—five pints; biliary fistula was closing, and he was up and on full diet on 74th day when transferred to 20 General Hospital. "The stomach and liver in all probability wounded."—(Captain WALTON, R.A.M.C.)

Stomach and liver—Collapse, hiccough, and hæmatemesis—Drainage—Recovered.

CASE 7.—Lieutenant B., wounded 19th August, 1900; admitted Imperial Yeomanry Field Hospital after five miles in ambulance.

Entrance (¼ inch), 3 inches to left of mid-line, and 2 inches below margin of ribs; exit, 11th intercostal space, 4 inches from spines of vertebræ.

Stated to have vomited dark-coloured fluid; pulse feeble and rapid; free bleeding from entrance wound. Died next day.—(Civil Surgeon SHEEN.)

Stomach—Hæmatemesis, rapid pulse, collapse—No operation—Died.

CASE 8.—Lance-Corporal P. I., wounded 25th January, 1900, at 600 yards range; admitted 2 General Hospital six days later. Entrance (Mauser) in post. axillary line, between left 10th and 11th ribs; exit through tip of xiphoid cartilage.

Ran 1,000 yards after being wounded, and vomited much blood; passed quantities of blood by bowel for two days; slight cough, but no expectoration; pain on deep inspiration. Collodion dressing; sent to Base convalescent on 13th day.—(Records, 2 General Hospital.)

Stomach (?)—Hæmatemesis and melena—No operation—Recovered.

CASE 9.—E. D., wounded 11th May, 1900; admitted 3 General Hospital 23 days later; had been in a field hospital and afterwards in Russo-Dutch Hospital in the interval. Entrance, 5 inches to left of 12th dorsal spine; no exit, but bullet located by X-rays just above and to left of umbilicus. There were no signs of pulmonary damage, no vomiting of blood, nor melena. As on admission the symptoms were "practically nil," he was invalided.—(Civil Surgeon A. YOUNG.)

Stomach (?)—No symptoms noted—No operation—Recovered. Bullet lodged

Stomach and liver—Vomiting, pain, and tympanites—No operation—Recovered.

Case 10.—Private C., wounded 2nd January, 1900, at 800 yards range; admitted 3 General Hospital six days later.

Entrance (Mauser), 2 inches to right of second lumbar spinous process; exit, 1½ inches to right and ½ inch above base of ensiform cartilage. A good deal of shock; much pain and tenderness, with dulness over lower half right chest, accompanied by dyspnœa; pain over abdomen, which latter was tympanitic for some days; marked tenderness over liver, with vomiting and jaundice for a week or more. Scar from liver abscess evacuated three years ago. Complete convalescence 43rd day when invalided.—(Civil Surgeon Stuart.)

Stomach and lung—Spleen (?)—Hæmorrhage—No operation—Recovered.

Case 11.—Admitted Maritzburg. Mauser traversed lower lobe of left lung superficially, causing small hæmothorax, then stomach and (probably) spleen. Dulness in left flank (hæmorrhage); no other untoward symptoms till a month later, when he had an attack of hæmatemesis; recovered.—(Civil Surgeon Irvine.)

Stomach and kidney (?)—Hæmatemesis, melena, and hæmaturia—No operation—Recovered.

Case 12.—Private Mc.C., wounded 28th November, 1899. Entrance (Mauser) immediately below right 12th rib; exit small also, in front near mid-line, about same level. Vomiting blood; blood in urine and stools for about two days. Discharged "fit."—(Records Royal Victoria Hospital, Netley.)

Stomach and liver—Peritonitis—Hæmatamesis and melena—Laperotomy—Died.

Case 13.—Entrance (Mauser), ¾ inch from spine, opposite eighth intercostal space; exit through seventh left costal cartilage, 1 inch from mid-line.

Vomited blood freely and passed blood by bowels. On third day frothy, bile-stained fluid of fæcal odour was escaping from exit wound; laparotomy by vertical incision through wound; rugged furrow on under-surface left lobe of liver; stomach contracted, and firmly adherent to latter and diaphragm; on separating adhesions, a slit found in lesser curvature close to right of œsophagus, which was sutured; cavity mopped out and irrigated; drained. Four days later suturing of stomach had given way, and constitutional infection was manifest. On 10th day severe hæmorrhage set in. Died 15th day. No *post mortem*.—(Mr. Makins.)

Group 2.—Small Intestine.

There were 37 cases in which wound of the small intestine was noted. Of these, it appeared to be the only viscus wounded in 20, with 12 deaths, and it was the principal viscus wounded in 15 others, 10 of which died. Thus in 35 cases in which the small intestine alone was wounded, or where it appeared to be the principal viscus wounded, 13 recovered and 22 died. The remaining 2 cases out of the total 37, where, from the apparent symptoms, wound of the bladder was considered the principal injury, also died.

Mortality of wounds of small intestine 62·8 per cent.

When the multiplicity of the perforations usually produced in the small intestine by small-bore bullets is remembered, it is not the high death-rate, but rather the fact that any of them recovered, that creates astonishment. The probable causes of the escape from peritonitis and death in these cases has been already referred to.

Some peritonitis present in all cases.

Peritonitis was more or less present in all the cases in this group, and internal hæmorrhage in 10; the bullet remained lodged in 6 of the cases, and 2 of them recovered; in one it was extracted during a laparotomy, and the case died.

Laparotomies.

Laparotomy was performed in 11 cases, of which 7 died (*vide* Table 11, page 120). Of the two cases of resection which recovered out of the three operations of this kind, one was done with a Murphy's button, and the other was a circular enterorrhaphy.

Wounds due to bullets other than Mausers.

It is a significant fact that all the 4 cases due to Henry-Martini or shrapnel bullets proved fatal.

Gunshot Wounds of Small Intestine.

Ileum—Pain, vomiting, and peritonitis—Bullet lodged—Laparotomy (suture)—Died.

CASE 14.—Wounded 15th December, 1899; admitted same day 4 Stationary Hospital. Entrance Mauser 2½ inches above left iliac crest—no exit. Collapse and great abdominal pain. Median laparotomy at 11 p.m., two perforations of ileum closed with Lembert's sutures, and peritoneum flushed with sterile saline. Did very well for 24 hours, but then gradually sank and died at 5 a.m. on third day from peritonitis. Probably got some food that he was warned to avoid. Bullet not found.—(Major MALLINS, R.A.M.C.)

Intestine (?)—Collapse, vomiting, tense and tender abdomen—No operation—Recovered. Bullet lodged.

CASE 15.—M. H., admitted 4 Stationary Hospital, 24th February, 1900. Was long time on field before he could be brought in. Wounded in four places, but most serious a Mauser in right iliac region—no exit. Much collapse; abdomen tense and tender; free vomiting. Had no food for some time before wounded; was now "starved" for four days—only given a teaspoonful of water at long intervals. Transferred to Base convalescent 16 days after injury.—(Records 4 Stationary Hospital.)

Small intestine—Peritonitis, obstruction, and fæcal vomiting—Bullet lodged—Enterostomy—Recovered.

CASE 16.—Trooper C. E., wounded 22nd March, 1901; admitted Klerksdorp next day—14 miles in ambulance wagon. "Penetrating wound of abdomen"; peritonitis; fæcal vomiting fourth day. Incision made in right iliac region; turbid fluid escaped, and coils of collapsed gut presented; distended knuckle found in upper angle of wound, fixed by stitching and opened. Only flatus escaped till glycerine was introduced, when copious fluid motion followed.

Vomiting and pain ceased; was able to sit up in a week; awaiting operation for closure of artificial anus.—(Captain F. THOMAS, N.Z.R.)

Small intestine (?)—Distension and restlessness—No operation—Died.

CASE 17.—L. P., wounded at 100 yards range, 30th October, 1900; admitted next day. Entrance 1 inch below centre of left iliac crest; exit just below extremity right 11th rib. Blood oozing from both wounds; restlessness; abdomen distended, and left leg flexed; tongue brown and pulse rapid. Morphia and champagne. Died following day. No *post mortem*.—(Hospital Records.)

Small intestine—Pain and vomiting—No operation—Recovered.

CASE 18.—G. S., wounded 12th September, 1900, at 200 yards range; admitted 3 General Hospital next day. Entrance small, 4½ inches to left of 12th dorsal vertebra; exit 2¼ inches to left of mid-abdomen, and 2 inches above umbilicus. Persistently sick from time of wound till admission. Had no food, but some Bovril given by a friend against orders; morphia given several times. No melena, hæmaturia, or hæmatemesis; local pain and tenderness in left lumbar and iliac regions. Treatment—no food for 48 hours, then ½ oz. champagne every half hour, and with 1 oz. milk next day; dry dressing. Recovered; sent to Cape Town 19th day.—(Records 3 General Hospital.)

Small intestine—Fæcal odour, pain, tenderness, and rigidity—No operation—Recovered.

CASE 19.—A. A., wounded 10th April, 1901, at 450 yards range, carried in wagon for eight days till admitted 12 General Hospital. Entrance (Mauser ?) oval and clean (¾ inch by ½ inch), ¾ inch below post. part of crest of right ilium, and 3½ inches to right of fifth lumbar spinous process; exit small and circular; ¾ inch to right of umbilicus.

Much discharge from entrance—fæcal odour, pain, tenderness and rigidity in right iliac fossa. Drain inserted. Wounds healed, and all abdominal tenderness had subsided two months later when invalided.—(Major LOUGHEED, R.A.M.C.)

Small and large intestine—Hæmorrhage and peritonitis—No operation—Died.

CASE 20.—P. M., wounded 12th April, 1901, at 80 yards range; admitted 12 General Hospital six days later. Entrance (Mauser) ragged and circular, ninth interspace right mid-axillary line; exit circular, with everted edges, between left trochanter and tuber ischii.

No blood by bowels or urethra; extensive dulness right abdomen; general peritonitis; died next day.

Post mortem.—Much blood in abdomen—from mesentery; small intestine eight, and large two, perforations.—(Major LOUGHEED, R.A.M.C.)

Small intestine—Collapse, rapid pulse, and fæcal vomiting—No operation—Died.

CASE 21.—Colour-Sergeant I., wounded 21st October, 1901; admitted 19 Stationary Hospital 46 hours later. Entrance (Mauser) 1 inch to right of umbilicus; exit 2½ inches below left ant. sup. iliac spine. Collapse; temperature, 98° F.; pulse, 120; fæcal vomiting; pain along course of bullet; wounds healed. Nutrient enemata. Died 11th day.

Post mortem.—General peritonitis; fæcal matter exuded on opening abdomen; coils of gut adherent to each other forming abscess cavities; bowel gangrenous in parts; four bullet holes in small intestine; right kidney inflamed.—(Records 19 Stationary Hospital.)

Jejunum and kidney—Hæmorrhage and peritonitis—No operation—Died.

CASE 22.—Private G., wounded 30th September, 1901, at 100 yards range. History of hæmorrhage and peritonitis; died one hour after admission.

Post mortem.—Entrance left lumbar region; exit in hypochondrium same side; great hæmorrhage from gastro-colic omentum; two holes in jejunum; outer edge left kidney torn; local peritonitis.—(Records 19 Stationary Hospital.)

Stomach, small intestine, and rectum (?)—Difficult micturition and rectal abscess—No operation—Recovered.

CASE 23.—Surgeon-Captain C., wounded 18th December, 1901, at short range; admitted 19 Stationary Hospital 10 days later. Entrance through flesh left arm, then eighth intercostal space same side, in axillary line; exit on outer side right buttock, "piercing stomach, many coils of intestine and rectum."

Kept absolutely at rest for 10 days; afterwards bore journey 18 miles to hospital well; pain at base of bladder; difficult micturition. On 20th day abscess 4 inches up rectum burst; after 33 days in hospital was invalided, "quite recovered."—(Records 19 Stationary Hospital.)

Lung—Intestines (?)—Hæmoptysis and abdominal pain—No operation—Recovered.

CASE 24.—Private W., wounded 11th March, 1900. Entrance at junction of right fourth rib with cartilage, 2 inches from border of sternum; exit 2 inches below ant. sup. iliac spine.

Shortness of breath, hæmoptysis, and great abdominal pain for two days; bowels not moved for nine days; recovered.—(Hospital Records.)

Small intestine (?)—Collapse and peritonitis—No operation—Died.

CASE 25.—An officer, S., brought to hospital in state of collapse. Entrance at one side of abdomen; exit opposite side, bullet having passed transversely. Died half an hour later; general peritonitis.—(Civil Surgeon HALL-OWEN).

Small intestine and descending colon—Vomiting, collapse, pain; abdomen hard—No operation—Died.

CASE 26.—Lieutenant D., wounded 1st June, 1901; admitted next day 17 General Hospital. Entrance midway between umbilicus and pubes; exit over left great trochanter. Much vomiting; collapse; abdomen hard and tender, but pain not marked. Starvation treatment for 24 hours, morphia and strychnia. Improved for two days. On seventh bowels acted naturally, and same evening he became restless; collapse and death next day.

Post mortem.—Two perforations small intestine, and one descending colon; general peritonitis; extravasation of fæces; abscess cavity in peritoneal sac.—(Major R. KIRKPATRICK, R.A.M.C.)

Small intestine (?)—Collapse and peritonitis—No operation—Died.

CASE 27.—Boer, P. M. Entrance (Lee-Metford) 1 inch above top of right great trochanter; exit 1 inch above and anterior to left great trochanter. General tenderness and resistance in lower half of abdomen; no dulness in flanks; no hæmaturia nor melena; much collapse and pain. Unfit for laparotomy; died shortly after admission.—(Major STONHAM.)

Small intestine—Gut protruding—Resection—Died.

CASE 28.—Captain S., wounded 27th August, 1900. Entrance (Martini-Henry) close to angle left scapula; exit right iliac region, 3 inches internal to ant. sup. iliac spine, irregular and elongated; bullet found inside his clothes.

Five inches blackened contused intestine, which was cut across, protruding from exit. Wound enlarged for exploring abdomen; bowel perforated six times in 10 inches of its length; excised 12 inches, end to end anastomosis; flushed and closed abdomen; operation lasted two hours. Seemed doing well until fourth day after operation; had passed flatus; no abdominal distension or pain. Death did not seem to be due to abdominal trouble, but lung had been traversed, and he had lost much blood.—(Colonel LOVE, R.A.M.C.)

Ileum—Peritonitis—Laparotomy—Died.

CASE 29.—Private I. K., wounded 11th December, 1899; admitted 2 General Hospital four days later. Entrance 1 inch above right Poupart's ligament, exit 1½ inches above centre left Poupart's ligament.

Wounds septic; peritonitis fairly marked. Next day laparotomy over exit, much pus and blood escaped, but apparently no fæcal matter; abdominal cavity irrigated with warm boric; wound closed; died following day.

Post mortem.—Extensive suppurative peritonitis; two small wounds of ileum.—(Records 2 General Hospital.)

Small intestine and ascending colon—Fæcal vomiting and distension—No operation—Died.

CASE 30.—Sergeant T., wounded 14th August, 1901; admitted two days later. Entrance right of sacrum 2 inches from mid-line; exit below umbilicus.

Constant fæcal vomiting; abdomen distended; liver dulness absent; temperature 100° F., respirations 40—chiefly thoracic, marked thirst. Second day after admission vomiting stopped for 24 hours, but came on again; eyes and face jaundiced; died fifth day. (Bowels confined throughout. Brand's essence, ice and milk given.)

Post mortem.—Peritonitis; fæcal matter and blood in peritoneum; small intestine perforated in several places; ascending colon also perforated.—(Captain FAICHNIE, R.A.M.C.)

Small intestine—Distension, hiccough, fæcal fistula and hæmorrhage—No operation—Died

CASE 31.—Sergeant B., admitted 19th April, 1902. Entrance right ileum; exit 2 inches above and 1 inch to right of pubes. Slight peritonitis, distension of abdomen, and hiccough; entrance healed fifth day, but exit remained open, discharging fæcal matter. On 1st May, 1902, a small slough separated from exit, and two days later hæmorrhage from bowel and wound set in; this could not be controlled, and he died 20th day.

Post mortem.—Right lobe of liver necrotic—pus in this situation shut in by adhesions; coil of gut firmly attached to wound of exit, shutting off peritoneal cavity; hole ½ inch in diameter communicating with interior of intestine.—(Civil Surgeon J. MALCOLM.)

Right pleura and diaphragm—Stomach and intestines (?)—Pain, vomiting, and pleuritic effusion—No operation—Died.

CASE 32.—Private J., wounded 24th January, 1900; admitted 4 General Hospital 18 days later. Entrance mid-sternum, 2 inches above xiphoid cartilage; exit 2 inches above right great trochanter. Continuous vomiting and pain in abdomen; pleuritic pain, with slight effusion in right chest, and dulness below liver on right side and flank set in 48 hours before death; died 59th day.

Post mortem.—Lesser omental sac full of serum, which had pushed up diaphragm, and formed large collection between it and liver; adhesions had closed foramen of winslow; numerous adhesions of some thickness united coils of intestine all over abdomen.—(Civil Surgeon F. POPE.)

Small intestine and lung—Bullet (shrapnel) lodged—

CASE 33.—Private H., admitted 4 General Hospital 25th February, 1900. Entrance sixth left intercostal space, just below and internal to nipple—shrapnel; no exit. Was moribund on admission, and died in two hours.

Moribund, hæmorrhage—No operation—Died.

Post mortem.—Diaphragm perforated; mesentery and ileum wounded in three places; peritoneal cavity full of blood; round bullet found in pelvis.—(Civil Surgeon S. B. HULKE.)

Ilium, colon, and diaphragm—Collapse, vomiting, and tenderness—Bullet lodged—No operation—Died.

CASE 34.—Private P., admitted 4 General Hospital 24th February, 1900. Entrance left ninth interspace, post. axillary line; no exit. Much collapse, feeble pulse, and cold extremities; abdomen distended, rigid, very tender, and motionless; persistent and copious bilious vomiting, and hiccough. Given opiate; abdomen fomented and belladonna applied locally; simple enema. Gradually sank, and died three days later.

Post mortem.—Splenic flexure of colon perforated; ileum perforated in two places, within three feet of termination, 18 inches of intestine here gangrenous; contents of gut in pelvis; coils of intestine adherent, and peritoneal covering much infected; diaphragm perforated, but thoracic contents normal; bullet not found.—(Civil Surgeon S. B. HULKE.)

Small intestine—Supposed absence of perforation—Distension and hæmorrhage, laparotomy—Died.

CASE 35.—Wounded at Magersfontein. Entrance (Mauser) over eighth rib, ant. axillary line (side not mentioned), exit 1 inch to left of second lumbar spinous process.

Vomiting and diarrhœa set in almost immediately after injury, and persisted till his arrival at Orange River four days later. Then there was pain in left half of abdomen, with some general distension, and disappearance of hepatic dulness; pulse 110—fair strength; temperature 101° F,; left abdomen immobile, with dulness from flank as far as linea semilunaris.

Laparotomy in latter line; 20 ozs. blood evacuated from loin; no lymph on intestines, nor sign of inflammation; no perforation discovered in stomach or intestine; on two coils of jejunum deep slits ¾ inch long—through peritoneal and muscular coats only; on other coils patches of ecchymosis; no bleeding point discovered. Abdominal cavity sponged, irrigated, and closed; died next afternoon in collapse—"apparently due to hæmorrhage"; no *post mortem*.—(Mr. MAKINS.)

(NOTE.—*All the abstracts of Mr. Makins' cases are taken from his book, "Surgical Experiences in South Africa."*)

Note.—This case is advanced as a support to the theory that the Mauser bullet has a tendency to traverse the regions of hollow viscera without perforating the latter. But in the absence of the *post-mortem* examination the significant symptom, "disappearance of hepatic dulness," should not be overlooked. Perforation without leakage is apt to escape detection during the operation of laparotomy.

Small intestine—Hæmorrhage—Resection—Recovered.

CASE 36.—Private A., wounded at 4 a.m., 27th November, 1899; admitted Convent Hospital, Estcourt—12 miles distant—at 10 a.m. Entrance to right of mid-line, half-way between umbilicus and pubes; exit 3 inches above right trochanter. Civil Surgeon J. F. Neale performed laparotomy at once. Abdomen was full of blood; small intestine found cut "right across," and there were four bullet wounds on each side of cut edges; 15 inches of intestine resected and end to end anastomosis established by Czerny-Lembert sutures; gauze drain; cyanide dressing; and infusion of saline fluid.

Fed by rectum 48 hours, after which drain was removed; slop diet for a month, with enemata to keep bowels regular; never had a bad symptom; up and about, gaining strength daily, before being invalided.—(Civil Surgeon NEALE (Notes by Mr. Bowlby).

Small intestine—Vomiting and laparotomy (suture)—Died.

CASE 37.—Wounded at Magersfontein. Entrance (Mauser) opposite centre left ilium; exit 1½ inches above centre right Poupart's ligament. Vomiting commenced soon after injury, and was continuous until patient's arrival in the Stationary Hospital fourth day. Then face extremely anxious; temperature 101° F., pulse 110, fair strength; sweating freely; tongue moist; abdomen much distended, rigid, motionless, and tympanitic; bowels confined;

no urine had been passed for 24 hours; 2 ozs. on catheterisation, clear and containing no blood

Laparotomy in mid-line; a considerable quantity of bloody fluid evacuated; intestine generally congested and distended; no lymph; two wounds found in ileum on opposite sides of one coil; the openings were circular, with the mucous membrane everted; no escape of fæcal matter visible, till intestine was delivered, when contents spurted freely across the room. Openings sutured with five Lembert's stitches; bowel punctured to relieve distension, and returned after washing with boiled water; saline infusion into vein and strychnine hypodermically. Patient did not rally and died 12 hours later.—(Mr. MAKINS.)

Note.—No *post mortem*, apparently. This case is strongly in favour of the view that a simple Mauser perforation of intestine does not always admit of leakage under ordinary circumstances, if the patient can be allowed absolute rest.

CASE 38.—Lance-Corporal B., wounded 23rd July, 1900. Entrance (Mauser) immediately above iliac crest right mid-axillary line; exit 1½ inches below and 1 inch outside left ant. sup. iliac spine. Had diarrhœa for four days after injury, but no blood in stools or urine; shooting pains down both thighs and legs for six weeks. Discharged "fit."—(Records Royal Victoria Hospital, Netley). Small intestine (?)—Diarrhœa—No operation—Recovered.

CASE 39.—Lance-Corporal P., wounded 1st January, 1900. Entrance (Mauser) at left ninth rib 4 inches from spine; exit "in centre of abdomen."

Had hæmatemesis for two days and blood in stools for three days. Discharged "fit."—(Records Royal Victoria Hospital, Netley). Stomach and intestines—Hæmatemesis—No operation—Recovered.

CASE 40.—Private S., wounded 28th November, 1899. Entrance small (Mauser), 3 inches to left of umbilicus; exit small also, on right of 10th dorsal spinous process.

Passed blood in urine and stools. Said to have wound of kidney and bowel. Discharged "fit."—(Records Royal Victoria Hospital, Netley). Small intestine and kidney—No operation—Recovered.

CASE 41.—Entrance just outside left post. sup. iliac spine; exit 1½ inches within ant. sup. iliac spine same side. Left on field 10 hours; had to be moved to Orange River second day. No symptoms followed till third night, when he became restless, and was in great abdominal pain. Laparatomy next morning; sigmoid flexture adherent to exit wound, with ecchymosed patch, but no perforation seen (possibly closed); foul pus and gas escaped from pelvis; three openings found in jejunum, all circular, clean cut and with everted mucous membrane; no fourth opening could be found; very little escaped contents near perforations; closed by Lembert sutures, belly washed out; died 17 hours later. —(Mr. MAKINS.) Small intestine and sigmoid flexure—Peritonitis—Laparotomy (suture)—Died.

CASE 42.—Entrance (Lee-Metford) midway between umbilicus and pubes; exit 1 inch to left of fifth lumbar spine. On third day in great pain; face extremely anxious; constant vomiting; pulse 150, respirations 48, temperature 100° F., distension, rigidity, and tenderness of abdomen. Operation deemed hopeless. Died on the seventh day.—(Mr. MAKINS.) Small intestine—Peritonitis—No operation—Died. (Lee-Metford.)

CASE 43.—Entrance (Mauser) above post. third left iliac crest, at last lumbar tran. process; exit 1 inch below and to same side of umbilicus.

At Field Hospital six hours later; considerable collapse, pain, and free vomiting; abdomen very tender but flat; bowels confined; died in 36 hours. Small intestine—Peritonitis—Hæmorrhage—No operation—Died.

Post mortem.—Extensive adhesions of omentum and intestine, enclosing numerous collections of pus, which was fœtid, though no appreciable intestinal contents were detected in it; large collection turbid blood-stained fluid in right loin; seven perforations, clean, circular, and less than ¼ inch diameter in lower part of jejunum and ileum, for the most part closed by eversion of mucous membrane; intestinal contents not apparent, but escaped freely

on manipulation of the bowel. There were also bruises of intestine and some gutter slits affecting serous and muscular coats only, with ecchymosis round latter.—(Mr. MAKINS.)

Small intestine, liver, and spleen—Hæmorrhage—Bullet lodged and removed—Laparotomy (suture)—Died.

CASE 44.—Entrance (Mauser) over 10th rib left mid-axillary line; no exit, but ecchymosis at tip of right 12th rib suggested position of bullet. Laparotomy 4½ hours later; found fracture 10th rib, lacerated hole in spleen; enormous quantity of blood in peritoneal cavity, evidently from spleen; linear rent 1½ inches in upper jejunum; four other holes in same, and a hole in right lobe of liver, with bullet lying loose under latter. All wounds in bowel carefully sutured; bullet removed; wounds in solid organs, not bleeding, were not touched; abdominal cavity flushed out with sterile hot water; died soon after.—(Sir F. TREVES.)

Small intestine—Peritonitis—Laparotomy (resection)—Recovered.

CASE 45.—Trooper L., wounded 11th June, 1900. Entrance just to left of body of fifth lumbar vertebra; exit in front, on same side, 1 inch from mid-line and 2½ inches below umbilicus; 12 hours later symptoms of peritonitis; temperature 102° F., laparotomy. Small intestine found congested in vicinity of wound; fibrinous lymph between coils, separated; a little extravasated fæcal matter; entrance in mesenteric border, exit in free border; found impossible to close entrance, so 2 inches excised and anastomosis made by Murphy's button; collapsed after operation, but uninterrupted recovery followed, and button passed 11th day.—(Civil Surgeon JAMES LUKE.)

Small intestine and liver (?)—Vomiting—No operation—Recovered.

CASE 46.—Private A., wounded 24th January, 1900; admitted 4 General Hospital three days later. Entrance (Mauser) in 8th intercostal space, right mid-axillary line; exit ½ inch above left iliac crest, and 2 inches behind ant. sup. spine. Vomited shortly after injury, but had no further trouble of any kind; recovered.—(Major S. F. FREYER, R.A.M.C.)

Stomach and intestines (?)—Hæmatemesis and internal hæmorrhage—Laparotomy—Recovered.

CASE 47.—Entrance (Mauser) ½ inch below margin of iliac crest at junction of its mid. and posterior third (side not given); exit below eighth costal cartilage just within left nipple line. Fell at once and remained 30 hours on field. Vomited "blood like coffee grounds" six times, and again twice after being brought in; bowels confined; abdomen became immobile and tender, and on 13th day diarrhœa, with pus in motions, set in. After six weeks exploratory laparotomy; retro-peritoneal hæmatoma drained; recovered.—(Mr. MAKINS).

Small intestine—Internal hæmorrhage—No operation—Died.

CASE 48.—Corporal C., wounded 12th January, 1901, at long range; admitted 2 Stationary Hospital next day. Entrance (normal Mauser) over left rib post. axillary line; no exit. Abdomen rigid, but no marked distension and no other signs of stomach or bowel injury; dyspnœa and faintness; died at 3 a.m. following day.

Post mortem.—Extensive intra-peritoneal hæmorrhage; commencing peritonitis; a small perforation of ileum at mesenteric border without visible escape of fæces; fracture of margin of right obturator foramen where bullet escaped from abdomen into thigh.—(Captain HENNESSY, R.A.M.C.)

Group 3.—Large Intestine.

Mortality of wound of large intestine = 32·2 per cent.

The large intestine was wounded in 47 cases; in 35 of them it appeared to be the only viscus wounded, with 10 deaths, and in 5 others it was the principal viscus wounded, with 3 deaths. Of the 40 cases, therefore, in which the large intestine was the principal, or the only, organ wounded, 13 died. The causes of death were fæcal cellulitis combined with some peritonitis in 11 cases, and internal hæmorrhage in 2.

Since the tendency to extravasation from the large intestine must be less than it is in the case of the stomach—its walls are almost as thick, and its contents much more solid—some explanation of the greater mortality of wounds in this region must be sought for. It will be found in the fact that this gut is not entirely covered by a peritoneal coat, but that a large area on the posterior surface of the ascending and descending colon is in direct contact with the loose cellular tissue of the loins, and that extravasation in this direction is almost certain to give rise to fæcal cellulitis and septicæmia. These complications, it will be noticed, were the causes of nearly all the more serious mischief in this group, and in very few of the cases in which they occurred can wound of the extra-peritoneal surface of the colon be excluded.

While apertures in the transverse colon and sigmoid flexure and in the ascending and descending colons where covered by peritoneum, may, in the various ways already suggested, not permit of an extravasation sufficient to produce general peritonitis, the extra-peritoneal portions of the large intestine are in a different position. Here the wall of the gut is fixed, and an aperture in it is very much less likely to become reduced in size by collapse from escape of gas, or to become closed by adhesive inflammation; it is in direct communication with loose cellular tissue, through which the intestinal contents become diffused, thereby setting up severe and widespread cellulitis and septicæmia, which are the causes of death in the majority of the fatal cases.

The apertures cannot close; cellulitis and septicæmia the causes of death.

Some signs of peritonitis were more or less present in 36 out of the 40 cases, but usually of a localised character, and melena occurred in 11. The bullet lodged in 6 cases, and was extracted in 4.

Peritonitis and melena. Bullet lodged.

Laparotomy was performed in 7 cases, 6 being for the purpose of closing apertures by suture, and 1 for exploration and irrigation; 4 out of the 6 cases in which suturing was done, died. Operations to afford drainage, the peritoneal cavity not being opened, were performed in 11 cases, and of these 2 died. One case in which the colon, liver, and kidney were injured by a shrapnel bullet recovered without operation.

Laparotomy.

Drainage.

Gunshot Wounds of Large Intestine (40 *Cases*).

Case 49.—G. G., wounded at Rensburg, at about 600 yards range; admitted 3 General Hospital 6th January, 1900. Entrance midway between right ant. sup. iliac spine and umbilicus; exit in right buttock. Felt sick when hit; vomited; fell down and lost much blood, but was able to crawl 50 yards to a place of shelter.

Wounds dressed with gauze; bowels normal; no operation; up and about three weeks after admission.—(Civil Surgeon Ker.)

Cæcum (?)—Sickness and vomiting—No operation—Recovered.

Case 50.—F. R., wounded 15th December, 1899; admitted 4 Stationary Hospital next day. Entrance (Mauser) in left iliac region; exit in buttock close to anus. Melena and extreme collapse; sigmoid flexure or rectum probably extensively damaged; operation not considered justifiable; palliative treatment; died next day. Had Mauser compound fracture of forearm and flesh wound of knee also. No *post mortem*.—(Major Mallins, R.A.M.C.)

Sigmoid flexure and rectum (?)—Collapse and melena—No operation—Died.

Case 51.—Private L., wounded 11th June, 1900; admitted 4 Stationary Hospital six days later. Entrance (Mauser) right iliac region 2 inches above and slightly in front of ant. sup. iliac spine; no exit. Track of bullet open; discharging fæcal pus; pieces of tape-worm also passed on former occasions through entrance wound. Did well, fistula closing when transferred to Base 27th day; bullet not found.—(Records 4 Stationary Hospital.)

Ascending colon—Fæcal fistula—No operation—Recovered. Bullet lodged.

Case 52.—Officer, wounded 15th December, 1899; admitted Maritzburg 36 hours later. Entrance (shrapnel) right mid-axillary line $1\frac{3}{4}$ inches above costal margin; extracted from under skin just to right of spine of third lumbar vertebra, at a level 1 inch below entrance. It traversed liver, colon, and right kidney.

Liver, kidney, and colon—Hæmaturia and melena—Shrapnel extracted—Recovered.

Abdominal distension; dulness in right flank, presumably hæmorrhage; marked hæmaturia, and once melena. Symptoms gradually subsided till five weeks later, when right empyema developed; this was evacuated, and he made an excellent recovery.—(Civil Surgeon IRWIN.)

Colon (?)—Melena—No operation—Recovered.

CASE 53.—W. M., wounded 7th August, 1900, at 8 yards range. Entrance 2¾ inches to right of umbilicus and on same level; exit 6½ inches further round, midway between right subcostal margin and crest of ilium. Lay on field till dark. Passed blood by bowel sixth day. Given teaspoonful of water every two hours on first day, and milk on second. No further complication. Recovered.—(Civil Surgeon A. YOUNG.)

Ascending colon—Pinched face, pain, and vomiting—Laparotomy (suture)—Died.

CASE 54.—Boer, P. H., wounded 13th September, 1901, at 200 yards range; brought on ambulance to 13 General Hospital same evening. Entrance (Lee-Metford), 3 inches to right of and on level with umbilicus; exit, 1½ inches below centre of crest right ilium, both small and circular.

Pinched expression; vomiting; abdominal pain. Had only slight hæmorrhage, but pulse quick, and dulness in both flanks.

Next day median laparotomy by 7-inch incision through umbilicus—found necessary to enlarge it by incision at right angles afterwards. Small intestine not wounded; three perforations ascending colon, with much discharge of fæces, closed by Lembert's sutures—one opening, probably a graze. Peritoneum flushed with warm sterile water. Operation lasted nearly two hours; died shortly after.—(Major LOUGHEED, R.A.M.C.)

Cæcum—Fæcal discharge—No operation—Recovered.

CASE 55.—A patient wounded by Mauser; entrance, midway between right ant. sup. iliac spine and umbilicus; exit in same flank. Fæcal matter oozing from both wounds—cæcum must have been wounded; no general peritonitis. Fed by rectum; wounds irrigated. Entrance closed and exit closing when last seen.—(Records Imperial Yeomanry Hospital.)

Ascending colon (?)—Collapse and pain—No operation—Recovered.

CASE 56.—Private L., wounded 22nd May, 1901; admitted 19 Stationary Hospital next day. Track of bullet from front to back through ascending colon. Galloped half mile and walked quarter mile, leading his horse, before dressed; lay on field all night, and jolted for eight hours in wagon on way to hospital next morning. Collapse; abdominal pain; temperature, 99·2° F. Starved for 10 days; discharged cured 24 days later.—(Records 19 Stationary Hospital.)

Ascending colon (?)—Melena—No operation—Recovered.

CASE 57.—C., wounded 24th June, 1900, at 350 yards range; admitted 19 Stationary Hospital 12 days later. Entrance (Mauser), 2½ inches below right costal arch, 1 inch outside nipple line; exit in buttock same side, 3 inches from mid-line, and 3½ inches below iliac crest. "Ascending colon wounded"; blood in first stool; temperature, 99°; little pain or inconvenience. Convalescent 38th day.—(Records 19 Stationary Hospital.)

Cæcum (?)—Pain—No operation—Recovered.

CASE 58.—Trooper K., wounded 26th February, 1902; admitted 19 Stationary Hospital two days later. Entrance (Mauser), "over cæcum; exit in corresponding position behind." No fever, but much pain round entrance, which passed off on ninth day. Did well; discharged convalescent.—(Records 19 Stationary Hospital.)

Ascending colon—Melena—No operation—Recovered.

CASE 59.—Trooper T., wounded 25th December, 1901. Entrance (Mauser), 3 inches from mid-line in front, right side; exit, 4 inches from mid-line back, same side. Ascending colon exposed at exit; passed blood for three days frequently per rectum. Rapid convalescence.—(Records 19 Stationary Hospital.)

Ascending colon—fæcal fistula—No operation—Died.

CASE 60.—Trooper G., wounded 28th July, 1901. Entrance (Mauser), 1 inch below right costal cartilage; exit same side, 1½ inches below crest of ilium, and 2½ inches from mid-line of back. No untoward symptoms for first

24 hours—no pain, tenderness, tympanites, vomiting, or fever. Fæces began to exude from exit; then he became very drowsy, and died sixth day.

Post mortem.—Entrance healed; general peritonitis, with fæcal extravasation; two wounds in ascending colon, one of them 1 inch in diameter.—(Records 19 Stationary Hospital.)

Cæcum—Collapse—No operation—Died.

Case 61.—Trooper S., wounded 22nd October, 1901. Was 22 miles from Harrismith, and lived only half an hour after admission.

Post mortem.—Entrance through right ilium, shattering bone; two perforations in cæcum; blood and fæces in peritoneum; signs of early peritonitis.—(Records 19 Stationary Hospital.)

Cæcum (?)—Abscess—Drainage—Recovered.

Case 62.—F. G., wounded at 300 yards range. Entrance through right ilium; exit, 2 inches to right of umbilicus. Bullet then smashed stock of rifle, and lodged in ball of thumb, from which extracted. Rode 1½ miles after being hit. Cæcum was evidently wounded, as abscess was evacuated from behind it. Good recovery; invalided.—(Hospital Records.)

Appendix—Tympanites, nausea tenderness and collapse—Laparotomy—Died.

Case 63.—Private P., admitted 7th June, 1900. Entrance just above right ant. sup. iliac spine; exit same side, below line of post. spine. Abdomen tender and tympanitic. Two days later abdomen more painful and swollen, nausea, temperature 100°, pulse 128, and features sunken. Laparotomy over entrance; no injury of intestine found, but perforated appendix. Latter thickened and adherent; pus escaped when adhesions separated; intestinal gas escaping from perforation. Appendix ligatured. Died of peritonitis on 35th day.

Post mortem.—Bullet passed through ilium two fingers' breadth below crest; much lymphy exudation over bowels; general peritonitis; no further perforation of bowels found.—(Civil Surgeon F. Green.)

Cæcum (?)—Drainage—Piece of bullet removed—Recovered.

Case 64.—Sergeant C. K., wounded 4th April, 1902; admitted 18 Stationary Hospital same day. Entrance small and circular (·3 inch) ½ inch inside right sacro-iliac joint; exit (1 inch by ¾ inch) lacerated and irregular, 1 inch below right ant. sup. iliac spine. Bowels confined seven days; 11th day exit closed; entrance enlarged, and curetted—piece of nickel casing and some loose bone removed. Invalided.—(Captain J. Alexander, R.A.M.C.)

Descending colon—Fæces escaping, limited abdominal movements—No operation—Recovered.

Case 65.—Private B., wounded 12th February, 1902; admitted 16 General Hospital same day. Entrance 1 inch below umbilicus, in midline; exit 2 inches above left iliac crest and 3 inches from ant. sup. spine. Lay on field nine hours. No abdominal distension, but movement limited; fæces on exit dressing; pulse good, temperature, 99; bowels confined for two days before wounded. Milk every hour, and Brand's essence for four days. Good recovery; discharged to duty.—(Captain H. Walton, R.A.M.C.)

Descending colon (?)—Vomiting and abdominal distress—No operation—Recovered.

Case 66.—Sergeant L., admitted 19th March, 1902. Entrance left loin; exit hypochondrium same side. Vomiting for four days after being wounded, also some slight abdominal distress. Invalided to Base 36th day—"seems as if descending colon must have been injured."—(Captain W. Faichnie, R.A.M.C.)

Cæcum and colon—Fæcal fistula—No operation—Recovered.

Case 67.—Patient wounded by Mauser. Entrance midway between right ant. sup. iliac spine and umbilicus; exit in flank same side, almost horizontally. Fæces issuing from both wounds—cæcum must have been traversed; no signs of general peritonitis; condition fair. Fed by rectum, and wounds irrigated with antiseptic solution thrice daily. Entrance closed and exit much smaller, and escape of fæces almost ceased when last seen.—(Records Imperial Yeomanry Hospital.)

Cæcum—Fæcal discharge—Bullet extracted—Recovered.

CASE 68.—Patient wounded by Mauser. Entrance just internal to right ant. sup. iliac spine; exit three irregular wounds right buttock—probably expanding fragmented bullet.

Fæcal matter discharging from exit. Exit wounds enlarged; irrigated at each dressing. After three weeks fæcal discharge had ceased, but a sinus remained till a portion of mantle of bullet was removed, when it rapidly healed.—(Records Imperial Yeomanry Hospital.)

Descending colon and lung (?)—Malena and fever—No operation—Recovered Bullet lodged.

CASE 69.—Corporal B., wounded 25th December, 1901. Entrance, left shoulder; no exit. Complained of pain near spleen, especially on deep inspiration; mild fever for a fortnight; blood passed with stool fifth day. Convalescent 26th day.—(Records 19 Stationary Hospital.)

Colon, liver, and lung—Hæmorrhage and peritonitis—No operation—Died.

CASE 70.—Admitted Maritzburg. Bullet had perforated transverse colon, and made lacerated track through liver, right pleura, and lung, finally fracturing third rib.

Dyspnœa, hæmoptysis, and hæmothorax; on fourth day peritonitis and death.

Post mortem.—40 ozs. sero-sanguineous fluid in right chest, with collapsed lung; peritonitis over right side; 10 ozs. blood in right lumbar region.—(Civil Surgeon IRVINE.)

Sigmoid flexure—Peritonitis—Laparotomy (drained)—Died.

CASE 71.—Private K., wounded 11th December, 1899; admitted Wynberg four days later. Entrance, $1\frac{1}{4}$ inches above mid. of left Poupart's ligament; exit, $1\frac{1}{2}$ inches above middle of right Poupart's ligament, bullet passing transversely. Face pinched and anxious; pulse small and thready, 120; temperature, 101° F.; abdomen rigid, tender, and painful; hard mass felt in left iliac fossa.

Next day laparotomy; mass of intestine matted together in left iliac fossa; general peritonitis; cavity irrigated and drained; died following day.

Post mortem.—Sigmoid flexure perforated in two places, and involved in adherent mass.—(Civil Surgeon PEGG.)

Ascending colon and ureter (?)—Abscess—Drainage—Recovered (with fistula).

CASE 72.—Private W., wounded 19th February, 1900, at 400 yards range; admitted 1 General Hospital nine days later. Entrance (Mauser), a little above McBurney's point; exit in mid-line, over fifth lumbar spine. Deep pain and tenderness in iliac fossa; flexion of thigh; moderate pyrexia; large abscess formed in iliac fossa—when opened, fæcal odour; pyuria for three days. When invalided three months after, still unable to walk, as wound not quite healed.—(Civil Surgeon GAISHER.)

Large intestine (?)—Blood per anum—No operation—Recovered.

CASE 73.—Private D., wounded 31st July, 1900, at 300 yards range; admitted 17 hours later. Entrance (Mauser) on left lower part of abdomen; exit on same side of lumbar spine.

Great pain and collapse; tenderness of abdomen; passage of blood per rectum for a day or two. Convalescent in three weeks.—(Captain WADE BROWN, R.A.M.C.)

Cæcum and sigmoid flexure—Peritonitis—Died.

CASE 74.—Private S., shot transversely through abdomen, died 48 hours later. Entrance wound just above and a little in front of the highest point of the crest of the ilium on right side; exit (where the bullet was impacted in the skin, base forwards) just above and a little in front of the same point on the left side. General peritonitis, died in 48 hours.

Post mortem.—Two small apertures in cæcum, no extravasation or peritonitis on this side. Extensive laceration in sigmoid flexture, giving rise to extravasation, general peritonitis, and death. No sign of injury to small intestines lying between these two situations, though carefully looked for.—(Mr. G. L. CHEATLE, C.B. (From "R.A.M.C. Journal," Jan., 1905).)

[For remarks on this case *see* page 74.]

CASE 75.—Private W., wounded 23rd July, 1900, at 350 yards range. Entrance (Mauser) 1½ inches above right iliac crest, and 3½ inches behind ant. sup. spine; exit through left ilium, 4 inches from ant. sup. spine and 2½ inches above great trochanter. Cæcum (?)—Diarrhœa—No operation—Recovered.

Had a painless motion soon after being hit; wound healed in seven days; no blood in stools or urine; lost power of left leg—muscles wasted, with swelling from toes up, and paralysis (quadriceps extensor especially).

States he was given nothing to eat or drink for three days, after which he began on biscuits, bully beef, and ale, "full" rations. Now feels "as well as ever." Discharged fit.—(Records Royal Victoria Hospital, Netley).

CASE 76.—Boer. Entrance (Lee-Metford) in right thigh 3 inches below and 1 inch inside ant. sup. iliac spine; exit in back, level with, and 4 inches from fourth lumbar spine. Half an hour after had severe stabbing pain; lay on field one hour, and second day went 25 miles by train. Cæcum and colon—Peritonitis—laparotomy (suture)—Died.

After 50 hours, face anxious; great abdominal pain about umbilicus; frequent vomiting; pulse 125, respiration 30 and thoracic. Laparatomy. Great omentum adherent to ascending colon, which was covered with plastic lymph; gas and intestinal contents escaped from an opening in colon; rent sewn up; 4 ozs. foul fæcal fluid evacuated from retro-peritoneal space behind colon, and counter opening made; drained. Died eighth day.—(Mr. MAKINS.)

CASE 77.—Entrance (Mauser) over ninth rib in line of right linea semilun.; exit buttock same side, below and behind tip of great trochanter. Sensation of gurgling, but little pain; cæcal abscess formed later, which was incised; fistula remained six months; recovered.—(Mr. MAKINS.) Ascending colon—Peritonitis—Drained—Recovered.

CASE 78.—Entrance (Mauser) sixth left intercostal space, mid-axillary line; exit loin same side, below last rib at outer margin erector spinæ. No serious abdominal symptoms for three days; during 50 miles journey became sick; afterwards abdominal distension with fæces escaping from exit, and later fæcal-smelling fluid from entrance. Exit enlarged; died seventh day.—(Mr. MAKINS.) Colon—Fæcal extravasation and peritonitis—Drained—Died

CASE 79.—Mr. Makins saw a similar case from Modder River, where death took place fourth day. No *post mortem* was made in either case.

CASE 80.—Entrance (Mauser) 3 inches from right ant. sup. iliac spine, in line of supra pubic fold of belly wall; exit in buttock same side, level with and 2 inches inside tip of great trochanter. Cæcum (?)—No operation—Recovered.

No sickness, retention of urine and constipation for three days with local tenderness. Recovered.—(Mr. MAKINS.)

CASE 81.—Entrance (Mauser) 2 inches diagonally above and inside right ant. sup. iliac spine, exit just to right of fifth lumbar spine. No sickness; diarrhœa and cystitis with offensive pyuria followed; abscess at exit wound incised; recovered.—(Mr. MAKINS.) Ascending colon—Abscess—Drained—Recovered.

CASE 82.—Entrance (Mauser) midway between last rib and iliac crest; exit below eighth cost. cartilage, in nipple line; no serious symptoms till 10 days later, when tympanitic abscess developed in right loin; three days after opening this, hæmorrhage set in from wound—source not discovered; recurred next day; died. Ascending colon and liver—Peritonitis—Fæcal abscess and hæmorrhage Drained—Died.

Post mortem.—Large quantity of chocolate fluid in abdomen and pelvis; abscesses in connection with wounds of colon and liver.—(Mr. MAKINS.)

CASE 83.—Entrance (Mauser) midway between right 10th rib and iliac crest; no exit (another retained bullet entered centre of left sterno-mastoid). Ascending colon (?)—Abscess—Drained

and bullet extracted—Recovered.

"Brought up" blood for half an hour after injury; no difficulty in swallowing; no abdominal symptoms except local tenderness and immobility; three weeks later, deformed Mauser bullet extracted from tympanitic abscess to right of umbilicus; foul pus, but no fæcal matter evacuated; sent home "well."—(Mr. MAKINS.)

Ascending colon—Distension, with escape of gas—Laparotomy (suture)—Died.

CASE 84.—Entrance in middle of right buttock, a little above level of trochanter; exit through abdominal wall in right semi-lunar line at level of umbilicus. Abdomen distended—gas escaping from exit wound on pressure. Laparotomy; perforation in ant. wall of ascending colon sutured; post. opening 2 inches lower, firmly closed by adherent omentum; abdominal cavity cleaned and drained; died after 24 hours.—(Mr. WATSON CHEYNE.)

Cæcum—Fæcal extravasation—Laparotomy (suture and drain)—Recovered.

CASE 85.—Wounded 1st November, 1899, by Lee-Metford at target practice. Entrance in right sacro iliac synchondrosis; exit midway between ant. sup. spine and ninth costal cartilage, after traversing cæcum.

Laparotomy by Dr. Allan; two apertures found in cæcum close together, with some fæcal extravasation; wounds invaginated and bowel closed over them by Lembert's sutures; posterior entering wound in bowel similarly closed; abdomen flushed and drained; uninterrupted recovery.—(Notes by the late Sir WILLIAM MACCORMAC.)

Sigmoid flexure (?)—Peritonitis—No operation—Recovered.

CASE 86.—Private J., wounded 24th January, 1900; admitted 4 General Hospital, Mooi River, three days later. Entrance (Mauser) 4 inches to right of mid-line, opposite 10th dorsal spine; exit just over left iliac crest, 1 inch behind its centre. Had dyspnœa and pain for first few days; no other trouble; recovered.—(Major S. F. FREYER, R.A.M.C.)

Ascending colon (?)—No symptoms—Recovered.

CASE 87.—Major H., wounded 14th June, 1900, carried to hospital three miles distant. Entrance in mid lumbar region, slightly to right of spine; exit same side, midway between ribs and ant. sup. iliac spine.

Suffered much pain, but no collapse; general condition remained good—no evidence of peritonitis. Starvation treatment, with absolute rest; recovered.—(Mr. WATSON CHEYNE.)

Sigmoid flexure—Hæmorrhage—Laparotomy (suture)—Recovered.

CASE 88.—Sir F. Treves performed laparotomy in a case of wound of sigmoid flexure with internal hæmorrhage. He sutured the apertures in the gut and removed a large amount of blood clot from loin; recovered.—(Note by Surgeon-General STEVENSON.)

Group 4.—Rectum.

Wound of the rectum is noted as having occurred in 19 cases, in 9 of which it appeared to be the only viscus wounded, and in 4 it was the principal one. Of the 13 cases in the 2 latter classes 4 died, or a mortality of 30·7 per cent. As the 4 deaths which occurred in this group occurred in those cases in which the rectum appeared to be the only viscus wounded, the inference is strong that the high death-rate was due to the rectal injury itself, and not to wounds of other viscera, which occurred in some of the cases.

Peritonitis and internal hæmorrhage.

Peritonitis was more or less evident in 6, and internal hæmorrhage took place in 1 case out of the 13 recorded; 3 of the cases with peritonitis, as well as that with hæmorrhage, died. The bullet lodged in 4 cases, and was extracted in 1.

Laparotomy.

The abdomen was opened in 1 case for exploration and irrigation, and the case died; colotomy was performed in 2 cases, 1 of which died. Drainage operations, not opening the cavity of the peritoneum, were done in 4 cases, and all recovered.

One case, in which both entrance and exit wounds were large and irregular, having the characteristics of shell injury, recovered without any operation.

Gunshot Wounds of Rectum.

CASE 89.—Private C., admitted 4 Stationary Hospital, 18th February, 1900. Entrance (Mauser) in left gluteal fold; no exit. In its course bullet caused a ragged wound of rectum just inside internal sphincter, damaged prostate, and opened urethra. Abundant hæmaturia and flatus per urethram; blood in stools; cystitis followed, but patient improved and was sent to Base.—(Records No. 4 Stationary Hospital.)

Rectum, prostate and urethra—Melena, hæmaturia and flatus per urethram—No operation—Recovered. Bullet lodged.

Note.—Traced in records. This case is said to have recovered completely, but there is no mention of any operation, such as colotomy, division of sphincters, or search for lodged bullet.

CASE 90.—J. C., wounded 18th February, 1900. Entrance (Mauser) right flank, near margin of ribs; exit post. to left trochanter major. Hæmaturia and blood per anum. Did well; treatment not mentioned; invalided. Had also flesh wounds of both legs.—(Civil Surgeon T. E. STUART.)

Rectum—Kidney or bladder—No operation—Recovered.

CASE 91.—Private F., wounded 12th June, 1901; admitted 2 General Hospital three weeks later. Entrance in ilium just below left ant. sup. spine; exit centre right buttock. Hectic—pus passing from rectum. Opening into rectum would sometimes close, and then fever became worse. Two attempts for closure of this opening failed. After a long stay in hospital was invalided "in fair condition."—(Lieut.-Colonel SYLVESTER, R.A.M.C.)

Rectum—Pus per anum—Recovered (with fistula).

CASE 92.—Private B., wounded 24th January, 1900; admitted 4 Stationary Hospital next day. Entrance 4 inches above left great trochanter; no exit—bullet lodged 1½ inches above and behind right great trochanter, and was removed. Flatus and fæces passing through both wounds; cellulitis developed.

Rectum—Bullet extracted—Flatus and fæces in wounds—Colotomy—Died.

Tube was passed up rectum, and parts packed with gauze; great pain; rectum irrigated twice daily.

A fortnight after wounded left iliac colotomy; died from exhaustion two days later.—(Civil Surgeon A. W. NUTHALL.)

Observations by Sir F. Treves on a similar case, "British Medical Journal," 10th March, 1900:—

"A man was shot through both hips by a Mauser or a shrapnel, probably the latter. The lower end of the rectum was wounded in two places, and in due course fæces and flatus were passed through each of the gluteal wounds.

"In one of these wounds the hip-joint was involved. The wound in the rectum was easily felt on anal examination.

"The man's condition was absolutely deplorable, and his pain intense. The questions were—Should the case be left? Should the lower end of the rectum be excised? or, Should left colotomy be performed? We decided to perform colotomy, and this was carried out by Dr. Nuthall.

"There were many difficulties in the way of a direct operation upon the rectum."

CASE 93.—Major S., admitted 25th January, 1900, 4 Stationary Hospital. Entrance, circular, right buttock, 1 inch below iliac crest; no exit. Intestinal gas escaping from wound; blood in motions: peritonitis developed; died next day. "Rectum lacerated; palliative treatment."—(Civil Surgeon STANLEY COPLEY.)

Rectum—Gas in wound and blood per anum—Bullet lodged—No operation—Died.

Rectum—Hæmorrhage per anum and collapse—No operation—Died.

CASE 94.—Lieutenant D. Entrance over left hip; exit front of right thigh, which was fractured in upper part. Had lost much blood per rectum, and was collapsed and pulseless on admission; vomiting; no hæmaturia. Given morphia and strychnia hypodermically. Rallied somewhat, but collapse came on again, and death from syncope.—(Major R. KIRKPATRICK, R.A.M.C.)

Rectum (shell?)—Blood per anum—Drained—Recovered.

CASE 95.—Private G. H., wounded 11th December, 1899; admitted 2 General Hospital a few days later. Entrance (probably piece of shell) large and irregular, in centre left buttock, passing upwards and inwards, comminuting ilium; exit also large and irregular, 2 inches above centre of crest right ilium. Frequent motions containing blood and mucus. Drainage tubing inserted into both wounds, and small pieces of bone removed 12th day; bloody motions ceased in a week, but sinus took long time to heal. Invalided 82nd day.—(Records 2 General Hospital.)

Rectum—Wound felt by finger—No operation—Recovered.

CASE 96.—Captain S., wounded 24th January, 1900, at 400 yards range. Entrance (Mauser) $\frac{1}{2}$ inch below and 1 inch behind head of right great trochanter; exit $\frac{3}{4}$ inch below left great trochanter, and over outer margin. Bullet cut through posterior wall of rectum about 1 inch above anal ring. Bowel, washed out frequently with hot boric lotion, healed without contraction.—(Civil Surgeon JOHNSTONE.)

Rectum—Fæcal fistula—Colotomy—Recovered. Bullet lodged.

CASE 97.—Private O'N., admitted 4 General Hospital 25th February, 1900. Entrance midway between tip of left great trochanter and iliac crest; no exit—failed with X-rays to locate bullet.

Diarrhœa; fæces passing through entrance wound causing sepsis.

Left iliac colotomy performed 12th March, 1900, and wound freely opened, washed and drained at same time; latter gradually filled in, but still communication remained between rectum and entrance when sent to England two months after admission.—(Civil Surgeon J. POPE.)

Rectum—Fæcal fistula—Laparotomy—Died.

CASE 98.—Private S., wounded 27th October, 1900; admitted 6 General Hospital six days later. Entrance in mid-line of thigh 4 inches below gluteal fold; exit not mentioned. Fæces escaping freely from entrance; nine weeks after, a fæcal fistula being established in pelvis, the abdomen was opened in mid-line, and pelvic gut found quite free; "much congestion and blackness over left pelvic peritoneum was observed; this was incised, but no pus being found it was sutured again"; thigh wound explored, and tubes put in; died of septicæmia three days later.—(Civil Surgeon R. W. MAXWELL.)

Rectum—Colon and base of bladder (?)—Drained and sphincters divided—Recovered.

CASE 99.—Private D., wounded 16th February, 1900; admitted 4 Stationary Hospital next day. Entrance (Mauser) above left iliac crest; exit 4 inches below, and slightly behind right ant. sup. iliac spine. Great abdominal pain and tension; emphysema left side scrotum; pulse 106, temperature 103·4° F.; after two days flatus passed per anum, and tension decreased; later on, retention of urine and epididymitis; transferred to 4 General Hospital, Mooi River, when sufficiently recovered.—(Civil Surgeon NUTHALL.)

Note (a month later).—At 4 General Hospital, Mooi River, 15th March, 1900, explored; tumour at exit wound incised—fæces and pus with foul-smelling gas; long probe dropped through this under femoral vessels, emerging in rectum inside sphincter; sphincters divided, and drainage tube brought through from outer wound; well irrigated—no more fæces appeared in wound; drainage tube gradually withdrawn inwards, wound closed in same direction rapidly; invalided.—(Major S. F. FREYER, R.A.M.C.)

Rectum—Much blood in stools—No operation—Recovered.

CASE 100.—Private S., admitted 23rd March, 1900; wounded some time previously at 700 yards range. Entrance $3\frac{1}{2}$ inches behind left ant. sup.

iliac spine; exit in back of right thigh, 4½ inches below tuber ischii. Pain in abdomen; much hæmorrhage from bowel first day, and lasting for three days. Invalided after a week.—(Civil Surgeon E. Ker.)

Case 101.—Entrance (Mauser) 1 inch to right of coccyx; exit 1 inch above junction of middle and outer third left Poupart's ligament. Pain in abdomen and retention of urine for two days; urine drawn off contained blood; frequent micturition, with gas and fæcal matter in urine, followed; foul-smelling abscess, 2 inches above pubis to right of mid-line, opened; discharge lasted three months, and fistula at original wound of entry remained when invalided, "otherwise quite well."—(Mr. Makins.)

Rectum and bladder—Gas and fæces per urethram—Drained—Recovered (with fistula).

Group 5.—Bladder.

The bladder is returned as wounded in 21 cases. In 12 of these it appeared to be the only viscus wounded, with 4 deaths, and it was the principal one in 5 others, with 3 deaths. Thus in the latter two classes, numbering 17 cases, there were 7 deaths, or a mortality of 41·1 per cent. All these deaths occurred in cases where the bullet had traversed the extra-peritoneal portion of the organ; it would therefore appear that, as in the ascending and descending colons, extra-peritoneal wound is by far the more fatal injury, and the notes of the cases demonstrate that the deaths were due in the bladder cases to the same causes, viz., cellulitis and septicæmia in the absence of efficient drainage.

High death-rate due to extra-peritoneal injury.

Some signs of peritonitis appeared in 13 of the cases, but not of marked severity.

The bullet lodged in 6 cases; it was extracted in 2 cases; in one case it was passed by the urethra, and in another it was impacted there and removed (Nos. 105 and 114).

Bullet lodged.

The abdomen was explored and irrigated in one case, which died, and 4 cases were drained, the general cavity not being opened, with 2 deaths. In 1 of the latter a rent was found in the extra-peritoneal portion, which was sutured, and recovery followed.

Laparotomy.

Judging from the causes of death in the fatal cases above referred to, it is evident the free incisions into the perineum and pre-vesical space, with drainage of the bladder, might have been practised with advantage in many of them.

Gunshot Wounds of Bladder.

Case 102.—C. R., wounded 24th July, 1900, at 500 yards range. Entrance 1½ inches from tip of great trochanter, on line joining it with right ant. sup. iliac spine; exit 2 inches above left Poupart's ligament, over position of femoral vessels. Wound of exit suppurated, and had to be enlarged; frequent micturition, but never passed blood—practically no other symptoms. Recovered.—(Civil Surgeon A. Young.)

Bladder (?)—Frequent micturition—No operation—Recovered.

Case 103.—Trooper W., wounded 6th December, 1901; admitted 18 General Hospital nine days later. Entrance 6 inches behind and below left ant. sup. iliac spine; exit 3½ inches behind and 3 inches below right ant. sup. spine—both healed, and size of sixpenny piece. Carried in wagon for three days till he reached a field hospital, and eventually admitted 18 General Hospital. Much collapse; loss of control over bladder and rectum; partial paraplegia; abdomen tender; pulse weak and rapid. Had an enema on 17th, and next morning was in great distress; tumour size of four months' pregnant uterus in hypogastrium, extravasation of urine. Incision in mid-line above pubes, 2 pints ammoniacal urine evacuated. The fluid extra-peritoneal from rent in ant. wall of bladder. Rent sutured, cavity flushed and drained. Urine continued to pass both ways for some time, but eventually it ceased from the wound, and he was able to walk about when invalided. The paralysis was reflex.—(Major Mallins, R.A.M.C.)

Bladder—Extravasation and collapse—Drained; bladder sutured—Recovered.

Bladder—Intestine (?)—Pain, hæmaturia, and collapse—No operation—Died.

CASE 104.—Civilian M. F., shot by sentry at 150 yards range; admitted 18 Stationary Hospital 4th November, 1900. Entrance ($\frac{1}{4}$ inch) 3 inches above right gluteal fold, and $2\frac{1}{4}$ inches to right of mid. sacrum; exit ($\frac{1}{3}$ inch) $\frac{1}{2}$ inch to inner side left ant. sup. iliac spine. Semi-collapse; great pain and constant desire to pass water, but unable to do so; no abdominal distension. Catheter only drew off blood from bladder. Condition too bad for operation. Died next day. No *post mortem* noted.—(Hospital Records.)

Bladder—Hæmaturia—Bullet passed per urethram—No operation—Recovered.

CASE 105.—Civilian Guard, C. W., wounded 30th March, 1902. Entrance ($\frac{1}{2}$ inch long) $3\frac{1}{2}$ inches below post. iliac spine, 3 inches from mid-line—no exit. Hæmaturia; unable to pass water for two days; fourth day spicule of bone, $\frac{3}{8}$ inch by $\frac{3}{16}$ inch, came away with urine; hæmaturia then ceased, but micturition became frequent and painful; 18th day, while making water, flow suddenly stopped; orderly M.O. failed to pass catheter on account of pain, but nothing was felt; 15 minutes later, while again attempting to pass water, a smooth Mauser bullet shot out of urethra. This was followed by some bleeding, but he was discharged quite well 29th day. "The range was 200 yards, and the powder was evidently defective, as a Kaffir, wounded at same time and range, also had bullet lodged in his body." The passage of the bullet by the urethra was certified by written statements of others in ward at time.—(Records 18 General Hospital.)

Bladder—Extravasated urine—Bullet lodged—Drained—Died.

CASE 106.—Private G., wounded 28th November, 1899; admitted 2 General Hospital five days later. Entrance right buttock; no exit—bullet passed through bladder, fractured left horizontal ramus of pubes, and lodged under femoral artery at Poupart's ligament. An incision had been made in left groin, evacuating much urine and pus; this was enlarged day after admission; piece of bone removed and drain inserted. Died from exhaustion 32nd day.

Post mortem.—Extra peritoneal wound front of bladder; Mauser bullet under femoral artery.—(Records 2 General Hospital.)

Bladder and rectum (?)—Loss of control over sphincters—Bullet extracted from under skin—Recovered.

CASE 107.—Private B. A., wounded 28th February, 1900, at 500 yards range; admitted 2 General Hospital three days later. Entrance (Mauser) $2\frac{1}{2}$ inches to left of mid-spine, level with iliac crest; bullet found lying under small ulcer $2\frac{1}{2}$ inches below right great trochanter, outer aspect of thigh; perineum and scrotum much bruised.

Could not pass water after being wounded, and now micturates with difficulty; no control over rectum.

Bladder daily washed with boric lotion; complete control of rectum and bladder in a month's time; invalided.—(Records 2 General Hospital.)

Bladder and rectum—Bloody urine—No operation—Died.

CASE 108.—Private G., wounded 1st April, 1902; admitted 20 General Hospital two days later. Entrance near inner edge right tuber ischii; exit over symphysis pubis. Collapse, semi-delirious, and very restless; pulse 110, weak and thin; 4 ounces bloody urine drawn off bladder; both wounds closed; no pain, nor signs of peritonitis. Champagne and hot-water bottles failed to improve condition; died next day.

Post mortem.—Bullet wounded rectum and passed through bladder—track extra-peritoneal; blood clots in bladder; small quantity of urine in pelvis; pelvic peritonitis extending upwards.—(Major WHAITE, R.A.M.C.)

Bladder and rectum—Blood and urine in stools—No operation—Recovered.

CASE 109.—Boer, R., wounded 48 hours before admission. Entrance (Lee-Metford) left buttock at the side of sacrum—no exit. States he passed blood with motion, and had pain on micturition; abdomen not distended; no special tenderness or inconvenience; temperature raised. Had many large watery motions, and at same time passed daily small quantity of urine (12 ounces), which contained pus. Litmus pill given caused water coming both ways to be stained blue—valvular wound of bladder suspected. After a couple of days urine passed in natural quantity, and watery motions ceased.

Examination of rectum showed it to be wounded. There was pus in urine still, and left leg was œdematous when handed over to Provost-Marshal.—(Captain FAICHNIE, R.A.M.C.)

CASE 110.—Trooper P., wounded 5th May, 1901; admitted two days later. Entrance middle left groin, missing vessels; exit middle right buttock. Painful micturition and hæmaturia—bright-red blood passed; no other symptoms. When invalided, 75th day, all bleeding had ceased, and irritability of bladder subsided. Treatment—rest and milk diet.—(Civil Surgeon T. A. HAIG.)

Bladder—Hæmaturia—No operation—Recovered.

CASE 111.—Private S., wounded 24th October, 1899; admitted Ladysmith. Entrance on upper aspect of left shoulder; exit in centre of perineum, bullet thus raking chest and abdomen. Blood in urine; extreme pain over abdomen; died at 5.30 p.m. third day. No *post mortem* noted.—(Colonel BRUCE, R.A.M.C.)

Lung, kidney, intestines, and bladder—Peritonitis and hæmaturia—Died.

CASE 112.—Private O'N., wounded 21st October, 1899; admitted Ladysmith next day. Entrance large and lacerated, between umbilicus and pubes; no exit. Lay out on veldt in the rain all night; transferred here from Field Hospital. Urine issuing from entrance. Incision made from umbilicus to pubes; muscles much swollen and infiltrated large ragged wound in fundus of bladder; removed four pieces of expanded Mauser bullet; doubtful as to whether peritoneum was opened; placed large drainage tube in bladder, and sewed up wound. Dressed frequently; transferred Maritzburg eighth day.—(Colonel BRUCE, R.A.M.C.)

Bladder—Extravasation—Bullet extracted; drained—Recovered.

CASE 113.—Private G., wounded 8th December, 1899; admitted Ladysmith next day. Entrance posterior part of right buttock, 2 inches from mid-line, and 4 inches below post. sup. iliac spine; exit left groin, immediately to inner side of femoral vessels (2 inches from mid-line).

Laparotomy in mid-line; peritoneal cavity full of blood-stained fluid, smelling strongly of urine; difficulty in finding wound in bladder, till permanganate solution was injected, when it issued from wound at apex the size of a threepenny piece; wound in bladder enlarged to search for entrance, but latter not found; glass drain put in bladder, and another in peritoneal cavity, and wound stitched up; died same day.—(Colonel BRUCE, R.A.M.C.)

Bladder—Peritonitis—Laparotomy—Died.

CASE 114.—Private W. T., wounded 20th September, 1901; admitted 7 Stationary Hospital seven days later. Entrance (Mauser) in right thigh posteriorly, 3 inches above knee-joint; no exit.

Was lying behind ant-hill when wounded from behind; wound healed; no hæmaturia nor other signs of bladder injury; no pain anywhere till 27th day, when complete retention of urine set in. Catheter passed freely to neck of bladder, but stopped there; urine passed on withdrawing catheter; three similar attacks, with intervals of a day or two, relieved in same way. Last time catheter stopped 1 inch from meatus by an obstruction, which on extraction was found to be a Mauser bullet covered with urinary salts. No further difficulty occurred.—(Captain ARCHER, R.A.M.C.)

Bladder (?) Retention of urine—Bullet extracted per urethram—Recovered.

CASE 115.—Private A., wounded 18th February, 1900, at 600 yards range; admitted 1 General Hospital eight days later. Entrance (Mauser) 3 inches from right ant. sup. iliac spine, and 2 inches above Poupart's lig.; exit on back of left thigh, large and bifurcated. Unconscious; felt as if "kicked in stomach"; blood in urine, with difficulty and heat in micturition for six days. Had no solid food for 21 hours before. Invalided; recovered 41st day.—(Major BURTON, R.A.M.C.)

Bladder—Blood in urine—No operation—Recovered.

Bladder (?)—No symptoms—Recovered.

CASE 116.—Entrance (Mauser) just above symphysis pubis; exit in left buttock, behind tip of great trochanter. Lay 12 hours on field, and passed water for first time when bearer company removed him, and only twice in next two days; no hæmaturia noticed; recovered.—(Mr. MAKINS.)

Bladder (extra-peritoneal)—Infiltration of urine—Drained—Bullet lodged—Died.

CASE 117.—Entrance (Mauser) in right buttock; no exit. Distension of abdomen and tympanites, followed with swelling of thigh below inner third of Poupart's ligament; latter incised, allowing two pints bloody urine to escape. Died of chronic septicæmia 21st day.

Post mortem.—Transverse wound of extra-peritoneal part of bladder behind pubes; bullet found beneath femoral vessels.—(Mr. MAKINS.)

Bladder (extra-peritoneal)—Infiltration of urine—Died.

CASE 118.—Entrance (Mauser) 3 inches above left tuber ischii; exit above symphysis, over right margin of penis. Next day urine escaped from both wounds, and this continued till 14th day, when entrance wound was enlarged, and a catheter was tied into bladder. Died 38th day.

Post mortem.—Cellulitis around bladder with slough and pus in cavum Retzii; entrance at base of trigone, and exit in anterior wall of bladder still open.—(Mr. MAKINS.)

Group 6.—Liver.

The liver is noted as having been wounded in 40 cases. In 12 of these it appeared to be the only viscus wounded, with 2 deaths, and it was the principal viscus in 16 others, with 6 deaths.

Death-rate.

Thus, of the 28 cases of the two latter classes, 8 proved fatal, or a mortality of 28·5 per cent.

Peritonitis and hæmorrhage.

Peritonitis was more or less present in 26 cases, and internal hæmorrhage in 7.

The bullet lodged in 6 cases, and was extracted in 3.

Laparotomy.

No operation implicating the peritoneum was performed in any of these cases, but procedures to afford drainage were carried out in 8 of them, 7 of which recovered.

In 6 cases the wounds were not produced by normal Mausers; one was a shell wound, and in 5 the "entrance wounds were large"; 4 of these recovered.

Internal hæmorrhage.

Severe internal hæmorrhage occurred in 7 of the cases of wound of the liver, and the large proportion of 4, or 57 per cent., of these died. This appears to have been a high rate for the occurrence of this complication, as many writers have stated that small-bore bullets do not often cause hæmorrhage of a dangerous character from the liver. Hæmorrhage was met with in 25 per cent. of the 28 cases noted, and in some of them the bleeding took place into the right pleural cavity in consequence of the bullet having traversed the diaphragm and pleura.

Biliary fistula.

Discharge of bile through the wound, with the formation of biliary fistula, was not an uncommon occurrence in these cases; it is noted in 5 of them. Fistulæ of this kind usually close spontaneously, but one case was at Netley nearly a year after the receipt of the wound with the opening still discharging. An operation had been done in South Africa, but had failed. The case was twice operated on at Netley, with success on the second occasion. The sides of the sinus through the abdominal wall were scraped, the skin edges refreshed, and silk-worm gut sutures passed deeply, closing the opening; as there was a free discharge of bile into the intestine, this simple operation was successful.

Jaundice. Abscess of the liver.

Slight jaundice was a symptom in 4 of the cases, and abscess of the liver developed in 3, all of which recovered with incision and drainage.

Gunshot Wounds of Liver.

Liver—Hæmorrhage, vomiting, pain, and distension—No operation—Died.

CASE 119.—Private E., wounded 18th November, 1900; admitted 2 General Hospital 36 hours later. Entrance right epigastric region; exit same side, near tip of last rib. Vomited frequently; abdomen distended and tender; pulse quick and feeble. Rest, and rectal feeding. Died two days after admission.

Post mortem.—About a pint of blood in peritoneum; liver much lacerated; intestines distended, but no general peritonitis.—(Lieut.-Colonel G. H. SYLVESTER, R.A.M.C.)

Liver and pleura—Pain, hæmothorax, and jaundice—No operation—Died.

CASE 120.—Private G., wounded 1st May, 1902, at 30 yards range; admitted 21 General Hospital four days later. Entrance between 11th and 12th ribs 1 inch to right of spine; exit same side, between sixth and seventh ribs, 1 inch from nipple line. Right chest dull and immobile; no fremitus nor breath sounds; pain; temperature, 101·4° F.; pulse, 156; respiration, 56. Aspirated 2¼ pints fluid containing blood and bile, and five days later 7 pints same. Pneumonia of other lung developed; died suddenly night of 15th day.

Post mortem.—Right pleura contained 2½ quarts bile-stained fluid—lung collapsed; left lung had two patches consolidation size of palm of hand; ragged tunnel in liver, and corresponding wound in right dome of diaphragm.—(Records 21 General Hospital.)

Liver—Pain, hæmorrhage, and abscess—Drainage—Recovered.

CASE 121.—Trooper P. S., wounded 24th March, 1902. Entrance 1½ inches below eighth right costal cartilage; site of exit not given, but track said to be "oblique from before back." A piece of clothing and brass button missing where bullet entered; "great pain and hæmorrhage 10 minutes after wound." In hospital for a month when sent to Matjesfontein, six days by convoy. On arrival temperature 104·3° F.; pain and enlargement of liver; deep fluctuation. Liver aspirated 49th day—3 pints pus, and incised 63rd day. Uninterrupted recovery. "Abscess evidently due to septic clothing and brass button in liver," no note of these having been found.—(Captain H. W. K. READ, R.A.M.C.)

Liver and kidney—Jaundice and hæmaturia—No operation—Recovered.

CASE 122.—W. W., wounded 6th March, 1902. Entrance right 10th intercostal space, 3 inches from vertebral spines; exit 1 inch below costal cartilage ninth rib, same side. "In its passage bullet wounded right kidney and liver"; jaundice and hæmaturia; tenderness over liver; temperature, 101° F.; abdominal movements good. Rest and starvation diet; did very well, discharged to duty.—(Captain H. WALTON, R.A.M.C.)

Liver—Stomach (?)—Collapse, jaundice, and hiccough—Drained—Recovered.

CASE 123.—Trooper M., wounded 2nd May, 1900, arrived by wagon at hospital next day. Entrance right ninth intercostal space, 3 inches behind nipple line; exit left seventh interspace, in nipple line. Much collapse; jaundice; constant hiccough; great distress, and pain over liver and stomach; upper half of abdomen rigid and fixed; dulness in both flanks, with hyper-resonance in front of dulness.

Perfect rest, morphia and strychnia, rectal feeding. Two months later a tumour containing six pints bile-stained fluid had formed over hepatic region, and was opened; bile discharging from sinus for a month, but patient did well, and bowels were acting normally when transferred.—(Captain H. WALTON, R.A.M.C.)

Liver—Hæmorrhage; viscus exposed—Bullet extracted—Recovered.

CASE 124.—Private B., admitted 18 General Hospital 10th January, 1902. Bullet struck his bandolier, exploding a couple of cartridges. Entrance (2 inches by 3 inches, and 1½ inches deep) over seventh to ninth ribs, mid-axillary line; no exit. Wound septic and cone shaped, with damaged liver tissue at apex; hæmorrhage. Very little shock or constitutional symptoms Pieces of detached rib were removed, and wound fomented. A month later

small sinus persisting was slit up, and cartridge casing and small pieces dead bone removed. Recovered.—(Major J. R. MALLINS, R.A.M.C.)

Liver—Bile-stained discharge—Shell removed—Recovered.

CASE 125.—Private W. I., admitted 2 General Hospital 8th March, 1900. Entrance (piece of shell) in right epigastrium. Before admission shell was removed, and drainage tube 10 inches long passed down and back through liver substance—profuse bile-stained discharge. Iodoform gauze substituted for tube after a week; pleurisy followed (20th March, 1900); temperature, 103° F.; 16 ozs. of flaky fluid aspirated, after which temperature fell, and he was invalided 14th April, 1900, with wound closed and in very good health.—(Records 2 General Hospital.)

Liver (and inf. cava)—Hæmorrhage and collapse—No operation—Died.

CASE 126.—Corporal M., wounded 1st April, 1900, admitted 20 General Hospital two days later.

Entrance 2 inches to right of mid-line behind, on level with first lumbar vertebra; exit a little to same side xiphoid cartilage. Much collapse; extremities cold; tumour and sense of resistance in epigastrium; mild delirium, but general condition masked by morphia. Died suddenly 2 days later.

Post mortem.—Bullet passed through liver, wounding inferior cava $1\frac{1}{2}$ inches below diaphragm; blood found its way to upper surface of liver, and formed large retro-peritoneal hæmatoma behind stomach and round right kidney.—(Civil Surgeon F. R. GARDNER.)

Liver and pleura (?)—Hæmorrhage and cough—No operation—Recovered.

CASE 127.—W. T., wounded 15th December, 1899, at 650 yards range. Entrance 11th intercostal space, $\frac{1}{2}$ inch to right of spine; exit eighth interspace, $2\frac{1}{2}$ inches to same side of nipple line. Severe hæmorrhage from exit; slight cough, but no hæmoptysis; right base up to line of sixth cartilage dull; vocal resonance and fremitus diminished; considerable pain in track of bullet; slight pyrexia at night. The symptoms cleared up, and he was doing well and allowed up the 40th day.—(Civil Surgeon J. E. KER.)

Liver and pleura—Hæmorrhage and rigid painful abdomen—Bullet lodged—No operation—Died.

CASE 128.—W. P., wounded 6th November, 1900, admitted 3 General Hospital eight days later. Entrance seventh intercostal space left axillary line; no exit, but a small nodule, like the top of bullet, felt 2 inches from tip of right 11th rib. Tongue dry and brown; sordes on teeth; respiration slow and laboured; pain and rigidity in right hypochondrium and loin. Given brandy and milk; died two days after.

Post mortem.—Left pleura contained one pint blood; ragged decomposing wound at outer and upper margin of liver; perinephritic hæmatoma left side, to which spleen was adherent.—(Hospital Records.)

Liver—Tympanites, vomiting, jaundice, and pyrexia—No operation—Recovered.

CASE 129.—W. C., wounded 2nd January, 1900, at 800 yards range, admitted 3 General Hospital. Entrance (Mauser) 2 inches to right of second lumbar spine; exit 2 inches to same side, and below ensiform cartilage. Pain over right chest and abdomen, tenderness in hepatic region; tympanites, vomiting and jaundice; temperature, 101° F.; no cough, hæmoptysis, or blood in stools. Steady progress; invalided 43rd day.—(Civil Surgeon J. E. STUART.)

Lungs, liver, and spine—Hæmoptysis, vomiting, paralysis, and discharge of bile—Drainage—Recovered. Bullet lodged.

CASE 130.—H. H., wounded 11th August, 1900, at 100 yards range, admitted 3 General Hospital 41 days later. Entrance ($\frac{3}{4}$ inch) just to outside left scapula and $1\frac{1}{2}$ inches above angle. No exit. After injury great dyspnœa; frequent vomiting; slight hæmoptysis; paraplegia. On admission had considerable use of right leg, and to a less extent of left; no tenderness over spine; right pleural cavity full of fluid; extreme emaciation; $3\frac{3}{4}$ pints dark-coloured fluid withdrawn from pleura; re-accumulated, and 4 pints bile-stained fluid drawn off, and finally, 47th day, 2 inches seventh rib resected and cavity drained. No suppuration took place; temperature fell to normal, and all unfavourable symptoms subsided. Skiagram showed bullet lying

vertically in liver substance. Sent to Cape Town 79th day, able to walk a little, though legs still weak, and with very little pleural discharge.—(Civil Surgeon A. YOUNG.)

CASE 131.—W. E., wounded 26th November, 1900, at 500 yards range. Entrance, second right intercostal space; no exit. Hæmoptysis and pain under right costal margin. X-rays showed bullet lodged here. Bullet removed from small abscess in liver, its base being embedded in abscess, and its point projecting through post. layer of rectus sheath; cavity packed; case did well.—(Civil Surgeon W. A. HOLT.)

Liver and lung—Pain and hæmoptysis—Bullet extracted and abscess drained—Recovered.

CASE 132.—Corporal S. R., wounded 21st August, 1901, at 100 yards range; admitted 12 General Hospital seven days later, after five days in a wagon.

Entrance size of half-crown, in right mid-axillary line, between 10th and 11th ribs; exit size of shilling, below last rib, 1 inch from mid-line. A second bullet passed through lower part of right thigh, causing compound comminuted fracture, which was septic.

Free discharge of pus and bile from entrance and exit of first wound; hæmoptysis; tunnel through liver, found under anæsthetic.

Wounds cleaned, irrigated, and drained; fractured thigh put on extension apparatus. Two months later abdominal wound was healed, but thigh was still discharging; sent to Base after another month, when general health was much improved, and appetite good. A sinus in leg was still discharging, but firm union had taken place.—(Civil Surgeon P. GRANT.)

Liver—Lung (?)—Hæmoptysis and discharge of bile and pus—Drained—Recovered. Compound fracture of thigh also.

CASE 133.—Captain M., admitted 22nd January, 1900. Entrance, region of right nipple; exit at upper part of sacrum. Emphysema around entrance; great collapse; septic swelling right side of abdomen; diarrhœa; gradually sank, and died 11th day. "Bullet traversed right lung and liver, causing hæmorrhage into peritoneal cavity."—(Major KIRKPATRICK, R.A.M.C.)

Liver and lung—Collapse, emphysema, and hæmorrhage—No operation—Died.

CASE 134.—Corporal T. Entrance in right mid-axillary line, 1 inch above bony margin of thorax; exit on level with and 1 inch to left of top of episternal notch.

Was running when hit, spun round, and fell; then crawled to cover. Tenderness along bullet track; slight rigidity of upper half of abdomen; no distension; temperature, 100° F.; pulse, 84; respiration, 48; no vomiting; bowels constipated. Respiration normal and wounds healed in seven days, when transferred.—(Civil Surgeon W. SHEEN.)

Liver and lung (?)—Rigidity of abdomen—No operation—Recovered.

CASE 135.—Private O'H., wounded 29th March, 1900, at 250 yards range. Entrance just below seventh left rib, in nipple line; exit just below eighth right rib, a little external to nipple line. Injury occurred at 3 p.m., and he had nothing to eat since 4 a.m. that day; after a few minutes vomited a small quantity of blood, followed by bile; vomited small quantities of blood at short intervals for four days; coughed up blood-stained mucus after eight or nine days—this continued for four days. Kept on small quantities of milk for a fortnight. When admitted 2 General Hospital 34th day had small discharging sinus at exit, but all symptoms had subsided. Invalided.—(Records 2 General Hospital.)

Liver and lung (?)—Hæmatemesis and hæmoptysis—No operation—Recovered.

CASE 136.—Private F., admitted 4 General Hospital 25th February, 1900. Entrance, seventh right interspace ant. axillary line; exit, 3 inches to left of eighth dorsal vertebra.

Much collapse; pain and dyspnœa; paralysed below umbilicus. Died next day.

Post mortem.—Right lung collapsed; pleura full of blood-stained fluid; diaphragm and liver grazed; eighth dorsal vertebra perforated.—(Civil Surgeon L. B. HULKE.)

Liver, diaphragm, and lung—Collapse, pain, and dyspnœa—No operation—Died.

Kidney and liver—Collapse, pain, and peritonitis—No operation—Died.

CASE 137.—Sergeant H., wounded 27th February, 1902; admitted 19 Stationary Hospital next day. Entrance (Mauser) over seventh right costal cartilage, 2½ inches from sternum; exit close to last rib, 5 inches from spine, left side.

Journey to hospital painful; collapse; great pain left side of abdomen; temperature, 101° F. Nutrient enemata; sucked a little ice. Peritonitis set in; pus exuded from exit; died seventh day.

Post mortem.—17 ozs. blood clot and pus round left kidney, outside peritoneum; upper third kidney disorganised; pus and blood gravitated into pelvis; liver traversed by bullet; body of 12th dorsal vertebra notched.—(Records 19 Stationary Hospital.)

Liver (?)—No symptoms—Recovered.

CASE 138.—Colour-Sergeant M., wounded 24th January, 1900; admitted 4 General Hospital seven days later. Entrance, 2½ inches below right nipple, at level of eighth rib; exit, 1 inch to right of spine, second lumbar vertebra.

No symptoms, but some numbness over outer side of right thigh. Invalided a fortnight later.—(Civil Surgeon F. MARTIN.)

Liver, kidney, and lung—Dyspnœa—Drainage—Died. Bullet split and lodged.

CASE 139.—Wounded 27th February, 1900; admitted Maritzburg two days later. Entrance (Mauser), through right humerus, close to elbow joint; then bullet split, making two wounds in chest wall; one piece fractured eighth rib, wounded lower margin right lung, and, piercing diaphragm, lacerated liver, where it lodged; the other fractured ninth rib, produced larger laceration of liver, and then right kidney.

Great dyspnœa on admission. Portions of both broken ribs removed, when 40 ozs. sanguineous fluid flowed out. Died seventh day.

Post mortem.—Large sanguineo-purulent effusion right pleural cavity; septic pericarditis, though pericardium not directly injured; abdominal injuries as stated above.—(Civil Surgeon IRVINE.)

Liver and lung—Hæmorrhage—Recovered.

CASE 140.—Admitted Maritzburg. Entrance (Mauser), just below angle left scapula; exit, just above costal margin in right post. axillary line. Hæmoptysis and hæmothorax, latter aspirated; retro-peritoneal hæmorrhage, burrowed to outer side of ascending colon, evacuated; good recovery.—(Civil Surgeon IRVINE.)

Liver and lung—Abscess—No operation—Recovered.

CASE 141.—Admitted Maritzburg. Mauser traversed right lung and liver. Abscess of liver evacuated itself through exit end of bullet track. Recovered.—(Civil Surgeon IRVINE.)

Liver—Biliary fistula—Recovered.

CASE 142.—Entrance (Lee-Metford) below seventh rib, in left nipple line; exit on opposite side, through eighth rib mid-axillary line. Lay on field 17 hours; no sickness. Biliary fistula from exit wound followed with escape of pus; fistula was closing when, 14 weeks later, he was invalided.—(Mr. MAKINS.)

Liver—No symptoms—Recovered.

CASE 143.—Entrance (Mauser) 1 inch below and to left of ensiform cartilage; exit in sixth right intercostal space, just behind post. axillary line. "Stitch" on coughing or laughing was the only sign noted; recovered.—(Mr. MAKINS.)

Liver—Slow pulse—Recovered.

CASE 144.—Entrance (Mauser) through seventh left costal cartilage, 1 inch from base of ensiform; exit below 12th rib, 2 inches to right of lumbar spine. Lay on field some hours, and as night was very cold suffered much from shock; pulse 66 for some days, but no abdominal symptoms developed. Returned to duty in six weeks; had a relapse after three months suggesting local peritonitis, but again returned to duty.—(Mr. MAKINS.)

CASE 145.—Entrance in eighth intercostal space, right mid-axillary line; exit 1½ inches below point of ensiform cartilage, ½ inch to right of mid-line—both large. Discharge of bile and pus from exit for a week; recovered.—(Mr. MAKINS.) Liver—Biliary fistula—Recovered.

CASE 146.—Entrance (Mauser) in 10th right interspace, 2 inches from dorsal spine; exit through sternum immediately to right of mid-line, and just above ensiform cartilage. Shock and dizziness; continuous vomiting for two days, and occasional for a week; hiccough and "stitch" on deep breathing; recovered.—(MR. MAKINS.) Liver—Vomiting and hiccough—Recovered.

Group 7.—Kidney.

The kidney is noted as having been wounded in 24 cases; in 8 of these it appeared to be the only viscus wounded, with 1 death, and in 6 others it was the principal one wounded, also with 1 death. Of the 14 cases, therefore, in which the kidney appeared to be the only viscus or the principal viscus wounded, 2 died, or a mortality of 14·3 per cent. nearly. Death-rate nearly 14·3 per cent.

The cause of death in the 2 fatal cases was peritonitis, and some slight signs of this complication were present in most of the cases. Hæmaturia occurred in 12 out of the 14 cases, or 85·7 per cent., but in none of them to an extent to endanger life. The limits of the duration of hæmaturia, as given in the notes, were from 2 to 14 days. Peritonitis and hæmaturia.

The bullet lodged in 4 cases, and was extracted in 2; they all recovered. Bullet lodged.

No operation of this kind was done, but an operation to provide drainage was performed in one case, which recovered. Laparotomy.

It is peculiarly difficult to estimate death-rates in this group, because of the high probability of the implication of other viscera in all kidney cases.

Gunshot Wounds of Kidney.

CASE 147.—M. T., wounded 18th February, 1900, at 100 yards range; admitted 3 General Hospital 32 days later. Entrance (Mauser) ¼ inch above 11th rib, in right mid-axillary line; exit slit-like (1 inch) 1½ inches to left of middle of sacrum. Wounds healed on admission, but diarrhœa continued for nine days, and hæmaturia for two—"damage to right kidney, and probably colon."—(Hospital Records.) Kidney—Colon (?)—Diarrhœa and hæmaturia—No operation—Recovered.

CASE 148.—Private F., wounded 9th June, 1900, at 600 yards range; admitted 4 Stationary Hospital eight days later. Entrance (Mauser) 2 inches from sternum, in eighth left costal cartilage; exit 2 inches from spinous processes, and 1 inch below 12th rib—antero-posterior direction. Fainted when hit; retention of urine for five days; no vomiting; hæmaturia. On admission was out of danger, but very careful to remain quiet. Under starvation treatment abdominal uneasiness and hæmaturia disappeared. Allowed up 18th day, and on 33rd day, when transferred, was able to walk about, but had a limp, and still some pain in neighbourhood of exit.—(Civil Surgeon NUTHALL.) Kidney—Stomach (?)—Hæmaturia—No operation—Recovered.

CASE 149.—Trooper W., wounded 18th December, 1901; admitted 19 Stationary Hospital two days later, after long journey in ambulance wagon. Entrance (Mauser) in right iliac fossa; exit in lumbar region, same side. Wounds healthy; much pain and hæmaturia; abdomen tympanitic. Only water in spoonfuls by mouth for 10 days; nutrient enemata. Convalescent in three weeks.—(Records 19 Stationary Hospital.) Kidney—Pain, distension, and hæmaturia—Recovered.

CASE 150.—Private W., wounded 12th June, 1901; admitted 2 General Hospital. Entrance (Mauser) in centre of left buttock; exit in middle of last rib, same side—rib fractured. Kidney (?)—Pain, swelling, and pyrexia—Exploratory

incision—Recovered.

Wounds had healed; pus in urine; swelling and pain in left renal region—latter incised, but no abscess found. Invalided four months later; still passing pus, but swelling had disappeared.—(Lieut-Colonel SYLVESTER, R.A.M.C.)

Kidney (?)—Pain, distension, and hæmaturia—No operation—Recovered.

CASE 151.—S. L., admitted Hoopslaat 1st February, 1901. Entrance 1 inch above right ant. sup. iliac spine; exit 1½ inches to left of last lumbar vertebra. Abdomen distended; pain in right testicle, and shooting down legs; hæmaturia; loss of sensation and motion in right lower extremity. Wounds healed in five days; hæmaturia ceased in a fortnight; power in leg returned almost completely, and pains in limb and testicle disappeared, when invalided.—(Records 11 General Hospital).

Kidneys and spleen—Hæmaturia, pain, and hectic—No operation—Died.

CASE 152.—Private F. F., wounded 11th December, 1899, at 60 yards range. Entrance 1½ inches to right of fourth lumbar spinous process; exit just above crest right ilium, 2 inches from ant. sup. iliac spine. Another bullet entrance 2 inches from mid-spine, between left 11th and 12th ribs; exit mid-axillary line, between left seventh and eighth ribs.

Lay out on field 12 hours. Rheumatic pains in knees and ankles; unable to pass urine or motions; urine foul and blood-stained; cystitis developed, and rigors, hectic, and much abdominal pain; died 32nd day.

Post mortem.—Left kidney and spleen much damaged by bullet; lower part right kidney destroyed, and connected with large cavity containing pus and urine; local peritonitis. (Quoted by Mr. Makins (Case 201) as a case of penetration through intestinal area without perforation of the bowel, but the *post mortem* 32 days after receipt of wound is hardly conclusive in this connection).—(Records 2 General Hospital.)

Kidney—Hæmaturia, pain, and peritonitis—Shell lodged—No operation—Died.

CASE 153.—Lance-Corporal F., wounded by a piece of shell. Entrance 2 inches long, ½ inch of left of second lumbar spine; no exit. Pain, hæmaturia and peritonitis; died from latter during apparent convalescence.

Post mortem.—Shell injured transverse processes second and third left lumbar vertebræ; large abscess cavity behind left kidney, lower part of which was involved; bladder contained blood clot; peritonitis round splenic flexure of colon; Peyer's patches indicated recent enteric.—(Civil Surgeon F. POPE.)

Lung and kidney—Pain, hæmaturia and hæmoptysis—Bullet extracted—Recovered.

CASE 154.—S. P., wounded 6th October, 1900, while lying prone at 1,500 yards range; admitted 3 General Hospital three days later. Entrance over left eighth and ninth ribs, 9½ inches from mid-sternum; no exit, but bullet afterwards extracted from point ⅜ inch to left of second lumbar spine; bullet was found inverted in this position. Had been in ambulance wagon all night, in farm next day, then travelled 30 miles in wagon to train before admission. "Blood oozing from back of throat and nose; urine soon lost any trace of blood, and he passed a motion also free from blood"; tender area in right loin; dulness left pulmonary area up to sixth rib; temperature, 104° F.; pulse, 100. Had been on starvation diet, and under influence of opium; now milk and soda-water hourly. Sent to Cape Town 22nd day with both wounds healed and pleura almost clear.—(Civil Surgeon A. YOUNG.)

Kidney—Pain and hæmaturia—No operation—Recovered.

CASE 155.—Corporal G., wounded 7th April, 1902, at 800 yards range; admitted 18 General Hospital 26 days later. Entrance between left 10th and 11th ribs, quite close to their anterior ends; exit ¼ inch to left of body of second lumbar vertebra. After wound much abdominal pain and free hæmaturia; both existing still in mitigated way; wounds healed; weakness and emaciation.

Rest and starvation diet for some further time. Abdominal pain had almost ceased, hæmaturia disappeared, and he was able to walk, when invalided.

A letter received August, 1903, stated that he was then "all right."—(Major J. R. MALLINS, R.A.M.C.)

Case 156.—Lance-Corporal J. H., wounded at 1,200 yards range; admitted 3 General Hospital 28th February, 1900. Entrance below right 12th rib, 2 inches from spine; exit sixth interspace, 2½ inches to outer side of nipple. Pain in stomach; hæmoptysis for four days; cough, especially when lying down. Kidney and lung—No operation—Recovered.

Invalided in a fortnight, "could then walk about and go to concerts, &c."—(Civil Surgeon Errington.)

Case 157.—Private L., wounded 11th December, 1899; admitted Orange River next day. Entrance (Mauser) 1 inch to right of fourth lumbar spine; no exit; bullet removed from costal margin in right nipple line. Kidney—Hæmaturia—Bullet extracted—Recovered.

Lumbar pain and hæmaturia; quite well later, except for slight hæmaturia at times.—(Civil Surgeon J. Pegg.)

Case 158.—Entrance (Mauser) in 10th right intercostal space mid-axillary line; exit in 11th interspace 2 inches from spinous processes. Passed blood in urine for two days. Recovered.—(Mr. Makins.) Kidney—Hæmaturia—No operation—Recovered.

Case 159.—Entrance (Mauser) in seventh right intercostal space in nipple line; exit 1 inch to same side 12th dorsal spine. Vomited frequently first day, and had hæmaturia for two days. Recovered.—(Mr. Makins.) Kidney and liver—Vomiting and hæmaturia—No operation—Recovered.

Case 160.—Entrance (Mauser) 2 inches to left and 1 inch below left nipple; no exit. Hæmaturia for four days; tenderness in left loin below 12th rib. Recovered.—(Mr. Makins.) Kidney—Hæmaturia—No operation—Recovered. Bullet lodged.

Group 8.—Spleen.

Wound of the spleen is noted to have occurred in only 4 cases. It was the principal viscus wounded in 1 of them which died. Peritonitis and hæmorrhage were present in this case, which was due to an expanding or ricochet Mauser. No operation was performed. One case with one death. Not due to normal Mauser bullet.

Gunshot Wounds of Spleen.

Case 161.—Private C., wounded 30th December, 1901; admitted 2 General Hospital next day. Entrance large, between eighth and ninth ribs, left nipple line, in which was fixed a piece of omentum; exit same side, behind, near spine, between 11th and 12th ribs. Abdomen tender and distended; frequent vomiting; pulse, 120; temperature, 100° F.; tongue furred. Fed by rectum; small doses morphia hypodermically; died following day. Spleen—Hæmorrhage, vomiting, and distension—No operation—Died.

Post mortem.—Much blood in peritoneum; general peritonitis; small piece of mantle discovered inside stomach, *but the opening by which it entered could not be found;* lower end of spleen blown away—much blood effused here; large cavity in muscles of back contained five fragments of Mauser and distorted sheath.

Note.—An interesting case, showing how easily perforations of hollow viscera may be overlooked.—(Lieut.-Colonel Sylvester, R.A.M.C.)

Group 9.—No Visceral Lesion Noted.

The line of demarkation separating the cases in this group from the others is, and must be, quite an artificial one. The cases in the various groups, as already mentioned, shaded into each other. Some of these cases, no doubt, have had to be placed in this group merely because the notes are incomplete in details, and others, which, beyond all doubt, were cases of visceral lesion, have had to be placed in it, because signs of visceral lesion were late in making

their appearance; many of them developed peritonitis, some of them required operation, and some died. But the general object with which the group is made at all is to show in how many cases of penetration of the abdominal cavity by small-bore bullets symptoms of visceral lesion were absent—at first, at all events. The possible causes of the absence of symptoms have been already discussed at page 73.

"No visceral lesion."

"No visceral lesion" was noted in 46 cases; in 1 the bullet had traversed both the chest and abdominal cavities, and this case, as well as 3 others, died of general peritonitis.

Peritonitis and hæmorrhage.

Peritonitis became more or less evident in 26, and internal hæmorrhage in 2 of the 46 cases. Of the former, 4 died, the peritonitis becoming general, and of the latter, both recovered.

Bullet lodged.

The bullet lodged in 8 cases, and was extracted in 4, of which latter 1 died.

Laparotomy.

The abdomen was opened for exploration and drainage in 3 cases, of which 2 died; drainage of localised collections, the general peritoneum not being interfered with, was done in 5 cases, of which 1 died.

Not Mauser wounds.

In 4 of the cases the missiles were not normal Mausers; in 1 the bullet was of "larger calibre," in 1 it had expanded, in 1 the wound was due to a piece of cartridge casing, and in another to a fuse-screw; these cases all recovered.

No visceral lesion noted—General peritonitis—Laparotomy—Died. Expanding bullet.

CASE 162.—P. H., wounded 21st July, 1900, at 30 yards range; admitted 3 General Hospital next day. Entrance ($\frac{3}{4}$ inch by $\frac{1}{2}$ inch) $\frac{3}{8}$ inch above right iliac crest, and $2\frac{3}{8}$ inches from spinal column; exit ($2\frac{1}{4}$ inches by $2\frac{1}{2}$ inches) $\frac{1}{2}$ inch below right iliac crest, and $1\frac{1}{4}$ inches from right ant. sup. iliac spine—"explosive bullet"—ilium extensively comminuted; wounds foul and sloughy; general peritonitis present. Wounds opened up, cleaned, and pieces of bone and clothing extracted; peritoneum found to be opened; anterior laparotomy for flushing and drainage; died 24 hours later.

Post mortem "confirmed injuries above described."—(Civil Surgeon A. YOUNG.)

No visceral lesion noted—Recovered.

CASE 163.—Wounded 12th February, 1900, at 100 yards range. Entrance (Mauser) right buttock; exit above horizontal ramus of pubes, passed through pelvis, but no signs of injury to any internal organ. Probable injury to sciatic and anterior crural nerves—only slight pain. Invalided a month later. Was retiring when hit. Wounded also in left forearm, thigh, and right side of neck.—(Civil Surgeon T. E. STUART.)

No visceral lesion noted—Drainage—Recovered.

CASE 164.—M. McQ., wounded 18th February, 1900, at 500 yards range. Entrance (Mauser) below cartilage seventh rib, in line with right nipple; exit $\frac{1}{2}$ inch to right of mid-line, and half way down sacrum. Wound of exit suppurating; dead bone at bottom of sinus; enlargement and tenderness inguinal glands. Sinus enlarged 41st day to give exit to pus; recovered.—(Civil Surgeon T. E. STUART.)

No visceral lesion noted—Recovered.

CASE 165.—J. R., wounded 31st March, 1900, at 400 yards range. Entrance $1\frac{1}{2}$ inches below margin of left iliac crest, and 5 inches behind ant. sup. spine, causing compound fracture; exit $\frac{1}{2}$ inch above left iliac crest, and $2\frac{3}{4}$ inches behind ant. sup. spine. Wounds healed well; no treatment mentioned; flesh wound left leg also.—(Hospital Records.)

No visceral lesion noted—Pain, dulness in flank (hæmorrhage), temp.—No operation—Recovered.

CASE 166.—C. B., wounded 14th October, 1900, at 100 yards range; admitted 3 General Hospital two days later. Entrance $4\frac{3}{4}$ inches to right of spine, and $\frac{1}{2}$ inch below sub-costal margin; exit $4\frac{1}{4}$ inches to right of, and on same level with, umbilicus. Lay in farm all night, and had two cups of milk. No hæmaturia; bowels not moved; temperature, 101° F.; dulness, pain and fulness right flank; no general abdominal pain or tenderness; wounds septic. Milk and soda-water in small quantities hourly. On sixth day wounds discharging freely—no fæcal odour. Passed gauze drain right

through, for one day, and then dressed each wound separately. Sent to Cape Town in a fortnight—exit healed and entrance nearly so.—(Civil Surgeon A. YOUNG.)

CASE 167.—A. P., wounded 26th May, 1901, at 80 yards range; carried with column for three days, till admitted. Entrance 2½ inches in diameter and irregular, between right 12th rib and iliac crest; no exit, but flattened bullet removed from suppurating hæmatoma, on back of right thigh. Entrance foul and discharging; ilium extremely broken; abdomen tender; temperature, 102·6° F. Loose pieces of bone removed, entrance enlarged and packed with gauze. Wounds healed, and able to get about when invalided two months later.—(Major S. F. LOUGHEED, R.A.M.C.)

No visceral lesion stated—Pain and fever—Bullet extracted—Recovered.

CASE 168.—Sapper G., wounded 14th December, 1901, from a cartridge exploding; admitted 4 General Hospital at once. Entrance size of shilling, 2 inches below and slightly to left of umbilicus; no exit. Cold and collapsed. Median laparotomy; copper casing 1 inch by ¾ inch embedded in omentum, removed; laceration of peritoneal covering of some coils intestine sponged; abdomen closed. Uninterrupted recovery; invalided 27th day.—(Major J. R. MALLINS, R.A.M.C.)

No visceral lesion noted—Pain and collapse—Laparotomy—Bullet extracted—Recovered.

CASE 169.—H. R., wounded 22nd November, 1900, at 40 yards range; admitted eight days later. Entrance 2 inches above middle of crest of left ilium; exit same side, in buttock—X-ray showed bullet passed through ilium. Transferred "nearly well" to Cape Town one month later.—(Civil Surgeon HOLT.)

No visceral lesion noted—Recovered.

CASE 170.—Captain B., wounded 23rd March, 1902; admitted 22 Stationary Hospital three days later after wagon journey of 30 miles. Entrance (Mauser) near umbilicus; exit not mentioned. "Abdominal expression"; great pain in back and right leg—lumbar plexus seemed to have been damaged. Wounds small and aseptic. Kept under morphia, patient did well, and was transferred 26th day.—(Major B. WILSON, R.A.M.C.)

No visceral lesion noted—Abdominal expression and pain in back—No operation—Recovered.

CASE 171.—Sergeant K., wounded at Klip River. Entrance ½ inch internal to post. iliac spine, through sacro-iliac joint; exit ½ inch below ant. sup. iliac spine. Temperature for seven days 99° to 100° F.; rapidly got well; discharged to duty.—(Captain H. WALTON, R.A.M.C.)

No visceral lesion noted—Fever for a week—No operation—Recovered.

CASE 172.—Lance-Corporal H., wounded 11th December, 1899; admitted 2 General Hospital a few days later. Entrance middle left buttock; exit 2 inches above centre Poupart's ligament, same side.

Wounds suppurating; temperature high; no peritonitis or passage of blood by bowel. A fortnight later some few pieces loose bone removed from entrance, and 5 ozs. pus from exit—outside peritoneum; drains inserted. Invalided 82nd day, with both wounds healed.—(Records 2 General Hospital.)

No visceral lesion noted—Abscess—Drained—Recovered.

CASE 173.—Private R. G., wounded 11th December, 1899; admitted 2 General Hospital a few days later. Entrance (Mauser) just above centre left iliac crest; exit ½ inch to left of third lumbar vertebra. Wounds healed in 10 days, but pain, tenderness, and swelling developed above Poupart's ligament. Swelling incised 50th day, and large quantity of blood clot evacuated. Difficulty in extending hip joint, but did well otherwise; invalided 83rd day.—(Records 2 General Hospital.)

No visceral lesion noted—Hæmorrhage—Drained—Recovered.

CASE 174.—Private G. M., wounded 23rd February, 1900, at 150 yards range. Entrance (Mauser), just above umbilicus, in mid-line; exit, between right crest of ilium and last rib, having passed horizontally. For three days

No visceral lesion noted—Hæmatemesis—No operation—Recovered.

pain, and vomiting of food mixed with blood; no melena. Invalided "well" 42nd day.—(Records 2 General Hospital.)

No visceral lesion noted—Frequent micturition—No operation—Recovered.

CASE 175.—Private R. W., wounded 20th February, 1900, at 1,000 yards range. Entrance, 2½ inches above pubes in mid-line; exit, 2 inches below centre of Poupart's ligament, left side. Slight pain left groin, and on defecation; could not hold urine long; tingling and numbness inner side left calf. Wounds healed; invalided end of March.—(Records 2 General Hospital.)

Omentum—Fuse-screw removed—Recovered.

CASE 176.—Lieutenant F., wounded 10th December, 1899, by fuse-screw of shell, which passed through abdomen in mid-line, and was removed from left side, just below ribs.

Omentum projected into entrance; no symptoms of intestinal injury. Wounds gradually healed; recovered.—(Civil Surgeon C. GLOSTER.)

No visceral lesion noted—Recovered.

CASE 177.—Corporal W., admitted 20 General Hospital 26th March, 1901. Entrance, 1½ inches behind and to right of anus; exit, above Poupart's ligament, 1 inch outside right pubic spine. No signs of damage to large vessels, bones, or important structures. Drainage tubes inserted; wounds healed; convalescent in two months.—(Records 20 General Hospital.)

No visceral lesion noted—Pain, fever, and liver enlargement—No operation—Recovered.

CASE 178.—Sergeant-Major G., wounded 22nd July, 1901; admitted two days later. Entrance, 2 inches above left iliac crest; exit, level of right 10th rib. Free from pain and fairly comfortable when admitted; bowels moved naturally two days later—no blood; temperature, 102° F. at night. Temperature continued above normal at night for nearly a month, with abdominal pain off and on; liver dulness extended to fifth rib in nipple line. Apparently no further abdominal trouble, but signs of tubercle right lung set in, for which he was invalided 69th day.—(Lieutenant PRESCOTT, R.A.M.C.)

No visceral lesion noted—Recovered.

CASE 179.—Private W., wounded 11th April, 1902. Entrance, tip left ant. sup. iliac spine; exit, close to and level with right sacro-iliac joint. Both wounds healed on admission; great pain down sciatic nerve. Sciatic needled, gave great relief; invalided 40th day.—(Captain THOM, R.A.M.C.)

No visceral lesion noted—Peritonitis—Bullet extracted—Died.

CASE 180.—Private J. P., wounded 24th January, 1900; admitted 4 General Hospital, Mooi River, 10 days later. Entrance (Mauser), 1 inch above umbilicus, in mid-line; no exit. Wound healed; recurrent peritonitis, tenderness of abdomen, fever, and legs drawn up. This persisting, he was X-rayed, and bullet located in right kidney region.

On 30th day 4-inch incision for exploring kidney was made, and undeformed bullet extracted from mass of inflammatory tissue in front of kidney, and lying against colon—peritoneum not opened; wound closed without drainage. Suppuration, with escape of gas, took place in wound, which had then to be opened up and drained. Died 36th day.

Post mortem.—Suppurative peritonitis, with thickening and adhesions from former attacks, which prevented discovery of lesion of gut.—(Major S. F. FREYER, R.A.M.C.)

Lung and diaphragm—Vomiting—Peritonitis—No operation—Died.

CASE 181.—Private H., admitted 4 General Hospital, Mooi River, 11th February, 1900, some days after receipt of wound. Entrance, 3 inches below right nipple; exit to left of spine, fifth lumbar vertebra. Had some vomiting, but was apparently improving, when he died suddenly two days later.

Post mortem.—Large abscess between right lobe of liver and diaphragm; diaphragm perforated; a vessel in right lung eroded, causing hæmorrhage. General peritonitis.—(Civil Surgeon F. POPE.)

CASE 182.—Private W., wounded 8th December, 1899. Entrance right lumbar region, 3½ inches from lumbar spines; exit same level, 1½ inches below and 1 inch to right of umbilicus. Transferred to Volunteer Hospital, where operated on (laparotomy?) by Dr. Currie. Died at 6.30 p.m.—(Records, Ladysmith.) — No visceral lesion noted—Laparotomy (?)—Died.

CASE 183.—Private M., wounded 8th December, 1899; admitted Ladysmith same day. Entrance (Mauser) 1 inch below right iliac crest, and 5 inches backwards from ant. sup. spine; exit in abdominal wall, 2½ inches above ant. sup. spine, and 4½ inches from umbilicus—both small.
No signs of peritonitis; transferred 12 General Hospital 10th day.—(Colonel BRUCE, R.A.M.C.) — No visceral lesion noted—Recovered.

CASE 184.—Gunner S., wounded 24th October, 1899. Entrance right gluteal region, 2 inches from mid-line; exit, 3 inches below and to left of umbilicus. No signs of peritonitis or of extravasated urine; pulse good; temperature, 100° F. Bladder washed out; returned to bed. At midnight suffered from severe pain in abdomen.
Transferred to Maritzburg eighth day.—(Colonel BRUCE, R.A.M.C.) — No visceral lesion noted—Recovered.

CASE 185.—Private H., wounded 24th October, 1899; admitted Ladysmith same day. Entrance in left lumbar region, 2½ inches from mid-line; exit right abdomen, 1½ inches below margin of ribs, and 2½ from mid-line.
No signs of peritonitis; temperature normal, pulse good; dressed and returned to bed under observation; skiagraphed—no bullet discernible, no injury to bone. Transferred to Maritzburg 9th day.—(Colonel BRUCE, R.A.M.C.) — No visceral lesion noted—Recovered.

CASE 186.—Entrance at highest point left iliac crest; exit through right ilium 2 inches horizontally in front of post. sup. spine. "Absolutely no abdominal symptoms followed"; bowels confined for five days, were then opened by enema; some stiffness in lumbo-sacral region, but right synchondrosis was no doubt implicated.—(Mr. MAKINS.) — No visceral lesion noted—Recovered.

CASE 187.—Shoeing-smith, wounded 11th May, 1900, at 100 yards range; admitted 22 days later. Entrance 5 inches to left of 12th dorsal spine; no exit—bullet located by X-rays just to left and above umbilicus, 3½ inches from surface. No symptoms except some abdominal pain, and sensation of dragging at site of bullet. Invalided.—(Civil Surgeon YOUNG.) — No visceral lesion noted—Abdominal pain—No operation—Recovered. Bullet lodged.

CASE 188.—Lieutenant De C., wounded 7th March, 1900, at 1,800 yards range; admitted 34 days later. Entrance (Mauser) in left groin, below mid. of Poupart's ligament; no exit. Considerable shock—had no clear recollection of what had happened; some abdominal pain and sickness, which continued for several days. No symptoms when invalided 46th day.—(Lieutenant-Colonel SIMPSON, R.A.M.C.) — No visceral lesion noted—Shock, sickness, and pain—No operation—Recovered. Bullet lodged.

CASE 189.—Lance-Corporal B., wounded 17th December, 1899, at 80 yards range; admitted next day. Entrance (Mauser) in mid-line of second sacral vertebra; exit 1 inch below and internal to left ant. sup. iliac spine. No abdominal symptoms; considerable hæmorrhage; loss of power left leg with pain along femur and tibia.
Pain disappeared; could bear weight on leg for short period, and movement regained when invalided 46th day.—(Civil Surgeon SUFFIELD.) — No visceral lesion noted—Recovered.

CASE 190.—Private G., wounded 7th January, 1900, at 500 yards range; admitted 3 General Hospital next day. Entrance (Mauser) midway between right ant. sup. iliac spine and umbilicus; exit in centre right buttock. — No visceral lesion noted—No symptoms—Recovered.

Lay on field quite still behind a stone nine hours before seen by stretcher-bearers; course of wound pointed to visceral lesion, but there were no symptoms; very free bleeding from entrance. Rest and liquid nourishment for three weeks, with occasional enemata. Invalided 38th day quite well, except for some pain in buttock and stiffness and pain down back of leg.—Civil Surgeon E. KER.)

No visceral lesion noted—Recovered.

CASE 191.—Colour-Sergeant G., wounded at 500 yards range; admitted Field Hospital 24 hours later. Entrance (Mauser) 2 inches to left, and ½ inch below umbilicus; exit 1 inch above and 1 inch inside ant. sup. iliac spine; right forearm also grazed.

Great shock, but never lost consciousness; pain at exit, none at entrance; passed blood once the day after injury; abdomen remained in collapsed condition it was in before injury; had no food for 24 hours before. Kept on liquid diet; wounds healed in 3 weeks; invalided 28th June, 1900.—(Civil Surgeon SIMPSON.)

No visceral lesion noted—Recovered.

CASE 192.—Private H., wounded 28th November, 1899. Entrance ½ inch below left ant. sup. iliac spine; exit at lower part of sacro-iliac articulation; both small. No treatment at Netley. Discharged "fit."—(Records Royal Victoria Hospital, Netley.)

No visceral lesion noted—Recovered.

CASE 193.—Lance-Corporal O., wounded 24th January, 1900. Entrance (Mauser) ½ inch below umbilicus; exit in front of anus. "No symptoms." Discharged "fit."—(Records Royal Victoria Hospital, Netley.

No visceral lesion noted—Recovered.

CASE 194.—Private H., wounded 15th December, 1899. Entrance (Mauser) 2 inches to left of 10th dorsal spine; exit midway between ensiform cartilage and umbilicus. "No symptoms." Discharged "fit."—(Records Royal Victoria Hospital, Netley.

No visceral lesion noted—Recovered.

CASE 195.—Entrance (Mauser) ½ inch to left of second sacral spine; exit immediately below ant. sup. iliac spine, same side. Bullet then traversed lower third of thigh as patient was kneeling. On third day lower abdomen motionless, tumid, and tender, but there had been no sickness or diarrhœa. He compared the pain to what he experienced once in an attack of acute appendicitis. No further trouble. Recovered.—(Mr. MAKINS.)

No visceral lesion noted—Recovered.

CASE 196.—Entrance (Mauser) at highest point left iliac crest; exit through right ilium 2 inches horizontally in front of post. sup. spine. "Absolutely no abdominal symptoms followed." Recovered.—(Mr. MAKINS.)

No visceral lesion noted—Recovered. Bullet lodged.

CASE 197.—Entrance (Mauser) 2 inches diagonally below and to right of umbilicus; no exit. Lay out with regiment and starved for two days; vomited greenish matter frequently for three days; belly hard and painful. Recovered.—(Mr. MAKINS.)

No visceral lesion noted—Recovered.

CASE 198.—Entrance (Mauser) on line joining right ant. sup. iliac spine with umbilicus at junction of mid. with outer two-fifths this line; exit at upper part of right great sacro-sciatic foramen, in line of post. sup. iliac spine. Fell, and crept 50 yards to shelter, where left 7½ hours; vomited freely for two days; bowels acted nine times after injury. Recovered.—(Mr. MAKINS.)

No visceral lesion noted—Recovered.

CASE 199.—Entrance (Mauser) at highest point right iliac crest; exit 2½ inches to right and ½ inch above umbilicus. No sickness nor diarrhœa, but "pain shot across abdomen" during micturition. On third day a little

pain; rigidity and immobility of lower abdomen; no track palpable in abdominal parietes; no dulness or distension. At the end of week recovered.—(Mr. MAKINS.)

CASE 200.—Entrance (Mauser) at junction of post. and mid. third right iliac crest; exit 3 inches to same side and ½ inch below umbilicus. Only soreness and tenderness, on pressure, complained of. Discharged in a month's time.—(Mr. MAKINS.) No visceral lesion noted—Recovered.

CASE 201.—Entrance (Mauser) at junction of post. and mid. thirds left iliac crest; exit 1 inch below costal margin, 3 inches to right of mid-line—bullet lying here. Left 7½ hours on field. Commenced to vomit when brought to hospital; vomiting continued two days. Sent to Base after a week, and home, well, a month later.—(Mr. MAKINS.) No visceral lesion noted—Recovered.

CASE 202.—Entrance (Mauser) 3½ inches above and 1½ inches inside left ant. sup. iliac spine; exit 1½ inches to right of 10th dorsal spine—bullet had perforated forearm previously. No symptoms except tenesmus, with blood and mucus in stools, thought to be due to dysentery, which was present at same time. Recovered.—(Mr. MAKINS.) No visceral lesion noted—Recovered.

CASE 203.—Entrance at centre of upper border of fourth sacral vertebra; exit 1½ inches above left Poupart's ligament, 2 inches from mid-line. Vomited and had involuntary action of bowel one hour later—no blood; incontinence urine and fæces for four days. Travelled six hours in wagon fifth day, and had relapse; fever, swollen and tender abdomen at end of third week, but recovered.—(Mr. MAKINS.) No visceral lesion noted—Recovered.

CASE 204.—Entrance (Mauser) 1 inch in front of tip of 11th cost. cartilage; no exit; starved for two days—small quantity of water allowed. No symptoms. Recovered.—(Mr. MAKINS.) No visceral lesion noted—Recovered. Bullet lodged.

CASE 205.—Entrance (Mauser) in right loin 2½ inches above iliac crest at margin of erector spinæ; exit same side 1½ inches above and inside ant. sup. iliac spine. Starved 36 hours, a little warm water allowed. Recovered.—(Mr. MAKINS.) No visceral lesion noted—Recovered.

CASE 206.—Captain D., wounded at Colenso. Entrance through right rectus, 1 inch from costal margin, and 1½ inches from mid-line; exit 1 inch above and 1 inch behind centre of right iliac crest. Felt giddy, and lay down on field for 12 hours, refraining from taking water; no food by mouth for two days; no symptoms supervened. Pain on exertion for some months, due to adhesions. Recovered.—(Note by Surgeon-General STEVENSON, R.A.M.C.) No visceral lesion noted—Recovered.

CASE 207.—Private C., wounded 24th January, 1900; admitted 4 General Hospital, Mooi River, five days later. Entrance (Mauser) between 11th and 12th ribs, vertically over centre of left iliac crest; exit 2 inches below centre of right iliac crest. Anæsthesia of left leg below knee followed; no abdominal symptoms. Recovered.—(Major S. F. FREYER, R.A.M.C.) No visceral lesion noted—Recovered.

Group 10.—Cases in which the Thoracic Cavity also was implicated.

Death-rate.

Of the 207 cases of penetrating gunshot wounds of the abdomen, 25 were further complicated by injury to the organs within the thorax, and of these, 11, or 44 per cent., died; not a large mortality considering the extent and severity of the injuries. The number of cases in which these combined injuries occurred was large in consequence of the frequency with which fighting was carried on from behind low cover in the prone position, the bullets entering in any situation in the upper part of the chest and passing more or less directly downwards through both cavities.

Causes of death.

In 11 fatal cases, general peritonitis is noted as having been present in 6; internal hæmorrhage into the abdomen in 2; hæmothorax in 4, one of which had also pericarditis due to septic conditions in the neighbourhood, the pericardium not having been touched by the bullet; and in 3 the liver was wounded.

Of the 25 cases in which the thorax was also traversed by the bullet, the liver was certainly wounded in 11, and probably so, judging from the direction of the track of the bullet, in 4 others, or 15 in all, of which 6 died, not necessarily in consequence of the damage to the liver, because many of them had sustained injury to other abdominal and thoracic viscera as well; but in 6 the deaths were probably the direct results, as severe internal hæmorrhage had taken place either into the right pleura or into the peritoneal cavity.

The notes of the cases in this group have not been separated from the others.

The Treatment of Gunshot Wounds of the Abdomen.

Class A.—Non-Penetrating Wounds and Contusions.

Usually due to kicks from horses or injuries from wagon wheels. In Boer War all due to missiles.

Notes of this class of injury during the Boer War are available for only 14 cases, of which only one died. Unlike the experience of other campaigns, where contusions were mostly due to kicks from horses, the passage of wagon and gun-carriage wheels over the abdomen, and other localised applications of force to the abdominal walls, in the Boer War all the cases of this kind were the results of missiles of one kind or another, but mostly of rifle bullets. In 3 cases the injury was pure contusion, 2 by shell fragments, and 1 by a Mauser bullet, the latter of which died from rupture of the ileum in two places; the remaining 11 cases were supposed to be mere flesh wounds of the abdominal parietes, and required no special treatment beyond attention to the preservation of an aseptic condition of the bullet track, and the occlusion of the apertures by the usual dressings.

Extensive ruptures of viscera or vessels common in these cases.

When severe contusions have been produced by kicks from horses and by wagon-wheels, ruptures of the solid or hollow viscera, or of vessels large enough to give rise to fatal internal hæmorrhage, are the very dangerous complications which are likely to be produced.

These cases die unless operated on.

Cases of this kind, as already stated, do not come under the same category as do penetrating bullet wounds as regards the advisability or necessity of operative interference in their treatment; the reasons why this should be so are suggested at page 68. Cases of lesion to the hollow viscera by small calibre bullets frequently recover without operation, whereas cases of rupture of hollow viscera due to contusions nearly all die unless means be employed to repair the rents in their walls and to cleanse the peritoneum; while some of them may recover if these procedures are carried out—not many of them, perhaps, because of the adverse circumstances under which operations have to be performed in the field; but refraining from interference practically means abandoning the patients to certain death. This applies equally to cases of persistent internal hæmorrhage.

Operation justified when peritonitis or hæmorrhage occurs.

When, therefore, in cases of contusion of the abdominal walls from any of the causes named, symptoms of peritonitis or of internal hæmorrhage present themselves, the surgeon is justified in exploring the abdomen for the purposes of closing apertures in the intestines and ligaturing bleeding vessels, notwithstanding the acknowledged impossibility, under ordinary circumstances, of real aseptic work in a campaign.

Symptoms due to contusion.

The symptoms which result from contusion of the abdominal walls are those of shock, collapse, pain, vomiting, or nausea; but during the first few hours of the course of the case there is nothing to indicate whether they are due to mere contusion, or to contusion accompanied by such visceral lesions as will almost certainly prove fatal if not repaired by operation. They are often present in as severe degrees when no visceral lesions have occurred as when ruptures have taken place. They may be well or ill marked in either case, but with this important difference in the course they pursue, that in the former case they tend to decrease and pass away in a few hours, whereas, when visceral lesions are present, they continue and become more marked in severity, and soon have added to them those of peritonitis from extravasation, rigidity of the abdominal muscles, sharp and more widespread pain, tenderness on pressure, general tympanites, and, perhaps, the disappearance of the normal liver dulness from the escape of the intestinal gas into the general cavity of the peritoneum, and a steady rise in the pulse rate, the last being a valuable sign.

Signs of visceral lesion.

Cases requiring operation.

When this is the course which the symptoms take in a case of non-penetrating wound or contusion of the abdomen, it may be looked upon as fairly certain that it is one complicated by internal injury, and as extremely unlikely to recover without operative interference. When, on the other hand, the initial signs begin to disappear in 6 or 8 hours, or if, at least, they have not increased in severity, the surgeon is justified in adopting strictly "expectant" lines in the treatment of the case.

Pain and the use of morphia.

Pain being one of the marked and distressing symptoms in these cases, the inclination towards the subcutaneous use of morphia for its relief is strong; but it must be remembered that morphia merely masks the symptoms, while it does not cure the conditions on which they depend, and that these symptoms, and the course they follow, are the only means the surgeon has of judging as to the necessity for his performing a laparotomy. If, therefore, the conditions of the hospital are such as would justify operation, should one be indicated, morphia should not be given until the lapse of time has shown that the case is evidently one of the less severe type, in which interference will not be required; but if, for any of the many reasons above mentioned, operation cannot be considered, morphia may be given from the first.

Laparotomy may save some cases.

It is, unfortunately, true that laparotomy will not save many of these cases; but it is the only treatment which does not amount to abandoning them to certain death, and those of them that die will have died in spite of the only treatment which could have given them a chance of their lives. In a crowded field hospital, moreover, the surgeon will be bound to take into his consideration what effect his decision to perform laparotomies will have in conducing towards the loss of life and limb amongst the less fatally wounded men, whose active treatment must be neglected while the 3 or 4 abdominal cases, the majority of whom will die in either case, are being attended to.

Only one case noted from Boer War.

The only case in this class from the Boer War of which a record is available, and in which symptoms of visceral lesion followed on mere contusion, was No. 7. Here the ruptures in the ileum were three or four times as large as the apertures usually made by small-bore bullets, extravasation occurred in large amount, and general peritonitis rapidly set in; whereas the *post mortem* showed that they might easily have been closed by operation.

Intra-peritoneal hæmorrhage.

For the same reasons operations should be performed when signs of internal hæmorrhage are clearly evidenced. The bleeding is most unlikely to cease spontaneously, and these cases come into the same category as those in which signs of rupture of hollow viscera develop; they die if ligatures are not applied, and for them, as for the others, operation is the choice of the lesser evil.

Treatment when operation is impossible.

When such conditions exist as absolutely preclude operation, the only treatment that remains consists in the avoidance of all movement, the subcutaneous use of morphia, and the complete withdrawal of all food and drink except by the rectum for at least four days.

Class B.—Penetrating Wounds.

Modification of former teaching as regards laparotomy.

The general considerations bearing on the necessity or advisability of undertaking operations for the treatment of visceral lesions in cases of penetrating gunshot wounds of the abdomen have already been discussed under the head of "Laparotomy." The old teaching, that diagnosis of penetration justified primary laparotomy, though correct in theory, must, in the face of the fact that many cases got well without it, be abandoned. That cases of penetration recovered without having shown any signs of extravasation and peritonitis amounts to positive proof that all cases do not require operation, and justifies the admission that a modification of the former teaching, to the effect that laparotomy should not be considered until such signs develop as show its necessity, is allowable.

When wounded gut protrudes.

The necessity of operation in cases of contusion of the abdominal walls which develop signs of general peritonitis, as well as in cases of persistent internal hæmorrhage due to any cause, has already been referred to. In one other class of case the indications for similar interference is equally imperative, viz., when lacerated intestine protrudes through one of the wounds. Cases of this kind never were common; they were usually the result of extensive injuries to the abdominal parieties by shell fragments or of long incised wounds, and it was hardly expected that this condition would be seen in cases of wounds by modern rifle bullets or even by bullets as large as a Martini-Henry. But one case (No. 28) occurred in the Boer War; the bullet had come out in its length, the exit wound was long, and 3 inches of ileum, completely cut across, protruded. Naturally, immediate operation must be undertaken under these circumstances.

Only one case noted in Boer War.

General treatment of abdominal cases.

Unfit for transport.

Position in bed.

"Starvation diet."

The avoidance of movement in cases of penetrating wounds of the abdomen is of the very first importance in order to escape the danger of breaking down adhesions which may be limiting the extravasation and protecting the peritoneum from general contamination. The position in bed should be with the shoulders raised and the knees well supported by pillows beneath them for the purpose of relaxing the abdominal muscles. No food or drink should be permitted for several days, all feeding being carried out by means of nutrient enemata.

Use of opium.

As regards other treatment, the administration of opium occupies one extreme, and operation the other, these two being diametrically opposed to each other. The subcutaneous injection of morphia should only be employed when the conclusion has been arrived at, either that the condition of the patient or that of the hospital in which he is being treated is so unfavourable that an operation should not be undertaken; in the one case, that hope could not be entertained that he would survive the necessary procedures, and, in the other, that even fairly antiseptic surgery is impossible, or when the hospital is so crowded with severely wounded men that the necessary time and assistance cannot be spared for the performance of laparotomies without an unwarranted neglect of the other cases.

Opium to be withheld if operation be feasible.

In the absence of all the conditions contra-indicating operation, cases of penetrating gunshot wounds of the abdomen should be treated without morphia, and carefully watched for the detection of signs of the onset of general peritonitis or of internal hæmorrhage, and on their appearance immediate steps should be taken for the repair of the lesions to which they are due.

Morphia lessens peristaltic action, and therefore tends to limit the amount of extravasation; but its use masks the symptoms, while it has no curative effect on the conditions producing them. Accordingly, it may be given in any desired quantity when the development of symptoms can have no effect on the treatment which it is possible to adopt, that is, when operations cannot be undertaken.

Rectal feeding.

The importance of rectal feeding, and of cutting off all food and drink supply by the mouth, cannot, of course, be exaggerated. The substances which are most readily absorbed from the large intestine are beef tea and beef juice, egg albumin, starch, milk, wine, brandy, &c., and various combinations of these food substances should be used as enemata, but always with the addition of 30 grains of common salt, which promotes their rapid absorption

from the lower bowel. About four a day, of about 8 ozs. in bulk and given at the temperature of the body, are sufficient. If not well retained opium should be added to them. This method of feeding should be maintained for two or three days. Thirst, which is usually a distressing symptom in these cases, may be allayed by the use of warm water enemata, or a teaspoonful of hot water may be given occasionally by the mouth.

Treatment must be "expectant."

The treatment, then, of penetrating wounds of the abdomen should at first be carried out strictly on "expectant" lines, interference by operation only being justified when such conditions are evidently present that little or no expectation of recovery without it can be held, and even then the percentage of cases saved by it will be small in consequence of the circumstances under which operations must usually be performed on active service.

The operation.

Laparotomies performed in the field for gunshot injuries differ in no way, as regards technique and procedure, from those done under other circumstances. Many apertures in the hollow viscera will require suturing, and an excision may be necessary as well. When apertures are separated from each other by considerable lengths of intestine they should be closed separately; when many are adjacent to each other they may all be included in one resection. Suturing of a small-bore bullet perforation should always be done in the transverse, not the longitudinal, direction of the intestine, as by this means its calibre at the spot is increased rather than diminished; and five Lembert sutures are usually sufficient for the purpose.

Suture for mere perforations.

Excisions.

When excision is found to be necessary in consequence of extensive damage to the gut at one spot, or of many perforations having been made close together, the continuity of the tube should be restored by means of an end-to-end anastomosis, using the Czerny-Lembert system—that is, two rows of suture, one, the Czerny, including all the intestinal wall at the edge of the section except the serous coat, and the other, the Lembert, including all but the Mucosa. The ideal Lembert suture should take up some fibres of the strong connective-tissue layer beneath the mucous coat, and should be interrupted, while the Czerny may be continuous, but when two layers are employed, one merely reinforcing the other, both may be continuous.

Bone plates and bobbins, buttons, &c.

As regards the use of any of the various mechanical means for facilitating the anastomosis of intestine—bone bobbins, buttons, &c.—as good and as water-tight seams can be made by a surgeon accustomed to the work without them as with them, whether for end-to-end or lateral union; but if they are to be used, the Murphy button is the one most likely to be available in the field, as it is easily obtainable, durable, and always ready for use.

Needles.

Ordinary round sewing needles are the most suitable for intestine suturing, but they should be thin. Straight ones are adapted for most purposes, but curved round needles will be required for working deeply within the abdominal cavity when the parts cannot be brought outside.

Suture material.

Sutures should be of aseptic silk, as fine as is compatible with the slight strain to which they are subjected, and absorbable material should not be employed, as it is likely to become loose from softening and to permit of leakage. Absolute contact of the serous surfaces only is required, and sutures should not be tightened beyond what suffices to achieve this object, lest they cut their way through.

Cleansing of the peritoneum.

The cavity of the abdomen should be thoroughly flushed out with hot sterile fluid (boiled water or weak boric lotion, at a temperature of 110° F.) to remove the extravasated intestinal matter, and this should be supplemented by dry sponging with pads of gauze wrung out of the irrigating solution, to remove the more adherent particles from certain situations, or the latter method alone may be used.

Closing the operation wound.

With a view to the prevention of the occurrence of ventral hernia, all incisions in the abdominal walls should be closed by means of three layers of sutures, one of fine silk for the peritoneum and muscles separately, and one of silkworm gut for the skin, the latter being passed deeply so as to include most of the muscular tissue as well.

Drainage.

In most cases, when operations are performed for gunshot wounds of the abdomen, drainage will be required, peritonitis being more or less developed in the majority of them, and it can be best arranged for by means of a glass tube with a strip of gauze loosely occupying its lumen; or ordinary drainage tubing or gauze alone may be used.

Constipation.

Constipation of the bowels is a common condition after operations of this kind, especially when peritonitis is present. Mr. Lawson Tait many years ago drew attention to the good effect of saline laxatives in preventing or curing peritonitis, and under the circumstances mentioned their administration is frequently indicated. But in cases where the intestines have been sutured, care must be taken not to begin their use too early, lest the union be broken down and the operation be rendered ineffective. They certainly should not be given under two days, and the best result is to be obtained from small doses frequently repeated.

The Treatment of Gunshot Wounds of the Various Abdominal Viscera.

If operation inadmissible.

If operative interference were set aside in this connection there would, of course, remain but little to direct attention to as regards the treatment of injuries to special organs within the abdomen—nothing, in fact, but to allude to the necessity for abstaining from all food and drink by the mouth and adhering strictly to rectal feeding, the position in bed, the avoidance of transport and movement, and the free administration of morphia. The conditions under which this merely expectant method is justified have been already pointed out many times. But as—at all events on some occasions—it happens that modern surgical procedures may be brought to the assistance of patients of this class when symptoms show that they are required, some brief reference must be made to the lines on which injuries of particular organs should be treated.

Wounds of the Stomach.

Normal Mauser wounds of stomach not dangerous.

Wounds of the almost empty stomach alone, many hours having elapsed since food was taken, and due to small-bore bullets, are not dangerous injuries; little or no extravasation takes place, and frequently no symptoms are produced. But when extravasation does occur, the normal Mauser aperture in the abdominal walls is unlikely to permit of the contents of the stomach escaping outwardly, the necessary result being, at the least, the formation of localised peritoneal abscess, often sub-phrenic in position in consequence of the passage of the acrid stomach-contents in that direction, as well as of wounds of the diaphragm and liver, which are frequently produced at the same time.

Localised abscess common.

Incision and drainage often necessary.

Symptoms of this condition are late in onset, and must be treated by incision and drainage when the best situation for it can be ascertained; or, as the patient will by this time have arrived at a stationary hospital, an exploratory laparotomy is justifiable to give exit to its contents and to enable drainage to be provided for. Even when the more systematic operation is not feasible, it is certainly necessary to enlarge and drain, either with tubes or gauze, apertures over the stomach when any sign of escape of the contents of the viscus appears at the skin wounds.

Two operations noted from Boer War.

Two operations of these kinds are noted: one a laparotomy, in which suture was performed, died; and the other a drainage case, recovered, *vide* Table 11, p. 120.

Wounds of the Small Intestine.

The lines on which wounds of the small intestine must be carried out are similar to those just mentioned. No cases of localised peritoneal abscess were noted, but when signs of this condition develop, the treatment must be by incision and drainage, the greatest care being taken to avoid breaking down the adhesions limiting the extravasation. When fæces appear at the apertures, or when the discharge has a fæcal odour, provision for drainage should be made. In both cases fæcal fistulæ are likely to persist for some time, but tend to close eventually.

The formation of an artificial anus should only be employed as a last resource, when the condition of the patient is such that he cannot be subjected to any prolonged operative interference. (*Vide* No. 16.)

Wounds of the Large Intestine.

Extravasation from normal Mauser wounds of those parts of the large intestine which are covered by peritoneum is unlikely to take place to a dangerous degree, though, of course, it sometimes does so. No extravasation occurred from the wounds in the cæcum in Mr. Cheatle's case (No. 74), and in the recent specimen the apertures were quite small. But cases of gun-shot wounds of the extra-peritoneal portions of this part of the intestine are much more fatal injuries, for reasons previously mentioned. The minute character of the track of the bullet from the bowel to the skin, and the probability of its not affording a free outlet for the intestinal contents, are the main causes of the cellulitis and consequent septicæmia so common and so fatal in these cases. The indications, therefore, for their treatment are quite clear—enlarging the skin wound and the track leading to the bowel wall, the introduction of a ½-inch drainage tube as far as the opening in the intestine, and packing around it with gauze to prevent fæces coming in contact with the surface of the recent wound. Once the wound has become well covered with granulation tissue the tube may be removed, as absorption of septic materials from the discharge is then improbable. The wound then contracts and becomes, in fact, a fæcal fistula, which usually closes spontaneously.

In portions covered by peritoneum.

In extra-peritoneal portions.

These cases require very frequent renewal of the dressings; but the all-important matter in their treatment is that free drainage be provided for.

Importance of free drainage.

Suturing the edges of the aperture in the bowel to the skin wound has been suggested for these extra-peritoneal cases; but this means the formation of an artificial anus, which will necessitate a second operation for its closure later on; and be no more effective for the prevention of cellulitis than the more simple procedure referred to above, which leaves a mere fistula which tends to close spontaneously.

Wounds of the Sigmoid Flexure and Rectum.

In these cases the bullet tracks are very likely to end or begin in the loins, the buttock, or the upper parts of the thigh, and extravasation into the soft tissues in these regions is then certain to take place, giving rise to cellulitis and complications similar to those met with in cases of extra-peritoneal wounds elsewhere, with the additional one of contamination of the peritoneal cavity as well in some of them.

Extravasation into cellular tissue.

The indications for treatment are, therefore, similar, enlarging the bullet track and the apertures in the skin, and providing drainage.

Drainage most necessary.

Colotomy has been recommended and performed for these cases, with a view to preventing the fæces reaching the apertures in the gut lower down, thus excluding the bullet track from further infection, and permitting it to close. Two operations of this kind are referred to in the notes: one died two days after operation from cellulitis, which had already developed; and the other was invalided two months after the operation, which had not been successful as regards closure of the bullet track, although the colotomy opening acted well.

Colotomy.

Instead of colotomy, and having the same object in view, viz., affording a free exit for the fæces otherwise than by the bullet track, division of the anal sphincters was recommended as long ago as the year 1872, by Simon, of Heidelberg,* and previously by Dupuytren.† This is referred to by Dr. Otis in "The Surgical History of the Civil War in America," page 319, Part II, and attention is drawn to the fact that, though some few of these cases were treated by division of the sphincters in that war, the advantages of this method were not sufficiently appreciated by the Army Surgeons of that time. So far as notes of cases indicate, the same statement may be made of surgeons in South Africa; only one case (No. 99) was treated in this way, but with complete success, no fæces passing through the wound after the operation and rapid healing taking place.

Division of the anal sphincter.

One case so treated in Boer War.

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* "Langenheck's Archives," 1872.

† "Leçon's Orales," Vol. VI, p. 471.

Rationale of the operation.

The rationale of this procedure is, of course, quite clear; the fæces, or some of them, pass out in the direction of least resistance through the wound, while the anus is closed by its sphincters; but, when these are divided, the direction of least resistance is changed to the natural outlet, and the abnormal one is permitted to heal up and close.

Dilatation of the sphincter.

The same object may be accomplished by the forcible dilatation of the sphincters, but, perhaps, with less certainty, because the muscles more rapidly recover their functions, and this may happen before the wound is completely healed. There is no record of this method having been used in the Boer War.

In one case (No. 91), Sir Frederick Treves mentions that excision of the rectum was taken into consideration, but it was decided to perform a colotomy. The man was in a very grave condition, and died two days later.

Wounds of the Bladder.

No marked peritonitis present.

Wounds of the bladder proved fatal in 7 cases out of 17 in which it appeared to be the only, or the principal, viscus implicated. In nearly all of these cases some signs of infection of the peritoneum developed, but peritonitis was not present in any marked degree, nor was it a common cause of death.

Extra-peritoneal injuries the fatal ones.

The cases which proved fatal were those in which the base, neck, or anterior portions of the bladder walls, where the peritoneal covering is absent, were opened, and the deaths were due, as in extra-peritoneal wounds elsewhere, to extravasation into the cellular tissue, producing cellulitis and septicæmia.

Many cases were complicated by wounds of the rectum, and had bullet tracks leading to the buttock or upper part of the thigh; these also were likely to develop severe inflammatory symptoms and to endanger life unless freely incised and drained.

The special points to be attended to.

The two principal matters to be attended to in the treatment of wounds of the bladder are:—

(*a*) The employment of means to keep the organ empty, and so prevent further extravasation of urine either into the peritoneal cavity in the intra-peritoneal cases, or into the cellular tissue in the extra-peritoneal ones; and

(*b*) The use of free incisions into the tissues where cellulitis becomes developed in consequence of extravasation, and the provision for drainage of the discharges to which it gives rise. Keeping the bladder empty is required in all cases—intra- or extra-peritoneal; incision and drainage only in extra-peritoneal cases, or when the track passes through the buttock or thigh.

Keeping the bladder empty.

Tying a catheter in the bladder is quite useless as a means of keeping it empty in the sense required here; mechanical suction or aspiration should be employed to remove the urine as nearly as possible as it is secreted, either with a syringe acting on a soft rubber catheter passed in the ordinary way, or on a tube introduced through a supra-pubic cystotomy opening. On the other hand, the use of the syringe can be omitted if a median perineal section be performed, and a tube passed through it just inside the neck of the bladder. The latter would probably be the safest and best procedure to carry out in all cases.

The ideal treatment for intra-peritoneal gunshot wounds of the bladder would, of course, be by suture of the apertures; but the dangers of laparotomy apply equally in these as in other cases, and no operations of this kind were noted during the war.

Vesical calculi.

In other campaigns cases were recorded in which vesical calculi formed on foreign bodies lodged in the bladder—fragments of bone, pieces of clothing, bullets, &c., and were removed by operation; but no such cases were noted in the Boer War, although in two (Nos. 105 and 114) the bullet remained in the bladder; one was passed during micturition, and the other was extracted from the urethra where it had become impacted.

Bullet passed by the urethra.

In the latter there had been no symptoms indicating injury to the bladder, while in the former hæmaturia had been present.

Wounds of the Liver.

Hæmorrhage, and the escape of bile from laceration of a duct, are the two complications which occasionally require special treatment in wounds of the liver; but they are not as commonly the result of small-bore bullet wounds as they were of the larger missiles. The stiletto-like apertures and bullet tracks made by modern small-arm bullets in the liver substance, except at quite short ranges, are unlikely to give rise to dangerous hæmorrhage. Of the 28 cases of wound of the liver noted, 7 had internal hæmorrhage, and 4 died. In the treatment of these cases the skin wound should be enlarged sufficiently to enable the wound in the liver to be packed with gauze, or the capsule should be sutured over the aperture in the slighter cases. When bile escapes care should be taken to give it a free outlet by keeping the wound open, and providing drainage by tubes or strips of gauze. Mr. Makins points out, in his "Experiences in South Africa," that the cases likely to show this complication are those in which the convex surface of the liver has been scored by the bullet, and some of the more superficial bile ducts opened. Biliary fistulæ are fairly certain to be left in these cases, but tend to close spontaneously with time.

Severe hæmorrhage not very common.

The escape of bile.

Abscess of the liver occasionally supervenes in gunshot cases, and requires the usual treatment—the situation of the abscess to be ascertained by means of the aspirator, followed by free incision and drainage, and possibly the excision of a portion of a rib. Three cases of abscess were noted in the Boer War, and all recovered under operative treatment.

Abscess of the liver.

Wounds of the Kidney.

Injuries of the kidney, as such, produced by small bullets are not dangerous to life, except when the pelvis or calices are opened, causing extravasation of urine and the formation of abscess or hydronephrosis.

Trivial when pelvis and calices escape injury.

Bullet wounds of the kidney substance do not cause dangerous hæmorrhage, and the hæmaturia which usually follows them is seldom of any importance; but they are almost certain to be accompanied by wounds of other viscera of a much more serious character.

When one of the wounds is in the loin the abscess and hydronephrosis which develop must be treated by incision and drainage as soon as they are observed, and the latter condition may possibly eventually require nephrectomy for the cure of persistent escape of urine and pus in that direction.

Extravasation into the loin.

Rest and the use of morphia hypodermically are the means to employ if hæmaturia is a marked symptom and if it continues. Retention of urine may occur in kidney cases, and cases are on record where blood-clots formed in the bladder which could only be evacuated by means of a supra-pubic cystotomy.

Retention of urine.

Wounds of the Spleen.

There are no signs which indicate injury to the spleen except those of internal hæmorrhage and the positions of the external apertures and of the bullet track. Formerly bullet wounds of this organ were considered as certain to prove fatal from hæmorrhage unless it could be controlled by operation; but there is now some evidence to show that the bleeding from small-bore bullet wounds may cease spontaneously, this having been observed in at least two cases in which operations had been performed, although a considerable quantity of blood was found in the abdomen in one of them.

No special symptoms.

Hæmorrhage sometimes ceases spontaneously.

As regards any special treatment in these cases, suture of the apertures, plugging the bullet track through the organ with gauze, or, where the damage is extensive, splenectomy, are the only means which can be employed.

Local treatment.

Tables 10, 11 and 12 are compiled from the notes of the cases already given, and supply certain statistics with regard to them; but it should be remembered that the percentages shown in them are obtained from cases almost all of which were treated in stationary or general hospitals, and indicate results which are probably much more favourable than the complete statistics of the war will afford.

Wounds of the pancreas and of large vessels not recorded.

No notes of cases of wound of the pancreas are available, and cases of laceration of the larger abdominal vessels did not, for obvious reasons, come under notice in hospitals.

TABLE 10.—Showing certain details according to viscera wounded (207 Cases).

—	Hollow Viscera.					Solid Viscera.				Total.	Percentages.
	Stomach.	Small intestine.	Large intestine.	Rectum.	Bladder.	Liver.	Kidney.	Spleen.	No visceral lesion noted.		
Cases	13	35	40	13	17	28	14	1	46	207	—
Peritonitis	11	35	36	6	13	26	12	—	26	165	79·7
Internal hæmorrhage ..	1	10	3	1	0	7	0	1	2	25	12·0
Bullet lodged	2	5	6	4	6	6	4	0	8	41	19·8
Bullet extracted	—	1	4	1	4	3	2	—	4	19	46·3*
Recovered..	11	13	27	9	10	20	12	—	42	144	69·5
Died	2	22	13	4	7	8	2	1	4	63	30·4
Death-rates per cent ..	15·3	62·8	32·2	30·7	41·1	28·5	14·3	100	8·7	—	30·4

* Of cases in which it lodged.

TABLE 11.—Operations on the Abdomen, exclusive of Extraction of Bullets (60 Cases).

—	Hollow Viscera.					Solid Viscera.				Totals.	Deaths.	Death-rates.
	Stomach.	Small intestine.	Large intestine.	Rectum.	Bladder.	Liver.	Kidney.	Spleen.	No visceral lesion noted.			
Cases—all wounds ..	13	35	40	13	17	28	14	1	46	207	63	per cent. 30·4
Laparotomy—resection ..	—	3	—	—	—	—	—	—	—	3	1	33·3
Suture	1	5	6	—	—	—	—	—	—	12	10	83·3
Colotomy	—	—	—	2	—	—	—	—	—	2	1	50·0
Artificial anus	—	1	—	—	—	—	—	—	—	1	—	—
Exploration and irrigation	—	2	1	1	1	—	—	—	3	8	6	75·0
Totals of laparotomy ..	1	11	7	3	1	—	—	—	3	26	18	69·2
Died after laparotomy ..	1	7	5	2	1	—	—	—	2	—	18	69·2
Drainage—general cavity not opened	1	—	11	4	5	8	1	—	5	35	—	—
Died—of cases drained ..	—	—	2	—	3	1	—	—	1	—	7	20·0

Death-rate for operations really higher than shown in Table 11.

With regard to the results shown in Table 11 for operations on the abdominal viscera for gunshot wounds, it must be admitted that a death-rate of nearly 70 per cent. is most unsatisfactory. At the same time, I have good reason to know that it does not represent the real mortality which followed on laparotomy during the war, because many cases were unsuccessfully operated on of which no records are available.

FIG. 17.

Rupture of Ileum in two places from a graze by a Mauser ; skin only abraded, not penetrated. The photograph exaggerates the injury to the skin.

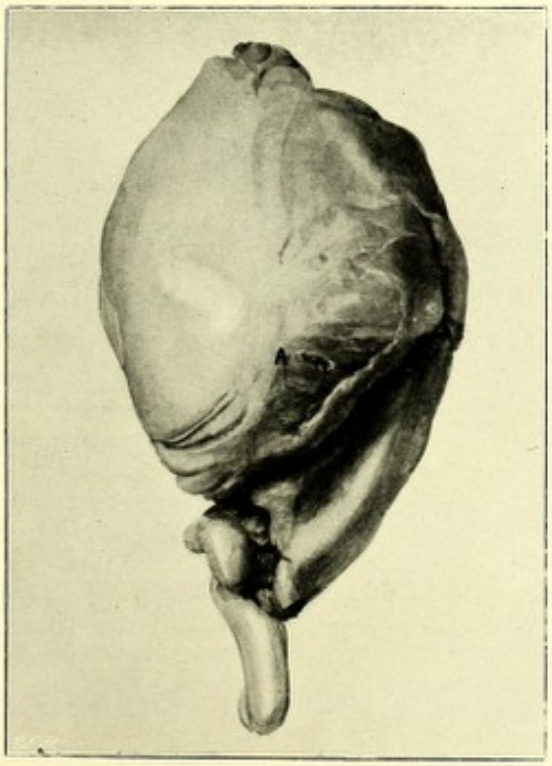

FIG. 18.

Exit through Cecum.—(Mr. CHEATLE's Case.

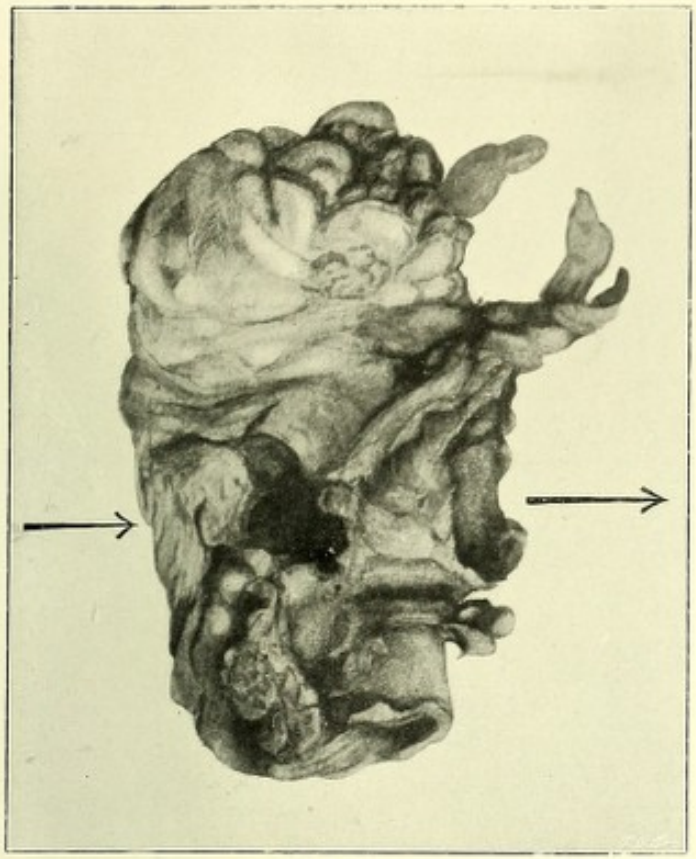

FIG. 19.
Laceration of Sigmoid —(MR. CHEATLE's Case.)

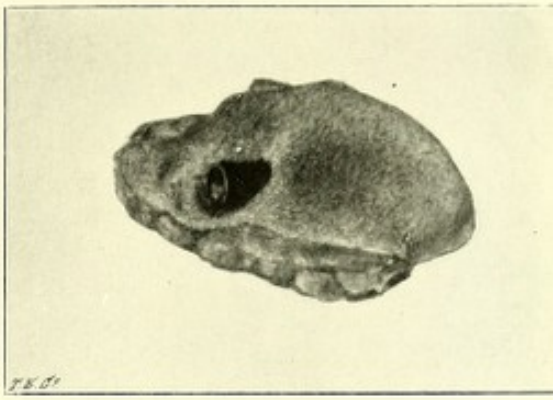

FIG. 20.
Bullet Lodged in Skin, base forwards.
(MR. CHEATLE's Case.)

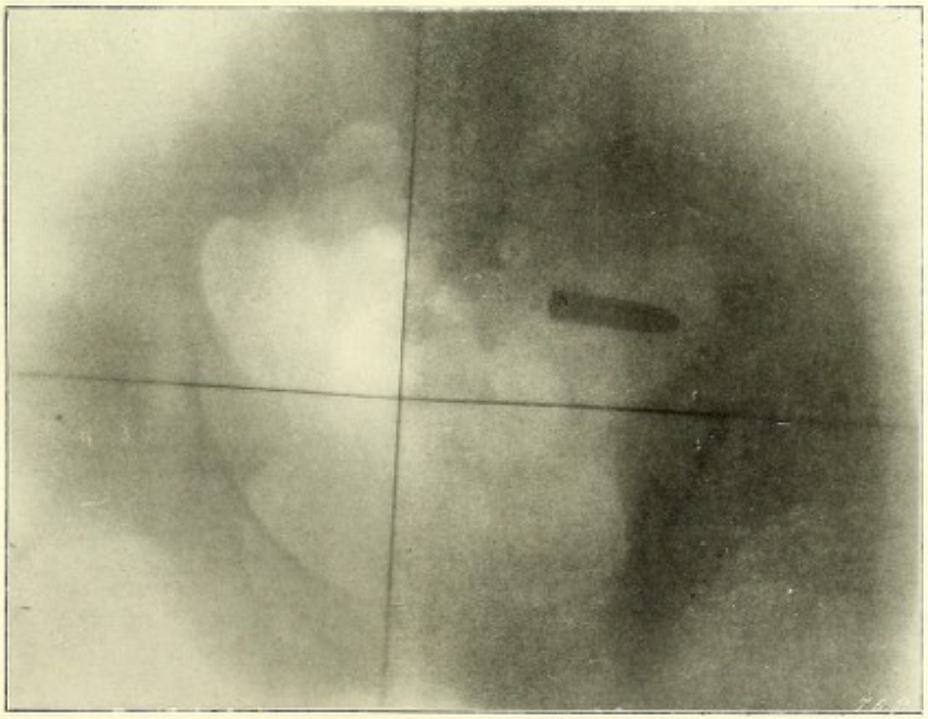

FIG. 21.
Bullet Lodged in Pelvis : not removed, as it caused no trouble.—(Skiagraphed by Captain PRESCOTT, D.S.O.)

TABLE 12.—Showing the number of Cases in which Peritonitis and Internal Hæmorrhage occurred, and the death-rates following them.

N.B.—In some, both complications were present.

Viscera wounded.	Total cases.	Peritonitis.			Internal Hæmorrhage.		
		Cases.	Died.	Death-rate.	Cases.	Died.	Death-rate.
				per cent.			per cent.
Stomach	13	11	2	18·1	1	1	100·0
Small intestine	35	35	22	62·8	10	8	80·0
Large intestine	40	36	13	36·1	3	2	66·6
Rectum	13	6	3	50·0	1	1	100·0
Bladder	17	13	7	53·8	—	—	—
Liver	28	26	8	30·7	7	4	57·0
Kidney	14	12	2	16·6	—	—	—
Spleen	1	—	—	—	1	1	100·0
No visceral lesion noted ..	46	26	4	15·4 (nearly)	2	—	—
Totals	207	165	59	35·9	25	17	63·0

N.B.—The number of deaths shown in this table does not correspond with those in Tables 10 and 11, because some of the cases shown here had both the complications referred to in this table.

SECTION IV.

By the Editor.

GUNSHOT WOUNDS OF THE GENITAL ORGANS.

Few cases of this class.

VERY few injuries of this class were noted from the war—only 9 in all—but fortunately they afford some indications of the results produced when either the urethra or testicles have been traversed by a small-bore bullet. All the cases recovered, and none of them were accompanied by symptoms of gravity as regards life.

Wound of the urethra.

When the urethral canal was traversed by the bullet, as in Cases 3 and 5, no difficulty was experienced in introducing a catheter, even several hours after the receipt of the wound. This is an important point, and renders these cases more easy of treatment than ruptures of the urethra due to other causes usually are, as in the latter cases it is often impossible to pass an instrument.

Catheter usually readily passed.

The facility with which a catheter could be introduced into the bladder in most of the gunshot cases seen in South Africa probably depended on the kind of sections made of the canal by the small bullet—notches at the side or clean perforations, not the jagged lacerations commonly met with in civil practice. Hæmorrhage does not seem to have been a marked characteristic of wounds of the external genital organs, though hæmatoma of the tunica vaginalis is referred to; and even extravasation of urine is hardly mentioned in the notes.

Traumatic stricture.

Stricture is only mentioned in one case in the notes, but that is probably due to the fact that the cases did not remain long under observation, for many were seen at home in which the usual difficulties of keeping the canal patent were met with. In one case seen at Netley nearly 2 inches of the under surface of the urethra in front of the scrotum was lost, and plastic operations on two occasions failed to produce any improvement.

Injury to the testicle.

The testicle was traversed in Cases 8 and 9, but no general disorganisation of its structure was produced, the damage sustained being apparently strictly localised and insignificant. In Case 6, where the cord was injured, the damage was more serious, as atrophy of the testicle is probable after any gross lesion of the vas.

In Cases 6 and 8 the bullets seem to have been deflected out of their course, and traversed the penis subcutaneously and emerged at its tip. Deflection of the Mauser bullet is so exceptional that these cases are quite curious, and were most probably caused by bullets at low velocity.

Treatment.

There is nothing special to be suggested with regard to the treatment of gunshot injuries of this region as apart from that of lesions due to other causes. The control of hæmorrhage, the limitation of extravasation, and repair of lacerations of the urethra are the points to attend to. In cases where the urethra is torn, if a catheter can be introduced into the bladder and there are no signs of extravasation of urine, nothing more need be done immediately,

Extravasation.

but they must be carefully watched for the onset of extravasation, and when

Perineal section.

the least signs of this complication appear a perineal section should be performed at the site of the laceration, the wound thoroughly irrigated, and, if one has not already been passed, a Jaques' catheter introduced. If the inflammatory condition due to the escape of urine into the perineum is only of slight degree, the urethra should be repaired by thin silk or catgut sutures, and

Repair of the torn urethra.

the catheter left in for a week, but if there is gangrene and sloughing of the cellular tissue and suppuration, sutures will not hold, and a plastic operation will probably be required later on.

Cellulitis from escape of urine.

When cellulitis from extravasation occurs it must be treated by incisions wherever signs of its presence show themselves, each wound being well

irrigated with an antiseptic solution and drained. Incision, drainage, and irrigation must usually be freely carried out in this latter class of cases, and the administration of stimulants and opium is often required in their treatment.

Gunshot Injuries of the Genital Organs.

Wound of penis.

CASE 1.—A. R., wounded (Mauser) whilst standing up at 50 yards range. Entrance 2 inches below line of tip of left trochanter; exit ½ inch outside and below pubic spine. Re-entered left side of dorsal aspect of penis, which latter it traversed for ½ inch, and made final exit on right side of penis. On admission to 3 General Hospital all wounds healed; no unfavourable symptoms.—(Civil Surgeon A. YOUNG.)

Wound of scrotum penetrating testicle.

CASE 2.—J. C., wounded (Lee-Metford) at 50 yards range. Entrance in left testicle; exit in scrotum, close to right testicle. Re-entered right thigh, where it lodged, after fracturing femur about its middle. The genital wound does not seem to have done much harm, as there is no further note except as regards treatment of fractured femur.—(Hospital Records.)

Wound of scrotum and urethra.

CASE 3.—A. W., wounded 15th August, 1900, whilst mounted, at 40 yards range. Entrance on right of base of scrotum, ½ inch below pubis; exit in left buttock 5 inches above gluteal fold and 2¾ inches to left of mid-sacrum. In its course bullet passed behind right cord and damaged membraneous part of urethra at its commencement. A catheter was introduced eight hours later, but after two days it was found necessary to perform perineal section. When admitted to 3 General Hospital, the 48th day, the perineal and other wounds had healed; dysuria and frequent micturition. Lister's bougies, 9 to 12, passed every few days. Discharged convalescent 17th October, 1900.—(Civil Surgeon YOUNG.)

Wound of perineum in vicinity of urethral bulb.

CASE 4.—A. B., wounded (Mauser) in perineum. Line joining entrance and exit passed close to urethral bulb. Straining micturition followed, with complete retention next day. Catheter had to be used for a few days. No swelling in perineum, or sign of extravasation. The retention supposed to be due to inflammation in bullet track—urethra probably not touched.—(Records Imperial Yeomanry Hospital.)

Wound of urethra and rectum.

CASE 5.—G. C., wounded 7th March, 1902, whilst rising from kneeling position. Entrance on dorsal aspect of base of penis; exit 1 inch behind anal margin traversing perineum, and wounding urethra and rectum. Admitted 11 General Hospital four days later. Urine passed almost entirely through perineal wound. Catheter passed under anæsthetic and tied in. After a fortnight urine ceased to come from wound, and catheter was removed. Invalided quite well, and without any symptoms of stricture so far.—(Records 11 General Hospital.)

Wound of penis.

CASE 6.—Captain P., wounded 6th March, 1902, whilst mounted. Entrance in right buttock. Bullet travelled up to Poupart's ligament, probably through ilium, and then passed along penis subcutaneously, without touching urethra; exit at tip of penis. A hæmatoma formed round right cord, and testicle was swollen, but he had no difficulty in micturition; good recovery.—(Lieutenant H. RICHARDSON, R.A.M.C.)

Wound of scrotum.

CASE 7.—Captain S., wounded 18th February, 1900, by Mauser bullet, which passed through scrotum. Hæmatoma into tunica vaginalis followed, which had to be evacuated after securing the vessels. Case apparently did well.—(Civil Surgeon JOHNSTONE.)

Wound of penis and testicle.

CASE 8.—Corporal C. D., wounded 11th December, 1899. Entrance (Mauser) at back of right buttock, in line with tip of great trochanter; exit

just to right of median raphe, in perineum. It then pierced right testicle, entered right side of penis, far back, and running forwards emerged from upper surface of glans. Had difficulty in micturition, and passed blood. Wounds healed rapidly, but testicle remained swollen and painful for a week. Invalided to England within a month from date of wound.—(Records 2 General Hospital.)

Wound of testicle.

CASE 9.—Private J., wounded at Colenso. Entrance (Mauser) in lower part of right testicle. Bullet lodged in adductor magnus muscle. The epididymis escaped, and there was only slight bleeding. Wound healed rapidly, leaving only a little cicatricial hardening in lower part of testicle, which caused no trouble.—(Civil Surgeon JOHNSTONE.)

SECTION V.

By Major Holt, D.S.O., R.A.M.C.

GUNSHOT WOUNDS AND INJURIES OF THE CHEST.

Classification.

Wounds in this region naturally fall into one of two categories, viz., non-penetrating and penetrating. It would be satisfactory to further divide the second class into sub-classes according as to whether there was injury to—

(*a*) The lungs;
(*b*) The heart and pericardium; or
(*c*) To neither of these organs.

Symptoms variable.

Had there been any constant train of symptoms, or even a single symptom, which would in all instances have proved the presence or absence of damage of these viscera, then, such a subdivision would be possible; but no one symptom was invariably present when there was almost without doubt a wound of the lung, or of the pericardium, or even of the heart; and, on the other hand, no one symptom was found to have been invariably absent when these organs were obviously not injured.

Escape of important structures.

It will be seen from the notes given below, taken from some of the many cases examined, that, although from the anatomical sites of the wounds of entry and exit, coupled with the justifiable assumption that the small-bore bullet passes between these points in a straight line, it is impossible to avoid the conclusion that the heart, or pericardium, or lung, as the case may be, was wounded; yet the symptoms present were only such as were at other times found in cases where these structures were undoubtedly not within the wound area, in fact, they were purely negative.

Classification founded on clinical as well as anatomical evidence.

Thus a subdivision of penetrating wounds founded on anatomical, as apart from clinical, evidence would at best be but an imperfect one; it can be said confidently, from both anatomical and clinical evidence, that in some of the instances the heart was wounded; but there were again instances where anatomically it was practically certain that the heart was wounded, yet no symptoms were present to support this conclusion; it must, then, be assumed that the heart can be wounded without consequent symptoms. But is this a sufficiently strong hypothesis to serve as a basis of classification? If not, the subdivision to be complete must be primarily founded on anatomical grounds, though not solely so, for it will be seen that a classification founded on purely anatomical considerations would not be without very reasonable objections. A further difficulty arises from the fact that, in order to estimate the probable damage done, it is necessary to take into consideration the position and posture of the patient at the time of receiving the wound. Given the sites of the wounds of entry and exit, the fact of penetration or otherwise may depend entirely upon whether the patient was standing or lying down or bending in any particular direction. The following is a case in point; on anatomical considerations, taking a straight line from entry to exit, it would have been concluded that in all probability the chest was not penetrated :—

Importance of position of patient when hit.

A case in point.

Case 1.—Private C., wounded 11th June, 1900. Entry, 1¼ inches outside the vertebral border, and 1 inch below the spine of left scapula; exit, opposite the highest part of left posterior axillary fold, in the middle line of posterior surface of arm. "Had hæmoptysis for two days; wounds remained aseptic; a straight line between these points does not penetrate the thoracic cavity when standing square and erect, but does so in the position in which the patient was when hit, viz., sitting on the ground, leaning forward, cutting up his trousers to attend to wounds in both thighs."—(Hospital Records.)

Another case.

Mr. Smith, in his address at Manchester on 5th December, 1900, mentioned a case where both great dyspnœa and hæmoptysis lasting four days, and sharp pain on taking a deep breath, were present for some time afterwards, but there was no perforation of the chest, the bullet having only sufficient velocity to partially embed itself in the fourth right costal cartilage, whence it was removed. These two cases instance the objection to basing a diagnosis of penetration in the first case on anatomical, and in the second on clinical, evidence alone; it may be presumed that the symptoms in the second case were due to lung concussion from transference of vibratory motion. Inferentially, dyspnœa without hæmoptysis would imply injury to the pleura alone, but it will be seen that in some instances such a conclusion would be inaccurate when the anatomical situations of entry and exit wounds are considered. It has long been known that severe concussion of the chest wall may cause hæmoptysis, and a case in point may be quoted :—

Case of concussion of chest wall.

Case 2.—Private W., wounded by fragment of shell at 900 yards; admitted to 3 General Hospital 5th January, 1900. "The fragment, however, did not penetrate, though it cut the straps of his haversack." Had hæmoptysis four days; "now only slight pain in right side and dyspnœa; otherwise quite well." Discharged 11th January, 1900.—(Major C. E. Nichol, R.A.M.C.)

The following bullet wound will draw attention to the point in question :—

Wound of lung without hæmoptysis.

Case 3.—Wound of lung; no hæmoptysis. Private D., wounded 26th September, 1900, at "close quarters." Entry at back of chest, $6\frac{1}{2}$ inches to right of mid-dorsum, at level of sixth dorsal spine, $\frac{3}{8}$ inch above inferior angle of scapula, and $\frac{3}{8}$ inch to its outer side; exit at anterior aspect of arm, $5\frac{1}{2}$ inches below acromion, and $2\frac{3}{4}$ inches outside anterior end of axillary flexure. Was also wounded in abdomen. All wounds septic; comminution of humerus; dyspnœa; dulness of right base; pyrexia; doubtful whether pyrexia due to chest or humerus; the latter only gave trouble.—(Hospital Records.)

Wounds of chest often implicated neighbouring regions also.

No note has been made in this section of wounds affecting the spinal column, or cord, except in so far as the injury to the thorax and its contents was concerned.

In a large number of cases neighbouring regions were also wounded, and the reason of this is sufficiently obvious when it is remembered that a very considerable number of men were hit when lying down, with or without shelter, or in a crouching attitude while advancing. This same consideration accounts for the large number of longitudinal bullet tracks found in all regions; nearly all antero-posterior penetrating wounds of the lower part of the thorax were complicated by symptoms indicating wound of the abdomen.

When chest and abdomen implicated.

In some cases where both thorax and abdomen were wounded, the chest symptoms, but in others the abdominal symptoms, were the more urgent; sometimes it was merely noted that hæmoptysis existed for a few days or hours, and when even a fatal result followed, no further note was made of chest symptoms; such cases frequently were fatal. Thus in the General Hospital at Maritzburg, of 27 cases of gunshot wound of the chest, the abdomen was also wounded (by the same bullet) in six, and of these two were fatal.

Relative innocuousness of small-bore bullets.

As to the comparative effects of small-bore and large-bore wounds at the General Hospital at Maritzburg, of a series of 21 cases of penetrating wounds of the chest, one was caused by a ·450 bullet, and was fatal; the remaining 20 caused by small bores recovered, and in two of these the bullet was travelling sufficiently slowly to lodge, after traversing apparently both lungs.

Entrance and exit often indistinguishable.

In the records of the various hospitals it was common to meet with a remark to the effect that "it is impossible to say which is exit and which entry wound"; and this, too, was not infrequently noted with reference to wounds inflicted accidentally or otherwise at a few yards distance. This being stated by men who were seeing, perhaps, some dozens of cases of gunshot wounds daily for a period of a year or two continuously, it must be allowed considerable weight.

Hæmorrhage.

External hæmorrhage was distinctly rare, the majority of chest wounds remaining from the first quite dry. The lay pictorial representation of a stream of blood down the shirt was almost unknown in small-bore wounds, a limited staining of the shirt being more often met with. The note "No hæmorrhage" recurs constantly. This all applies to wounds inflicted by the undeformed small-bore bullet, but the results were otherwise with larger or deformed missiles; occasionally exit wounds, where ribs had been fractured, bled freely, probably from the intercostal artery being ruptured in consequence of the bone fracture. Only one instance of free hæmorrhage from the internal mammary artery was recorded, though undoubtedly this vessel must have been frequently wounded.

Primary hæmorrhage (external) very rare.

Case 4.—Private S., wounded 11th June, 1900, at 200 yards range. Entrance 1½ inches inside, and ¾ inches above right nipple; exit 3¼ inches to left of 11th dorsal spine. Free hæmoptysis at first; anterior wound bled freely for first 24 hours; both wounds now dry and aseptic; stabbing pain right chest; no friction rubs; slight dulness; diminished respiratory murmur; diminished vocal resonance and fremitus at right base; June 26th aspirated; 8 ozs. blood removed with fibrinous flakes; relief; lowering of temperature; and lessening of dull area and of dyspnœa.—(Hospital Records).

Internal mammary artery wounded.

Asepsis.

As a rule, small-bore wounds of the chest remained aseptic, and healed immediately. As to whether an undeformed small-bore bullet travelling at high velocity can carry with it septic infection from without, the probabilities are strongly against it; should, however, the bullet pass through a septic area, cases on record prove that infection may be occasionally set up at intermediate points, or through the entire track. Thus in a case in the General Hospital, Maritzburg, the bullet having traversed the ascending colon and liver, passed into the right pleura and lung, finally fracturing the third rib; there were dyspnœa, hæmoptysis, hæmothorax, and death on fourth day. At the *post mortem* there was right empyema, with collapse of right lung, besides general peritonitis, but no note is made of the presence of sepsis in the track within the liver, which formed an intermediate zone.

Aseptic healing the rule.

Wound infection from within, by implicating intestine.

Wounds made by ricochet bullets, by bullets of large calibre, or by fragments of shell, were usually septic, as also those made by fragments of stone. Ricochet wounds generally suppurated through the entire track, with an abscess at the site of lodgment when this occurred; but an empyema did not invariably develop; the bullet in these cases, after passing through the pleural cavity, lodged, and was surrounded by an abscess. In not a few instances where a ricochet bullet lodged, and was subsequently removed from within a collection of pus, there was no suppuration along the track. Such a case (Private D. N. F.) was recorded in 18 Stationary Hospital, where the point of entry was in eighth right intercostal space, mid-axillary line, with comminution of the eighth and ninth ribs; the bullet was subsequently removed from under the skin in the right lumbar region, and, at a still later date, some small pieces of necrosed rib were removed from near the entry wound, no suppuration following in the length of the track.

Wounds other than normal Mauser usually septic.

Bullet track does not often lend itself to spread of septicism.

Again, there may be septic contamination of the surface-wound, which fortunately does not spread along the track, even when the latter is a very short one. This is well instanced in a case recorded by 3 General Hospital (Boer J. H.), wounded by Lee-Metford bullet; two small wounds in right chest; entry in fifth space, exit in sixth space, both 1 inch outside nipple line; on admission "both wounds were covered with scabs; under these scabs there were small areas of strictly localised suppuration"; not extending along the length of even so short a track. But more interesting and important, cases of this nature were recorded in connection with wounds of the mouth and neck (q.v.).

In septic cases secondary abscesses, at a distance from the wound track, were very seldom recorded, but the following are cases in point:—

Secondary abscess in septic cases.

Cases :—

(1) CASE 5.—Private McD., wounded 23rd November, 1899; admitted 1 General Hospital, eight days later. Entry left upper part of posterior axillary fold; exit at back, 2½ inches from spine, at level of eighth rib. On admission, discharge of broken down blood clot and pus from wounds; cough; dyspnœa; pyrexia; fracture of sixth rib. Drainage instituted; signs of air and fluid in chest, and of consolidation of lung; discharge became more purulent, but never offensive, and continued copious for some weeks; pyrexia persisted, but the general condition remained good. On 1st January, 1900, a large secondary abscess had developed in right buttock, and was opened; healed rapidly; 20th January, 1900, well.—(Hospital Records).

(2) A case is quoted in the section dealing with wounds of the neck (No. 11), in which sepsis spread along the track, through the neck into the lung, where an abscess was found *post mortem*.

Direction of Bullet Track.

Direction.

Bullet tracks were recorded in almost every conceivable direction, and of every possible length, from one, an inch or so long which opened the pleura, to the full length of the thorax. As a rule, antero-posterior penetrating wounds were much less serious than longitudinal ones, and, generally, the nearer the middle line the more serious was the lesion; even the cardiac area was apparently traversed with but unimportant after-results in a considerable number of instances. Longitudinal tracks were mostly of greater severity, being complicated by injuries to abdominal viscera, and the mortality was correspondingly high. Probably most of the wounds about the root of the lung were immediately fatal, though several cases of recovery were recorded. Several cases, however, were recorded where the bullet passed from the upper to the lower outlet of the chest, or *vice versâ*, with very little harmful result.

Longitudinal wounds most serious.

Collapse of Lung.

Collapse of lung.

Collapse of lung, whether partial or complete, was very seldom recorded, unless in conjunction with hæmothorax or empyema; with these conditions it naturally occurred in a corresponding degree.

In the following case partial collapse was diagnosed :—

Case.

CASE 6.—Private M., wounded 17th September, 1901. Entry 3 inches below left nipple; no exit. Wound healed at once. On the 26th day it was noted that there was very severe dyspnœa, with the symptoms of "partial collapse of left lung."—(From Hospital Ship *Spartan*.)

In a large number of cases it was thought that there was a lesion of the pleura, without wound of the lung, but there are difficulties in accepting such a diagnosis, as will be seen later.

Symptoms.

Order of frequency of symptoms.

When the thoracic wall was penetrated, the symptoms mentioned in the 214 cases noted were, in order of frequency, as follows :—(1) Hæmoptysis; (2) Dyspnœa; (3) Fever; (4) Dulness to percussion; (5) Hæmothorax; (6) Pain; (7) Pyothorax; (8) Collapse and shock; (9) Extensive surgical emphysema; (10) Severe cough; (11) Friction rubs; (12) Deficient chest movement; (13) Cyanosis; and (14) Pneumothorax.

The actual numerical frequency of these symptoms is given in the table at the end.

In a considerable number of penetrating wounds the symptoms were of so slight a nature that no notes beyond the points of entry and exit were considered necessary.

Above order not reliable for statistics.

In noting the symptoms recorded by many surgeons in a large number of wounded, allowance must be made for the personal equation of the observers, and for the circumstances in which their observations were made. Some apparently attached more importance to this, and others to that, group

of symptoms. Few medical officers appear to have had or made opportunity for carrying out stethoscopic examinations, which are sufficiently difficult in tent life, with a free breeze playing on the stethoscope to discourage the attempt; and in most instances there is little doubt that they had much more pressing and useful work to do than to record niceties of physical examination. It is necessary to keep this in mind when the reader is inclined to criticise the only too obvious paucity of many of the details of the cases recorded. On this account no attempt has been made to offer any conclusions or statistical statements as to the mortality or prognosis attending particular symptoms or complications; a few observations, however, will be found attached to the table at the end.

Hæmoptysis.

Hæmoptysis immediate and scanty; not demanding treatment.

This was almost invariably early, appearing perhaps immediately after receipt of the wound; and, though it generally ceased within four days, long persistence occasionally was met with (*see* Case 7). It was seldom profuse, generally very scanty; in one case it was noted that a teaspoonful of blood was spat up at the time of the wound, but none subsequently. Hæmoptysis, therefore, seldom called for treatment. In some instances of obviously extensive tracks through the lung there was little beyond prolonged hæmoptysis to indicate the nature and extent of the injury, but an extensive lesion was by no means necessarily followed by correspondingly severe hæmoptysis.

Case of long persistent hæmoptysis.

Case 7.—Admitted 6 General Hospital 2nd March, 1900, Colour-Sergeant D., wounded 15th February, 1900, when lying prone at 400 yards; transferred to 3 General Hospital 22nd March, 1900. Entry 6¾ inches to left of mid-sternum, 4 inches below tip of acromion in line with anterior fold of axilla; healed. Exit 1 inch long, obliquely to left of spine, with lower end ⅝ inch, and upper 1¼ inches from mid-dorsum, at level of first lumbar vertebra; not yet healed. Slight hæmoptysis immediately and continued for 14 days; some ecchymosis for several days. No evidence of fracture of rib; had surgical emphysema on both sides of chest extending to genitalia. Well 22nd March, 1900; no dyspnœa.—(Civil Surgeon A. Young.)

Absence of hæmoptysis common.

On the other hand, in many instances, where it is impossible to doubt that the lung was wounded, it was expressly stated that there was not at any time hæmoptysis; thus—

Cases:—

(1)

Case 8.—Private G., wounded at Colesberg 2nd January, 1900, at 500 yards range. Entry (Mauser) near scapula, 4 inches to right of, and at level of, first dorsal vertebra; exit seventh interspace, below and to left of apex beat. No hæmoptysis; some dyspnœa, pain and fever; left on field all night intentionally; no palpitation; some tenderness over precordia, which appeared to be superficial, and connected only with exit wound. Heart sounds normal. Occasional pyrexia till 17th January, 1900, but no other symptoms. 13th February, 1900, invalided.—(Records 3 General Hospital.)

(2)

Case 9.—Private W., wounded 19th June, 1900; admitted to 20 General Hospital three days later. Had three bullet wounds as follows:—

(1) Entry 1½ inches to left of mid-line through second rib in front; exit 2 inches above inferior angle of left scapula, and 1 inch internal to its axillary border.
(2) Entry at back, 2 inches to right of mid-line, at level of tenth rib; exit 2 inches in front of angle of right scapula at same level; then through arm.
(3) Through skull. Was wounded in attack on armoured train; no hæmoptysis or other chest symptoms; discharged well 31st July, 1901; the wound of head alone gave any trouble.—(Hospital Records.)

(3)

Case 10.—Sergeant C., wounded 26th January, 1900; admitted to 2nd Cavalry Brigade Field Hospital. Entry through sternum, ½ inch internal to second right costal cartilage, and 1 inch below sterno clavicular articulation; exit through posterior fold of left axilla, at level of angle of

scapula. No hæmoptysis or cough; pain in chest only on moving; pyrexia. —(Hospital Records.)

(4) Case 11.—Private G., wounded 18th February, 1900, at Paardeberg; admitted 6 General Hospital from Modder. Entry in front of third right costo-sternal joint; exit in ninth right interspace in posterior axillary line. No hæmoptysis; quite well on 1st March, 1900, except for some pain on respiration, which persisted for some time afterwards.—(Hospital Records.)

(5) Case 12.—Captain C., admitted 7 Stationary Hospital 28th April, 1902. Entry just below junction of middle and outer thirds of clavicle; exit at inferior angle of scapula on same side. No hæmoptysis; some bronchitis; damage to brachial plexus; arm partly paralysed. Some cough and bronchitis persisted 34 days later, and after another month it is noted that there was extreme atrophy deltoid muscle.—(Hospital Records.)

(6) Case 13.—Sergeant L., wounded 16th July, 1900, at Heilbron, 50 yards range. Entry (Mauser) 2¾ inches to right of mid-sternum, ¾ inch below clavicle; exit behind 2½ inches above lower end of posterior axillary flexure—both wounds healed by first intention. At first there were symptoms of damage to right brachial plexus, but these quickly passed off. No hæmoptysis or dyspnœa. Was also wounded in right leg, which was subsequently amputated owing to sepsis.—(Records 3 General Hospital.)

(7) Case 14.—Captain M., wounded 16th May, 1902, by Mauser. Also flesh wounds left thigh and right leg, which healed aseptically. Admitted 22 General Hospital six days later. Entry at junction of second left costal cartilage with sternum, grooving each; exit at angle of left scapula, just below seventh rib; was kneeling when hit. No hæmoptysis, but bled freely from posterior wound; some dyspnœa; not treated or fed for 36 hours. No cough; temperature normal; left chest all dull except at apex; hæmothorax; physical signs cleared up slowly. Invalided 101st day.—(Hospital Records.)

(8) Case 15.—Private C., wounded 19th December, 1901; admitted to Imperial Yeomanry Field Hospital six days later. Entry close to right edge of sternum, at level of fourth rib; exit 4 inches from centre of spine, in seventh right interspace, in line with inferior angle of scapula. Dulness of right base; absence of breath sounds; apex resonant. No history of any hæmoptysis. The absence of hæmoptysis might lead to the inference that the lung was in all probability not injured.—(Hospital Records.)

(9) Case 16.—Corporal B., wounded 13th December, 1901; admitted to Imperial Yeomanry Field Hospital two days later. Entry 11th right interspace, in posterior axillary line; no exit, bullet afterwards removed from mid-dorsal line. No hæmoptysis, but lower lobe of lung dull to percussion. Some surgical emphysema over lower ribs.—(Hospital Records.)

Dyspnœa.

Dyspnœa of hæmothorax.

Dyspnœa was usually noted as being present for some 2 to 7 days after the injury, but it often persisted very much longer. Early dyspnœa was commonly associated with more or less severe pain. It is doubtful whether local pulmonary œdema was ever sufficient to cause it, the mechanical effects of fluid within the pleura being the more usual cause; but, on the other hand, it often persisted long after all signs of fluid had disappeared. Dyspnœa was common on even moderate exertion for very considerable periods, and was associated with diminished expansion of the lung, probably due to more or less extensive pleural adhesions subsequent to absorption of hæmothorax; it was constantly accompanied by long persisting pain on exertion. The dyspnœa varied greatly in severity; in some it was quite trivial, and in many most urgent cases it caused extreme distress; in not a few instances it was noted as being "extreme" many days after the wounds had healed.

Fever.

Fever a concomitant of hæmothorax.

Fever in its ratio of incidence so very closely approaches that of dulness and of hæmothorax, that the presence of the first two may be said to connote the presence of the last named. Pyrexia was generally moderate in degree, and continued rarely for more than a few days unless sepsis developed; but fever *per se* did not necessarily imply sepsis. Colonel Sylvester, in 2 General Hospital Report, says:—"The presence of blood in the pleura appears of itself to cause a certain amount of fever . . . . and in these patients a peculiar waxy pallor of the face has been noticed; the fever lasts a varying time, depending upon the amount of effused blood"; further, "It has not much effect upon the general health; the patient feels well, and has a good appetite." "Nor does pyrexia denote any change in the effusion, unless high, and accompanied by pain and other signs of serious illness"; and this is in accord with opinion expressed in many other places.

Dulness to Percussion.

Aspiration did not always reveal cause of dulness.

Dulness to percussion was very commonly noted, and where it persisted aspiration generally revealed blood effusion; but not seldom aspiration, even when repeated, failed to account for it.

Case:—(1)

Case 17.—Captain G., wounded in a blockhouse 27th December, 1901. Entry 1 inch above right sterno-clavicular joint; exit twice the size of entry wound, over spine of right scapula. Taken to hospital at once suffering extreme dyspnœa. On admission to 10 General Hospital on 13th January, 1902, both wounds already healed; some swelling and tenderness on right side of neck and upper part of right arm; veins slightly distended; heart apex in normal site; right lung dull, front and back, over lower two-thirds; faint breath sounds front of right lung, none to be heard over base behind; pain in right shoulder and liver; now no dyspnœa while at rest; 14 days later dulness still persisted; aspirated in eighth space in posterior axillary line with negative result; few days later slight pyrexia, and acute pain over liver, which gradually disappeared; dulness quite cleared up on discharge to duty six weeks later.—(Hospital Records.)

Occasionally dulness persisted, with diminished or absent breath sounds, without dyspnœa, but with persistent pain for a long period. Fever was absent in these cases, and aspiration still gave negative results, the symptoms eventually clearing up. This was evidently due to the fact that the blood had clotted.

Hæmothorax.

Hæmothorax generally accompanied by pyrexia even in sterile wounds.

A great deal of interest has been centered round this symptom, by reason, firstly, of its frequency; secondly, of its mechanical effects; and, thirdly, of the question of absorption or surgical treatment. A combination of early fever and dulness to percussion practically always indicated hæmothorax, the additional symptoms being rapid pulse and respiration, with deficient chest movement. The constancy of dulness and early pyrexia was noted by many observers, though a few cases are recorded where both these symptoms were present, but exploration afforded negative results, and the symptoms subsided without delay or incident. As seen from the tabular statement, hæmothorax was comparatively frequent, probably more so than there stated; but frequently the diagnosis was withheld until confirmed by aspiration necessitated by its mechanical effects. The onset of hæmothorax was, as a rule, gradual; rarely was it sufficient in quantity to cause restlessness, and the dulness was occasionally noted as being obscured, or variable, when pneumothorax was also present. The blood was generally definitely described as sterile, and it has been noted by very many surgeons that the presence of fever did not in any way imply sepsis. Colonel Sylvester, in the Report of 2 General Hospital, says "cases with injury to lung probably have more or less hæmothorax, but as a rule it gives no trouble." He refers, however, to a case of shrapnel wound where the bullet traversed the chest wall, and caused

hæmothorax, without touching the lung, due, it may be suggested, to the large aperture permitting some collapse. When hæmothorax was removed by aspiration the temperature generally fell at once to normal (provided the case continued aseptic); but if the hæmothorax recurred, then the temperature rose again, to fall in turn when a further aspiration was performed. This point is well illustrated in the following case :—

Hæmothorax; temperature fell after each aspiration.

CASE 18.—Captain B., wounded 27th February, 1901, at 40 yards from behind; lay four hours on the veldt, then rode three miles, when he fell from his horse. Admitted to 11 General Hospital six hours after being wounded. On admission, pale; breathless; much external hæmorrhage; respiration, 60; temperature, normal; pulse, 100. Entry 2 inches to right of sixth dorsal spine at level of angle of scapula size of threepenny piece; surgical emphysema. Exit 3 inches below right clavicle size of sixpenny piece; edge clean. Free hæmorrhage; air rushing in and out with each respiration; no emphysema at exit wound. Next day restless; cyanotic; breathless; tympanitic note all over right side anteriorly (pneumothorax); respiration, 60; pulse, 112. On sixth day chest movement deficient; breath sounds entirely absent; duli to percussion behind, especially up to spine of right scapula, probably due to hæmothorax; temperature, 101·2 to 100° F. 21st March, 1901, temperature regular for last five days; aspirated; 40 ozs. blood removed. 31st March, 1901, breath sounds improved all over; heard behind now. There is considerable falling in of right chest. 4th April, 1901, aspirated; 30 ozs. blood-stained fluid removed, which coagulated after removal. 29th April, 1901, discharged, with still slight dulness on percussion posteriorly. The temperature began to rise before first aspiration, but was generally falling, with stili an evening rise before the second aspiration, after which it remained normal. Pulse remained over 80 till after second aspiration.—(Civil Surgeon HUNTER.)

The following is a typical instance of the course of hæmothorax before and after aspiration :—

Hæmothorax; aspiration.

CASE 19.—W., wounded 15th March, 1901; admitted 7 General Hospital 13 days later. Entry, back, 1½ inches to left of fourth dorsal spine; exit in front in third left space 2 inches internal to anterior axillary fold; both wounds now clean and dry; collodion and gauze dressing; increasing intrathoracic pressure. Symptoms:—Temperature, 101° F.; dyspnœa; pain; pulse very weak; dulness up to fifth rib in axillary line; aspirated; 75 ozs. dark fluid blood removed, which coagulated within few moments; as he became considerably distressed, given 12 m. hypod. inj. liq. strych. 15th April, 1901, up all day; quite strong; no trouble since aspiration 28th April, 1901. Sent on sick leave; well.—(Major HOLT, R.A.M.C.)

And *see* Case 83 after thoracotomy.

Hæmothorax; aspiration—Recovered.

CASE 20.—Private H., wounded 8th March, 1900, through upper part of right chest, from front to back; both wounds typical and closed on arrival at 2 General Hospital, Wynberg; dulness right side, up to third rib in front; some dyspnœa; no rise of temperature. 26th March, 1900, aspirated; 36 ozs. blood-stained serum removed through seventh space, in posterior line; did not refill; lung expanded well. Invalided 17th May, 1900. —(From Hospital Records).

Late hæmothorax.

As a rule, hæmothorax developed and could be recognised within a few days, or even hours, of the receipt of the wound. On the other hand, several cases were recorded where no symptom or suggestion of hæmothorax arose until many days, or even one month, after the injury, when it had been thought that convalescence had long been well established, a rise of temperature being generally the first indication of anything to the contrary; and then percussion rendered diagnosis easy.

Relative frequency of hæmothorax.

As to the frequency, as already said, allowance must be made for the differing opportunities and personal equation of surgeons when drawing conclusions from a large number of observations. In one series of cases hæmothorax was recorded as being present in 15 in a total of 20 examined (75 per cent.).

Effect of transport on occurrence and amount of hæmothorax.

It was generally suggested that hæmothorax more often followed early transport from the field, or early exertion, but not a few instances to the contrary occurred (*see* Case 28, quoted under "Shock"). Mr. Makins gives an important opinion on this point, viz., that 30 per cent. of those moved by train probably suffered from hæmothorax, whereas he conjectured that it occurred in as many as 90 per cent. of those moved by wagon. Very considerable hæmothorax was found in several of those cases where the men rode or walked long distances, or continued firing after being hit, as in those cases quoted showing absence of shock; but many could be given showing that this was not a necessary sequence of events. Thus Captain E. rode no less than eight miles after being wounded from the fourth left costal cartilage to a point through the centre of the scapula on the same side, without any symptoms supervening beyond slight dulness at the base.—(Records 2 General Hospital).

Origin of the hæmorrhage.

As to the origin of the effused blood, it was generally assumed that this was due to wounded parietal vessels, and not from the lung. This cannot be accepted without some reserve, and at least one observer has stated that in his opinion parietal hæmorrhage did not account for more than a small minority of the cases of hæmorthorax.—(Mr. Bowlby, in Portland Civilian War Hospital).

The blood sometimes clotted very late.

In the subsequent history of the blood effusion, it was sometimes found to be still fluid as long as six weeks after injury; in others, early clotting was proved to have taken place. A reference to Case 41 is interesting on the former point.

Occasionally it was found that hæmothorax was sufficient in quantity to cause displacement of the heart apex.

Hæmothorax causing displacement of heart.

Case 21.—Private M., wounded at Driefontein; admitted to 6 General Hospital 3rd April, 1900. Entry above apex of right axilla, healed; exit below tenth right rib behind. No hæmoptysis at any time; dyspnœa at time of wound; ulnar paralysis; apex beat, fluttering, 2 inches outside left nipple-line; no pneumothorax; dulness over lower part of right lung, œgophany above; fever (103° F.). Aspirated eight days later; 12 ozs. pure defibrinated blood removed; 25th April, 1900, still fever; aspirated; 7 ozs. defibrinated blood removed; 3rd May, 1900, apex beat in nipple-line. Heart sounds normal and regular; right lung expanded.—(Hospital Records).

Ditto.

In a case (Captain T.) reported in 10 Stationary Hospital, the apex beat was displaced to a point 1 inch to right of sternum, in third space, and returned to its normal site after aspiration; and in the case of a Boer reported in the Cape Field Hospital, the apex beat was displaced to the fourth right space, near the edge of the sternum; a large hæmothorax was evacuated, and within 14 days he was quite well.

Ditto.

The following is a case of double hæmothorax:—

Double hæmothorax—No operation—Recovered.

Case 22.—Corporal N. admitted to 2 General Hospital 24 hours after being wounded. Entry just above left scapula; exit in right loin just below 12th rib. Some fragments of bullet casing removed at exit wound from under the skin; small left hæmothorax; large right hæmothorax, reaching up to spine of scapula; hyperpyrexia for 14 days; general health good; healed without suppuration; returned to duty three months later, in perfect health.—(Lieut.-Colonel Sylvester, R.A.M.C.).

Very rarely was uncomplicated hæmothorax recorded as the cause of death. The following is therefore interesting:—

Hæmothorax; aspiration—Relapse—Died.

Case 23.—Private McL. admitted to 4 General Hospital. Entry in sixth left space, ¼ inch internal to nipple; exit in ninth space, behind posterior axillary-line; pain in chest; whole left chest dull; deficient chest movement, and breath sounds; fracture ninth rib. Explored with negative result; temperature 101° F.; 20th March, 1900, again explored below angle of scapula, with negative result; 22nd March, 1900, aspirated higher up; 40 ozs. of fluid blood removed, but lung did not expand; 27th March, 1900, died; had all along temperature 101°–103° F.

Post mortem.—Left chest still full of blood; lung collapsed; lymph on visceral and parietal pleura, but no pus; fracture eighth and ninth ribs; both wounds healed; right lung congested.—(Records 4 General Hospital.)

Pain.

Pain absent, or slight and transient.

Direct pain, as the immediate result of the wound, was sometimes noted as having been entirely absent, and many observers have given a number of instances where only some accidental circumstance made the patient aware that he had been wounded, generally by seeing blood on his hand or clothes, or feeling wet. In one case, when the man's clothes were taken off for the examination of a fractured humerus, a complete perforating Mauser wound of the right chest, of which the patient knew nothing, was found. Mr. Makins gives a case where the patient heard a pipe break in his pocket, which was the only circumstance that led to the discovery of a wound. Again, the pain was felt sometimes only at a considerable distance—as at the ends of the fingers, in case of wound at the root of the neck. Many such cases could be quoted. Seldom was the local pain at all severe, and it rarely persisted beyond a very short period. However, it is impossible to lose sight of the mental factor in considering the question of direct pain. Referred pain was sufficiently common, and was generally described as "stabbing"; but this, too, was often entirely absent, though it was otherwise when extra or intra-thoracic complications followed. The pain attending damage to the pleura was occasionally noted as severe, like that experienced in painful attacks of pleurisy due to other causes commonly met with. In one case only was diaphragmatic pain recorded (Private J., 7 General Hospital), and it was not severe; the entry and exit wounds were in fourth right space, in front, and ½ inch higher in horizontal line, at back, on same side, respectively; there were no symptoms beyond hæmoptysis, cough, and "slight diaphragmatic pain."

Pyothorax.

Primary pyothorax rare in Mauser wounds.

As a primary sequela, this appears to have been extremely rare with uncomplicated small-bore bullet wounds. Three cases of this rare condition are quoted below; but with larger bullets, ricochets, fragments of shell, or low-velocity pistol wounds, primary empyema was often met with, and also when the abdominal viscera were traversed by the same bullet. The indications of pus were much as are seen in cases due to other causes. More marked pyrexia, with large remissions, rapid wasting, loss of appetite, sweating, &c., were noticed in cases due to gunshot.

Cases:—

(1) Case 24.—Private C., wounded 23rd July, 1900 (800 yards); admitted to 7 General Hospital 17th September, 1900. Entry and exit at outer edge of left erector spinæ, in 11th space; two scars, one small and circular, the other ½ inch square, irregular in shape, the two being separated by a bridge of healthy skin ½ inch wide. Slight cough; pyrexia (100–103·6° F.); no dulness; hæmaturia for three days, which he said was profuse at first. A few days later dulness over left base, up to angle of scapula; loss of vocal fremitus; feeble voice and breath sounds; deficient movement of chest wall; compensating hyper-expansion on right side; heart apex displaced to right; 22nd September, 1900, thoracotomy; drainage; 7 ounces pus evacuated, and a wad of leather the size of a Mauser bullet removed. Eventually invalided.—(Hospital Records.)

Compare with Case 86 of revolver bullet wound, and with the following case also:—

(2) Case 25.—Private S., admitted 17 General Hospital 27th December, 1900, with temperature varying from 103–104° F. Entry ½ inch outside left nipple; exit 1 inch below inferior angle left scapula. Thoracotomy at once; "pus gushed out"; drainage. Next day temperature 99° F.; but on 6th January, 1901, dyspnœa; 8th January, 1901, signs of pneumonia present; 10th January, 1901, died.—(Hospital Records.)

CASE 26.—Sergeant E., wounded 24th April, 1901; admitted to 2 General Hospital 16 days later. Entry, seventh left space, in mid-axillary line; exit, centre of right axilla. Wounds already healed; pyothorax on right side, up to middle of scapula; pyrexia continued till 6th June, 1901. No pain; then temperature rose higher, with severe pain in right chest and with rigors. On 10th August, 1901, aspirated; some offensive serum withdrawn; thoracotomy performed, 1 inch of seventh rib in axillary line resected; large quantity of blood clot and sero-pus removed; large drainage tube inserted. Was very ill for a long time; gradual improvement; lung expanded, but sinus persisted till shortly before he was invalided on 10th October, 1901. Ordinary aqua menth. pip. with hot water was used in this as in all other cases of empyema requiring irrigation, with good results.—(Records 2 General Hospital.) (3)

Very severe cases of pyothorax seldom recovered, and very rarely was the heart displaced by the purulent collection to such an extent as in the following, where drainage was instituted three times:— Severe pyothorax very fatal.

CASE 27.—Boer Du T., wounded at Graspan 25th November, 1899, whilst running in a stooping position. Entry between 10th and 11th ribs, behind, on left side; exit through seventh left rib in post. axillary line. Fell and remained on the ground for three hours; had hæmoptysis for eight days; taken to field hospital, and then to Orange River on 27th November, 1899, where he remained till 18th January, 1900; whilst there a rib was resected, and a hæmothorax drained. On admission to 1 General Hospital on 20th January, 1900, was very ill and wasted; pyrexia; two healed wounds in chest; fluctuation under scar; respiration rapid; face dusky; heart apex 1½ inches to right of right nipple line; dulness left base; absence of breath sounds and vocal fremitus; pneumothorax of upper part of left chest. The abscess under scar was opened; 1 oz. pus let out, but no communication with pleural cavity. 22nd January, 1900, pyrexia; dusky colour; heart apex still to right of right nipple; explored; found pus in sixth space; resected ¾ inch of seventh rib; let out two pints of pus; drained. In two days temperature normal, and in four days heart apex barely 1 inch to right of sternum. On 30th January, 1900, heart apex behind sternum; daily irrigation with iodine solution. 8th February, 1900, heart apex 1 inch to left of sternum; air entering upper part of left lung. 5th March, 1900, no pyrexia; irrigation discontinued. 2nd April, 1900, some re-accumulation; under chloroform, drainage re-established by resecting further portion of rib, which was sinking in and shutting the sinus. After this progress was uninterrupted.—(Hospital Records.)

Shock and Collapse.

The amount of shock was most variable, both in degree and duration, sometimes there being no trace of it; at others it was extreme, amounting to complete collapse, with intense pallor, rapid pulse, &c. This was but seldom, if ever, due to hæmorrhage, hæmoptysis, or external bleeding from the wound; more often it was associated with extensive injury of the chest wall, and the most intense degree of shock often disappeared in a remarkably short time. The complete absence of shock in some cases, however, of even severe injury, was very noticeable. Some men, after being hit, walked or rode long distances, sometimes many miles: thus one man walked four miles unaided after being hit; another went on firing for an hour after being hit (*see* Case 29); another walked three miles unaided after receiving an undoubted penetrating wound involving the lung, without subsequent ill results. One other case was shot through the left lung by a bullet which was afterwards extracted from the back; he went on advancing under fire until he was hit a second time by a bullet which wounded his left elbow. Shock variable, and not depending on loss of blood. Entire absence of shock common. Cases:—

CASE 28.—Private C., wounded 18th July, 1901 (Mauser, 200 yards); fell off horse; lay on ground for one hour, then walked three miles; admitted to 12 General Hospital three days later. Entry, ½ inch to right of fifth dorsal spine; exit in fourth right interspace, mid-axillary line; bullet then entered right arm on inner side, fracturing humerus; made exit finally on outer side, by an oval, ragged wound 1¼ inches long. Had hæmoptysis; no evidence of (1)

hæmothorax ; rapid recovery. All the wounds, except the final exit, were clean type wounds. This is only one instance of very many where the bullet appeared to have produced the so-called "explosive" effects, by the agency of small fragments of bone driven onwards in the track of the bullet.—(Hospital Records.)

(2) Case 29.—Sergeant F., wounded at 300 yards range on 28th June, 1901. When dismounting felt nothing, and did not know there was anything the matter with him until he saw blood on his clothes ; went on firing for one hour ; remained on duty with column three days, during which time there was much hæmoptysis—as he said, "by mouthfuls." Admitted 12 General Hospital 7th July, 1901. Entry (Mauser) just below and external to inferior angle of right scapula ; exit ½ inch above right nipple. Dulness on right side, at back ; (?) rhonchi ; hæmothorax ; cough ; rusty sputum for 20 days after admission ; returned to duty 27th July, 1901.—(Hospital Records.)

In other words, the small-bore bullet frequently showed a marked absence of stopping power, as evidenced in wounds of the chest.

The following is quite as remarkable, showing absence of pain and shock :—

(3) Case 30.—Corporal S., wounded 21st August, 1901, at 30 yards. He "felt a peculiar feeling in his chest, and found his mouth full of blood unexpectedly, after which he coughed up blood for five days." Was carried in wagon three days. Admitted 28th August, 1901, to 12 General Hospital. In front wall of chest four small circular wounds size of threepenny piece. First entry is in third intercostal space, 1½ inches above and internal to right nipple ; the bullet (Lee-Enfield) emerged on same side of chest, and re-entered immediately, emerging finally 1 inch lower down. These three wounds are all in a vertical line, 1 inch external to right nipple line, the lowest just below costal margin opposite eighth space ; the bullet was found in the right sleeve. Pain on breathing, front and back ; now no hæmoptysis ; cough present ; temperature, 102° F., for first two days, now normal. 22nd September, 1901, still some pain in chest, and some cough, with shortness of breath. 10th October, 1901, sent to Base.—(Hospital Records.)

Surgical Emphysema.

Not necessarily dependent on wound of lung.

On this point the evidence of the records of the hospitals is somewhat at variance with the experience already published. In all the nine cases referred to in the tabular statement at the end, the emphysema was extensive ; in one case it was noted as being present on both sides of the chest, extending down to the groin and genitals ; in others it extended over the whole of one or other side of the trunk, pelvis, and neck ; in a number of cases it was noted as being limited to the immediate vicinity of the wound. Mere penetration of the chest, without evident injury to the lung itself, does not appear to have influenced its incidence, since it was seen in cases of wound of the neck not involving the trachea or any part of the thorax, so that it cannot be used as evidence of wound of the lung. It appeared not unlikely that low velocity of the bullet (if small bore) contributed to its appearance, by lessening the probability of immediate closure of the wound, as compared with wounds inflicted by bullets passing at higher velocities. It would seem to have more frequently, but not invariably, followed wounds caused by shell fragments, ricochet bullets, soft-nosed missiles, and large-bore bullets, and also to have occurred with extensive lesions of the chest wall. (*See* a case quoted under pneumothorax, and Case 58). When present it was not, *per se*, of importance, even though very extensive, and usually cleared up very rapidly without complication.

Case of emphysema.

Case 31.—Private L., wounded 11th June, 1900 ; admitted 7 General Hospital, eight days later. Entry 1 inch below, and ½ inch to inner side of right sterno-clavicular articulation ; exit in right posterior axillary fold, 1½ inches above level of angle of scapula ; already healed ; had hæmoptysis at first, now ceased, has still some cough ; surgical emphysema over whole of

right side of chest; soon disappeared; breath sounds weak, and loss of resonance at right base. Invalided practically well.—(Hospital Records.)

Cough.

Cough was but seldom noted, and then only when severe. It persisted sometimes for several weeks, and was noted as being of a dry, irritable, hacking nature; no suggestions as to its cause were made, whether of phrenic or other nervous origin, when the lung symptoms were practically nil. Cough irritable and dry.

Pleurisy.

Pleurisy with friction rubs, with or without effusion (as apart from the serous residuum of hæmothorax) was seldom observed; it was only occasionally recorded as a late complication, a period of pyrexia marking the onset of the pleurisy, after a period of some weeks' apparent normal health. In oblique wounds, with extensive or tangential lesion of the pleura or fracture of ribs, friction sounds were not only prominent, but persisted for very considerable periods, amounting to months, without any dulness to percussion. Pleurisy.

Case 32.—Trooper M., wounded 25th February, 1902; transferred to 18 Stationary Hospital seven days later. Entry $\frac{3}{4}$ inch to left of spine of third dorsal vertebra; exit 1 inch inside inner end of left clavicle, and $\frac{1}{2}$ inch below it. Both wounds small; soon healed; no pyrexia until 17th March, 1902 (20th day), when left pleurisy set in, with "friction sounds between cardiac apex and fifth left rib, in mid-axillary line" (?); localised effusion followed; aspirated with negative result; gradually cleared up.—(Hospital Records.) Late pleurisy cases:— (1)

Case 33.—Trooper S., wounded 31st March, 1902. Entry 2 inches below lower angle of left scapula; exit 2 inches above, and in line with posterior axillary fold. Admitted to hospital seven days later; hæmoptysis during first three days; dyspnœa; wounds already healed; there was dulness which cleared up in three days, and he had apparently made a complete recovery. But on 22nd April, 1902, there appeared pleurisy with effusion; dulness up to spine of scapula, at back; none in front; heart not displaced; absence of breath sounds over dull area; temperature, 99° to 102° F. for nine days; all cleared up by 7th May, 1902. On 46th day loud friction rub felt and heard, at right base, but cleared up in a few days. This was probably due to adhesions formed by a very small blood clot (basal hæmothorax) in process of absorption.—(Hospital Records.) (2)

Pleuritic rubs were occasionally long persistent, as in the next case:—

Case 36.—Sergeant D., wounded 28th April, 1901 (Mauser) at 200 yards range. Entry on axillary side of angle of right scapula, over sixth rib; exit $1\frac{1}{2}$ inches above, and $\frac{1}{2}$ inch to inner side of right nipple. Was in hospital till 1st October, 1901; had hæmoptysis three days; hyperæsthesia, lower part of right axilla; was then sent to light duty; was again admitted to hospital (22 General Hospital) on 10th May, 1902, with a pleuritic rub over area size of five shilling piece, below, and to axillary side of nipple, 4 inches from scar of exit; 29th May, 1902, still friction rub with some pain; invalided 14 months after receipt of wound.—(Hospital Records.) Long persistent pleurisy.

Refer also to Case 44.

Deficient Chest Movement.

Deficient chest movement was not commonly recorded; it was found to occur early or late. When early it was commonly associated with shock or immediate pain; later the cause was almost invariably mechanical, due to fluid within the pleura, or dependent on referred pain. Limited chest movement due to pain or fluid collected.

Cyanosis.

Beyond the occasional mention of the presence of this symptom, no remarks were recorded as to its duration; it was apparently seldom severe. (*See* Cases 44 and 18.)

Pneumothorax.

Pneumothorax rare in Mauser wounds.

Pneumothorax was only definitely recorded in 11 of the 214 cases of penetrating chest wounds examined. It appears to have chiefly followed wounds caused by the larger missiles, or small-bore wounds involving the larger bronchi or trachea. A note was made of pneumothorax occurring in 3 out of a total of 20 cases, in one series.

There does not appear to have been a high mortality in wounds followed by this condition. Often it was noted as co-existing with pyothorax. Only in 3 cases of wounds by small-bore bullets was the issue of air and frothy blood from the wounds noted, while in former wars this was not an uncommon occurrence. Two cases only are noted here :—

Cases :—

(1) Case 37.—Private F., wounded 1st April, 1901; admitted 3 General Hospital next day. On admission drowsy; flushed; perspiring freely; pulse rapid; respiration shallow and hurried; tongue furred; breath offensive. Exit 2½ inches by 1½ inches along line of eighth rib in posterior left axillary line, lacerated and irregular, exhibiting lung and pleural cavity, also sharp ends of rib, with a gap of 1 inch between them. Air rushing in and out; fluid in pleural cavity. Entry, small and circular, towards mid-line at back.—(Hospital Records.)

(2) Pneumothorax, cyanosis, and aphonia.

Case 38.—Sergeant E., admitted to 20 General Hospital 4th April, 1902, with large circular ragged wound in back, 3 inches from mid-line, at level of root of right lung; wound foul, but draining well; no exit wound. On admission collapsed; respiration rapid and embarrassed; pulse, 140; cyanosed. On percussion tympanitic note in upper half of right thorax; remainder dull; diminished respiratory murmur over whole side; cardiac dulness, and impulse displaced 2½ inches to left of nipple line. Next day extreme cyanosis; pulse, rapid and compressible; aphonia. 9th April, 1902—less cyanosis; pneumothorax improved; heart within 1 inch of normal site; temperature, 101° F. 18th April, 1902—improving; voice stronger; X-rays show many small bits of bullet and mantle in right lung. 3rd May, 1902—temperature, normal; much improved; pneumothorax and fluid clearing up; some aphonia persists. 7th May, 1902—wound closed. 17th May, 1902—aspirated; only pure blood, no pus found; has had irregular temperature all along.—(Hospital Records.)

Further cases of pneumothorax :—

Two similar cases were recorded in the Imperial Yeomanry Field Hospital Report :—Private R., 7th June, 1901, where, after extensive injury to the seventh and eighth ribs, surgical emphysema, and pneumothorax were present, air being blown in and out of the chest with every respiration. Lieutenant B., 7th June, 1901, shell wound just below clavicle; "air bubbling in and out of wound." Both these cases died.

(1)

(2)

Late pneumothorax.

There were a few instances of late appearance of pneumothorax. These are difficult to explain, and no suggestion was made by those reporting them :—

Cases :—

(1) Case 39.—Boer, G., wounded 10th April, 1900; admitted to 20 General Hospital 10 days later. On admission no marked symptoms; had hæmoptysis; right chest not expanding as well as left; no signs of fluid in pleura; both wounds healed.' Entry fourth right rib in post. axillary line; exit higher and 1½ inches to left of spine. On 23rd April, 1900, there was noted a marked change for worse; extreme right pneumothorax; absolute loss of respiratory murmur; heart displaced fully 2 inches to left; liver displaced downwards; increased circumference of right chest with fixity in position of full inspiration; great pain in hepatic region, limiting respiratory movements (*sic*); abdominal muscles rigid; no peritonitis; temperature, 101° F.; pulse, 120. Next day pneumothorax improved; signs of hæmothorax; pulse, 130; no cyanosis;

heart nearly in normal position. 30th April, 1900—pneumothorax again increased; precordial friction rub; pulse imperceptible. 8th May, 1900—died.

Post mortem.—Air in right pleura, with large amount of pus and serum (9 pints), right lung collapsed, airless; wound through middle upper lobe; not healed, containing recent blood; right lung weighed 15 ozs.; left, 28 ozs. Pericardium contained 5 ozs. fluid, and was adherent to heart, which was covered with flaky lymph; liver depressed.—(Hospital Records.)

See also Case 18, and the following case :— (2)

Case 40.—Trooper W., wounded 26th October, 1901, at 150 yards by Lee-Metford. Entry 1 inch below left coracoid process; exit between seventh and eighth ribs, 1½ inches to right of vertebral column. Admitted to 26 Stationary Hospital 14 hours after with great dyspnœa, paralysis of left arm, severe pain all down back, from left shoulder to sacrum; hæmoptysis which lasted five days; breath sounds over both bases good. Convalesced uninterruptedly till 13th November, 1901; sudden pain on left side, arm, and shoulder; increased and spread to cardiac area; orthopnœa; rapid pulse. 16th November, 1901, aspirated; small amount of blood-stained serum and air. Again convalesced 30th January, 1902; discharged. A year later the arm was still somewhat weak; otherwise the picture of health.—(Hospital Records.) (3)

Case 41.—Private P., wounded at Paardeburg 18th February, 1900. Admitted to 6 General Hospital 12 days later. On admission, much exhausted and collapsed; breathing much embarrassed. Entry (Mauser) immediately beneath left clavicle, at junction of middle and outer thirds; exit between ninth and tenth ribs, posteriorly, on left side, a little external to erector spinæ. Left chest wall moved well on respiration; tympanitic, except obscure dulness behind; too exhausted to move; absence of breath sounds over whole left chest, except near sternum; on right side breathing harsh; clanging sound or coin percussion (hacks klang) was marked, and distinctly audible without stethoscope. Heart pushed over to right till apex beat 1½ inches to right of border of sternum; great loss of power and aching pain in left arm and hand; no loss of sensation; no swelling; radial, ulnar, brachial, and axillary pulses on left side imperceptible; limb, though warm, colder than right. Apparently there was some occlusion of third part of subclavian, fair collateral circulation being established. Case of severe pneumothorax.

4th March, 1900, left chest aspirated; 2½ pints dark fluid blood and some air removed; pus was anticipated, temperature having varied from 100–102° F.; great relief to breathing and circulation. 5th March, 1900, cardiac impulse just at right edge of sternum; faint breath sounds audible over left chest, back and front, except below ninth rib. 6th March, 1900, apex beat still to right of sternum; physical signs as before; considerable pain and dyspnœa; aspirated; 8 ounces fluid blood and a considerable quantity of air removed; much relieved, still some pyrexia; "probably a valvular opening in lung." 21st March, 1900, still more marked dyspnœa, sometimes very severe; heart still displaced; about 1½ inches of 7th rib resected; pleural cavity full of fibrinous bits of clot and blood-stained serum; about 8 ounces removed, and tube inserted, with much relief. 26th April, 1900, much improved; temperature normal, heart's apex in normal site. 2nd May, 1900, invalided to Base.—(Hospital Records).

Fracture of Bony Walls of Chest.

When one, or even two, ribs were fractured by a small-bore bullet, the almost invariable experience was that few or none of the usual characteristic symptoms, as met with in fracture caused by other forms of violence, were present. This being so, it is not surprising that so often no mention of this complication was recorded, there being no symptoms calling attention to the condition; or, if present, they were of very secondary importance. Though often enough the point of entry or exit was given as being directly over or through a rib, occasionally the fracture was first made obvious by a skiagram, Ribs. Symptoms of fracture usually absent.

and sometimes it was obvious only on very careful examination. Experience varied widely as to the presence and extent of comminution, and the facts were in accordance; for, on the one hand, there was sometimes merely a simple perforation, and at other times very extensive comminution of one or more ribs. Much depended upon the direction of impact, whether perpendicular or tangential, and also upon the part of the rib hit. Comminution was not uncommon at the angle, or about the head and neck of a rib; perforation or simple linear fracture being more common in front; tangential impact invariably caused comminution. When several adjacent ribs were broken by a wound, the track of which was in or near the long axis of the body, through a considerable extent of the chest wall, the symptoms of fracture were obvious enough (*vide* Fig. 13, at end of Spine section); but there was seldom any of the displacement so common in such injuries when met with in civil practice.

When considerable areas of bone were denuded of periosteum, as by glancing wounds, or where sepsis occurred, necrosis and abscess were not uncommon, the symptoms of abscess sometimes first appearing some time after the wounds had healed; and in several a succession of small abscesses proved to be due to small spicules of bone. The symptoms were more severe on those few occasions where fragments of rib were driven into the lung tissue, and sepsis was not unusual.

Fragments of rib driven into lung.

Case 42.—Private J., wounded at Spion Kop 24th January, 1901; admitted to 4 General Hospital 11th February, 1900, with pyothorax; 1 inch of rib had been excised and pleura drained at the front. Two days later, as he was becoming exhausted from the discharge, and the lung was collapsed, an Estlander's operation was performed; the greater part of four ribs, including that previously resected, was removed, the pleura irrigated, and drainage established; also a large suppurating wound of right shoulder, burrowing under clavicle (the inner third of which was pulverised) was cleared out, and pieces of necrosed bone removed; died 17th February, 1900. At *post mortem* Mauser cicatrix found high up in left chest; fracture of third rib, near sternum; track led through anterior mediastinum, into which several fragments of rib had been carried. The wound on right side was then seen to be the exit of bullet, which had crossed ant. mediastinum without opening any large vessels.—(Major S. F. Freyer, R.A.M.C.)

A somewhat similar case (Lieutenant V.) was reported in Maritzburg General Hospital, where a spicule of rib lacerated the lung, followed by empyema, pyæmia, pericarditis, and death.

It is not easy to understand how in some instances the ribs escaped fracture, unless a very low velocity of the bullet in certain of them allowed a deviation of the track from a straight line, or a simple perforation (drilling) without solution of continuity occurred—the latter more probably in one or two cases of very short-range injury recorded; but a further explanation has been offered in the elasticity and resiliency of the bone, though this can scarcely be considered satisfactory. Mr. Makins drew attention to some interesting instances of fracture of ribs from within, especially in longitudinal wounds.

Clavicle.

In a large number of cases fracture of the clavicle was recorded; all degrees were met with, from simple transverse fracture or splitting to extensive pulverising of a considerable length of the bone, as occurred in Case 42.

Scapula.

Wounds of the scapula when such occurred as mere perforations, more or less clean, in the compact plate of the body of the bone, caused little or no trouble or symptom; there were no signs of this fracture. But when the spine of the scapula, the coracoid, acromion, or glenoid process was fractured, the severity of the injury was well marked, and only in these cases were the movements of the shoulder-girdle impaired.

Sternum.

But few instances of wounds of this bone were recorded, doubtless for one of two reasons: first, that wound of this bone was so frequently associated with injury to the larger vessels or heart incompatible with life; or, second, that in oblique wounds of the bone the actual injury to the sternum, which was simply drilled, was really of secondary or no importance. The bare

record of entry or exit through the sternum was not infrequently met with, and that without any further reference to the bone injury. Case 77, where a piece of the sternum was driven into the lung, is recorded under the remarks on "short range" wounds.

Caries of the sternum after gunshot injury was recorded in one instance as follows :—

Caries of sternum.

CASE 43.—Private L., admitted to 2 General Hospital 1st June, 1901. Entry (Mauser) at centre of manubrium sterni ; exit below left scapula. Caries of the bone present around entry hole ; a small abscess inside ; otherwise no symptoms of any sort ; abscess scraped, and some fragments removed on two occasions ; invalided 12th October, 1901 ; still with a small sinus open.—(Lieut.-Colonel SYLVESTER, R.A.M.C.)

Pericarditis.

Pericarditis usually due to direct wound of sac.

Pericarditis was, with very few exceptions, due to direct wounds of the sac ; in other cases it was of pyæmic origin, when it was found *post mortem*, and the track of the bullet lay at a considerable distance from the pericardium. A very considerable number of cases were recorded where death followed empyema, with pyæmic pericarditis.

However, in the following case there was neither pyæmia, empyema, or wound of the sac :—

Obscure case of pericarditis.

CASE 44.—Private R., "sniped" whilst cooking, in column near Harrismith, on 5th June, 1901. Entry, outer border of left scapula ; no exit ; bullet was removed from a point just internal to left shoulder-joint, in front ; no hæmoptysis. Admitted Harrismith General Hospital four days later ; distressing dyspnœa ; loud pericardial rub, which soon became so loud that it could be heard by placing the ear near the chest ; left pleurisy soon developed ; became deeply cyanosed, and the difficulty of breathing became alarming ; temperature 100°–102° F. till 10th day, when all symptoms improved ; was discharged convalescent on 1st July, 1901.—(Hospital Records.)

Pneumonia.

Pneumonia when present of patchy variety usually.

Pneumonia as a primary symptom was quite exceptional ; as one surgeon reports, "it was conspicuously absent," but when present he described it as being "in the form of patches of pulmonary catarrh." When present over any considerable area it was usually a fatal complication. In one case reported by the Imperial Yeomanry Field Hospital there was an unclosed wound in the pleura.

An interesting point appears in the following case :—

CASE 45.—Private A., wounded 23rd February, 1900 ; admitted to 3 General Hospital seven days later. Said he had expectorated pus and blood for a few days. There was a patch of pneumonia the size of the palm in mid-axillary line low down. Entry over left scapula ; no exit. X-ray examination showed a bullet lying in the site of the pneumonic patch. 15th March, 1900, sent to England.—(Hospital Records.)

"General pneumonia" due to exposure.

When pneumonia was more general it appeared to have been due to exposure ; for instance, a case fatal on the 12th day was recorded in the Imperial Yeomanry Hospital Reports ; the man was lying in the open for no less than four days, after being wounded, before he was found.

Case :—

CASE 46.—Private B., wounded 13th December, 1901 ; admitted to Imperial Yeomanry Field Hospital five days later. Wounds—(1) one inch above right costal margin at mid-axillary line ; (2) circular, size of a shilling, in 11th space, splitting 11th rib ; lying in the bottom of this latter wound was the mantle of a Mauser bullet, wounding the pleura, which was opened ; (3) entered chest at vertebral border of right scapula, opposite fourth dorsal spine ; (4) 2 inches below centre of right clavicle. Pneumonia followed, and death on 25th December, 1901.—(Hospital Records.)

The following is quoted as an instance of localised pneumonia, where apparently penetration of the chest wall had not occurred.

Pneumonia without penetration of chest cavity.

Case 47.—Private McL., wounded 13th December, 1901; admitted Imperial Yeomanry Field Hospital five days later. Entry mid-axillary line, level of fifth space; exit 1 inch below level of 12th rib slightly external to mid-spine; ribs apparently undamaged, track being superficial to them. On 30th December, 1901, wound laid open, on account of continued fever at night; found that the 12th rib was broken near its tip; an abscess cavity extended up between spleen and lower ribs to diaphragm, containing coagulated lymph; freely opened and drained; had in first instance left basic pneumonia. Improved sufficiently to be sent on sick convoy.—(Hospital Records.)

Pneumonia and pericarditis.

Case 48.—Captain B., wounded 30th December, 1901, at 40 yards range. Entry (Mauser) immediately behind tip of left acromion process; exit just to left of mid-line between 11th and 12th dorsal spines. Hæmoptysis; no hæmorrhage from wounds; was unconscious for about 1½ hours. Admitted to 22 General Hospital 21 days later; arrived somewhat collapsed; temperature, 102° F.; pulse, 100; respiration, 26; pain in left side; wounds healed; slight cough, no expectoration; base dull; fine crepitation; tubular breathing; first stage of pneumonia; five days later aspirated; drew off some recent blood and old clots; on 29th day pericarditis; night sweats; hectic temperature. 12th April, 1902, dulness still up to angle of scapula behind, and to fourth and fifth ribs in front. 4th May, 1902, well, except occasional pain in chest; still unable to rest on left side. 6th May, 1902, invalided to Base.—(Hospital Records.)

Non-Penetrating Wounds of Chest.

Non-penetrating wounds often septic.

The records of a large number of non-penetrating wounds were examined. The cases varied in extent from short, simple gutter wounds of the superficial tissues on the one hand, to severe injury to the shoulder girdle on the other. In some cases there were long subcutaneous tracks, covered in by unbroken skin, which sometimes showed a reddened or bluish wale between the entry and exit wounds, the intensity of the surface discoloration varying inversely with the depth below the surface; they were confined to the chest wall, or passed to or from the abdominal wall. In a few cases only was there any notable hæmorrhage; cases complicated with fracture of the ribs, sternum or shoulder girdle, with more or less extensive communition, were noted. The after course of uncomplicated cases was uneventful, but where extensive subcutaneous laceration and comminuted fracture (generally with sepsis from non-closure due to obliquity of entry or exit wounds) occurred the recovery was very tedious, and contrasted sharply with most of the penetrating wounds with injury to chest contents in this respect. Even in the complete absence of shell fire some very extensive injuries to the chest wall without penetration were met with; such were due either to soft-nosed bullets, ricochet hits at low velocity, bits of stone, or, in some instances, from articles carried on the person, such as buttons, cigarette cases, cartridges in bandolier, buckles, &c. (*Vide* Fig. 23.)

One instance of unusually severe injury to soft tissues is quoted in the Imperial Yeomanry Hospital Report, where almost all the pectoralis major and minor were carried away; recovery was rapid, and there was no evidence of injury to the thoracic contents; but, as would be expected, there was some necrosis of the ribs. Instances of such extensive damage, without opening of the pleura, were rare; the prognosis was, of course, infinitely better than when the pleura was not opened, and hence the importance of the point. Three instances very similar to the above were reported in 7 General Hospital. In one (Private S.) there was a large bag of pus along the outer edge of the scapula, between the muscles, which were extensively lacerated, the point of entry being one inch behind the acromio-clavicular joint; at the bottom was lying a ragged bullet firmly fixed to the sixth rib, which latter was fractured; there was no clinical evidence of the penetration. In another the greater part of the outer half of the scapula, together with the glenoid process, was necrosed and removed; in a third the tip of the coracoid process was found at the bottom of a bag of pus, under the pectoralis major, being drawn down by the pectoralis minor to near its origin.

An instance was also reported by 10 General Hospital (Lieut. H.) where, as a consequence of an "expanding Mauser bullet, setting up" on the bandolier, there was a wound, from 2 inches in front of and 3 inches below the right nipple, extending directly downwards, 4 inches across at the widest part, and 3 inches (*sic*) deep, with extensive tearing and laceration of the muscles; bits of bullet and pieces of clothing were removed on four occasions.

Even instances of double entry and double exit by the same bullet, without any evidence of penetration, were recorded, but with little injury to the soft structures. Thus Private H., wounded 27th June, 1900, whilst bent forward, going through a fence, at 100 yards— Case 49; double entry and exit.

Entry	...	(1)	at level of 4th rib	$6\frac{1}{4}$	inches	to left of mid-sternum.
Exit	...	(1)	,, 5th rib	$6\frac{3}{4}$	,,	,, ,,
Re-entry	...	(2)	,, 6th rib	$7\frac{1}{4}$	,,	,, ,,
Final exit		(2)	,, 11th rib	$9\frac{1}{4}$	,,	,, ,,

No signs of any pulmonary, pleural or costal injury; all wounds healed quickly; cicatrices all about equal sizes, viz., from $\frac{1}{3}$ inch to $\frac{3}{8}$ inch.—(Hospital Records.)

Also the case of Private N., wounded 17th September, 1901; admitted to 7 Stationary Hospital. From before backwards at the level of fifth rib there was a series, in line, of small punctures of the skin, alternately entry and exit, none penetrating the chest wall; all healed in 10 days.—(*Vide* Fig. 24*a*, photograph of similar case.) Ditto.

Most extensive injuries were inflicted by shell fire and also by pieces of stone set in motion by shell. An instance of this last was that of an officer (Captain C.) in Ladysmith, who was struck in the back by a piece of stone the size of the palm of a man's hand; the fragment ploughed its way through the scapula, and its muscles, and lodged in the anterior fold of the axilla; the whole width of the scapula and upper end of the humerus were reduced to fragments, but there was no evidence whatever of penetration or injury to the lung; sepsis supervened, but eventually the patient recovered with a fairly useful arm. Severity when caused by shell.

Occasionally skin grafting was required to assist healing in large superficial non-penetrating injuries, where much destruction had occurred.

Subsequently, disability from contracting cicatrices were occasionally met with where there had been much destruction of soft tissues with suppuration.

Fragments of Clothing, &c., in Wounds.

In penetrating wounds fragments of clothing, &c., were very rarely carried into the chest by an undamaged small-bore bullet; but where the wound was caused by a ricochet or soft-nosed bullet which had "set up" on some hard substance, such as a bandolier or cartridge, then not uncommonly pieces of shirt, khaki clothing, or leather, were found within the chest. One instance was recorded where an undeformed Mauser bullet travelling at low velocity lodged and carried in a piece of shirt. Rare in normal Mauser wounds.

Case 50.—Dr. B., admitted to 9 General Hospital. On 7th February, 1902, a Mauser bullet was removed "from the right side of the chest." And on 18th February, 1902, a rib was resected, and a large abscess opening into the lung evacuated, from which was removed a small piece of shirt; the patient eventually recovered.—(Hospitals Records.) Cases:— (1)

When such foreign bodies gained entrance sepsis invariably followed. When the wounds were explored and the offending bodies found, the wounds healed uneventfully; thus bits of leather, bullet, pieces of necrosed rib or cartilage were found in the following case, lying over the pericardium:—

Case 51.—Private P., admitted to 20 General Hospital, 5th November, 1901, with gunshot fracture of left tibia above ankle, and a wound 4 inches below and 1 inch to left of left nipple; wounds very septic, heart's impulse seen at bottom of chest wound. Next day some pieces of shirt, lead, and rib were removed from wound. 8th November, 1901—amputation of leg (2)

for severe sepsis. Two days later some more pieces of shirt and khaki coat were removed from chest wound; amputation stump suppurating. 21st November, 1901—piece of leather, $\frac{3}{8}$ inch by $\frac{1}{2}$ inch, removed from chest wound. 26th November, 1901—piece of lead removed. 12th December, 1901, nickel mantle of bullet removed. 14th December, 1901—another small piece of lead. 18th January, 1902—chloroformed; pieces of loose cartilage and pieces of lead removed. 7th February, 1902—small piece of cartilage removed under cocaine. 7th March, 1902—chloroformed; pieces of necrosed rib and cartilage removed; a sinus leads down to bare sternum. 15th March, 1902—piece of cartilage necrosed, $\frac{1}{4}$ inch by $\frac{1}{2}$ inch, removed. 30th April, 1902—invalided.—(Hospital Records.)

(It was not stated what broke up the bullet. It may be presumed that the position of the wound, over cardiac area, in conjunction with sepsis, necessitated extremely cautious surgery in this case.)

Heart and Pericardium.

Wounds of heart presumed fatal on field.

Wounds of the heart and pericardium were so seldom met with in the hospitals that the inference is inevitable that such injuries caused immediate or very early death upon the field; but fatal wounds of the pericardium were not all immediately lethal, as seen from the following two instances:—

Wound of pericardium—Died 10th week.

Case 51.—Private F., wounded 2nd March, 1900; admitted 4 General Hospital 10 days later. Entry one inch below and internal to left nipple, opposite lower edge of fifth rib; no exit—bullet had been removed from right side, at back, 3 inches from mid-line, opposite third dorsal spine. Dyspnœa and dulness right base, in axillary line and back; aspirated; some serum withdrawn; area of heart dulness from lower edge of second left rib to right of sternum, in fourth and fifth spaces, and extending 2 inches outside left nipple. Died 9th May, 1900.

Post mortem.—Pericardium distended with $1\frac{1}{2}$ pints of fluid; blood clot $\frac{1}{8}$ inch thick enveloped heart, but no scar detected on heart; extensive right pleural adhesion; no scar in pleural sac.—(Civil Surgeon F. Martin and Major S. F. Freyer, R.A.M.C.)

Died 12th day after admission.

Case 53.—Private B., admitted to 17 General Hospital 15th February, 1901. Entry just below cardiac area; exit in left side, through 10th rib; wounds healed quickly; cough and dyspnœa. On 24th February, 1901, slight dulness over cardiac area; explored with negative result. 27th February, 1901—died.

Post mortem.—Bullet had cut through lower edge of pericardium, in which pus was found; date of wound not given.—(Hospital Records.)

Recovery after wounds of pericardium.

A few instances of undoubted wound of the pericardium without fatal result were recorded, and it is noticeable that the symptoms of pericardial damage did not appear until some days had elapsed.

Cases:—

(1) Case 53A.—Boer prisoner, Van R., admitted 4 General Hospital, Mooi River, 7th January, 1902. Entrance (Lee-Metford) 2 inches inside and $\frac{1}{2}$ inch above left nipple; exit $1\frac{1}{2}$ inch to left of sixth dorsal spine—both healed. The heart itself was believed to have been wounded. Dyspnœa and cyanosis; pulse 120, without noticeable pyrexia, and irregular; dulness all over left chest; pericardial friction sound; heart sounds muffled.

Aspirated 65 ounces blood serum from pleura; cyanosis relieved. Lay in bed for many weeks, while some fluid re-accumulated, but was absorbed again; pulse all this time irregular, and about 100. Convalesced very slowly, but was able to be sent to Durban for oversea deportation three months after admission.—(Major S. F. Freyer, R.A.M.C.)

(2) One case was quoted in the Imperial Yeomanry Hospital Reports where the bullet was seen lying apparently in front of the heart, and where there had been a suppurating wound of entry in the cardiac area.

Apparent wound of pericardium without symptoms.

Further, many instances were recorded which support a conclusion that the pericardium may be penetrated without producing any symptoms at all; thus it is difficult to understand how the pericardium escaped injury in the following :—

Cases :—

(1)

Case 54.—Colonel B. Entry ½ inch to left of sternum, just above fourth rib; exit in sixth space in post-axillary line. Beyond some dulness at right base, no symptoms; heart sounds normal. Returned to duty.—(Records 1 General Hospital.) *

(2)

Case 55.—Trooper C., wounded 23rd February, 1902; admitted Boshoff Temporary Hospital same day. Entry through manubrium sterni by oval opening size of sixpenny-piece; exit just below left nipple—irregular and ragged. Callapsed; dyspnœa; hæmoptysis; pyrexia for few days; no cardiac symptoms. Discharged convalescent 5th April, 1902.—(Hospital Records.)

Hæmopericardium.

Pericarditis was noticed following wounds of the sac, and in not a few cases the condition was probably one of hæmopericardium.

Case.

Case 56.—Lieutenant P., wounded 4th November, 1901, at 15 yards range, or less (Lee-Metford); rode 1½ miles, then fainted; much frothy hæmoptysis. Admitted to 22 General Hospital 14 days later. Wounds had healed. Entry posteriorly, between eighth and ninth ribs, 2 inches from spine of vertebra; exit between third and fourth ribs, in front, ¼ inch above and to inner side of left nipple. Old tendency to Pott's curvature, in upper dorsal region; deficient expansion of left chest; dulness up to spine of scapula behind, and to third rib in front; diminished vocal resonance and fremitus. Heart, no bruit; apex impulse only felt on deep inspiration, in normal position. "Evidently hæmothorax and hæmopericardium." Recovered. —(Hospital Records.)

Possible wound of heart without symptoms.

In not a few instances the heart, from the absence of symptoms, must be presumed to have escaped injury, though from the anatomical track of the bullet one would infer that a lesion must have occurred, unless it be admitted that the heart may be wounded without any obvious ill effects.

Attempted explanations.

(1)

It has been suggested by some surgeons that, at the moment of passage of the bullet, the heart was in systole, or that the patient was lying prone or supine, and that by reason of its state of contraction, or not inconsiderable change of position in the latter case, it escaped lesion.

(2)

The suggestion has been made, and supported by a few cases, that a small-bore bullet, travelling at a very high velocity, may wound, if not perforate, the substance of the heart itself, with no appreciable after effects.

In the following case the pericardium, if not the heart, may be presumed to have been injured :—

Presumed wound of heart.

Case 57.—Private G., wounded 2nd January, 1900, at 500 yards range; admitted 3 General Hospital six days later. Entry (Mauser) at superior angle right scapula; exit in seventh left space, in line with and just below apex beat. Precordial tenderness; dulness left base, but no abnormal precordial dulness; feeble, irregular pulse; marked tendency to syncope; dyspnœa on any attempt at movement; hæmoptysis on first day, with great shock; life probably saved by his having been left on the field with blankets, &c., during the first night, by order of Surgeon-General Wilson. There was pyrexia for two or three weeks; with perfect rest, gradual recovery, up in one month.—(Surgeon-Captain Stuart.)

Rupture of pulmonary abscess into pericardium.

Death was attributed in one case to probable rupture of a pulmonary abscess into the pericardium, though unfortunately no *post mortem* was made to confirm such an unusual and interesting occurrence.

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* Colonel B. informs me that his left arm was in the most advanced position when he was hit. With the arm in that position, if the bullet came from his right side the bullet track would probably be outside the ribs.—(Editor).

Supposed case.

CASE 58.—Boer, B. T., wounded 11th June, 1900, at 20–30 yards range; admitted to 7 General Hospital eight days later. Entry (Lee-Metford) 2 inches above, and to outer side of left nipple, undermined on outer edge to extent of 3 inches by $\frac{3}{8}$ inch; exit $1\frac{1}{2}$ inches diameter; lacerated and contused between eighth and ninth left dorsal transverse processes. Extensive surgical emphysema; much sero-purulent discharge from chest wall; fracture sixth left rib; no direct communication with wounds. Extensive comminution of left transverse processes of eighth and ninth dorsal vertebræ, and of heads and necks of corresponding ribs; severe shock; urgent dyspnœa; finger enters posterior wound about 3 inches easily; fragments of bone removed; had also lacerated wound right arm. Two days later respiration 38; temperature 101·2° F. Following day respiration less rapid; temperature 102° F.; much pain; copious discharge; no pneumothorax; less emphysema. 28th June, 1900, better; temperature normal; respiration, 32; died suddenly at 5.30 p.m., after agonising pain in precordium and left chest for half an hour; "probably a pulmonary abscess ruptured into pericardium." No *post mortem*.—(Hospital Records.)

Bile in pleura.

Bile was occasionally found in the pleural cavity mixed with blood.

Case:—
(Liver wound)

CASE 59.—Private G., wounded 1st May, 1902, at 30 yards; admitted to 21 General Hospital four days later. Entry behind eleventh and twelfth right rib, 1 inch from spine; exit sixth right space in nipple line. Right chest quite immobile and distinctly bulged; no voc. frem; complete dulness up to third rib; no breath sounds heard; pyrexia; pulse, 156; respiration 56; heart apex, $2\frac{1}{4}$ inches outside nipple line. Aspirated $2\frac{1}{4}$ pints fluid containing large amount of bile and blood. 10th May, 1902, again a collection of fluid; heart's apex 2 inches outside nipple line in seventh space Aspirated seven pints, containing less blood but much bile. 1st May, 1902, left base catarrhal pneumonia; severe pain right side; cough; sputum tinged with bile, and contains mucus and liver cells; there had been some jaundice since disappeared. 13th May, 1902, again jaundiced. 15th May, 1902, died; *post mortem*. In right pleural cavity $2\frac{1}{2}$ quarts bile-stained fluid; right lung partly collapsed and base firmly adhered to diaphragm; whole lung deeply bile stained; lying deeply in base of lung a cavity, size of orange, filled with fluid containing liver cells. Left lung two patches of consolidation size of palm; clots in both pulmonary arteries. Pericardium normal; clot in right ventricle; liver much enlarged, extending downwards 5 inches from costal margin in nipple line, and in mid-line half-way between Xiphisternum and umbilicus; in right lobe a track from back to front size of little finger, with corresponding hole in diaphragm. Microscopically the clots from right ventricle of heart and from lung identical, in containing bile-stained liver cells.—(Hospital Records.)

(Ditto)

A very similar case was reported by 3 General Hospital where the bullet had lodged; the man was twice aspirated, and then thoracotomy was performed; there was bile in the empyema, but he recovered eventually.

Wounds of kidney and chest remained aseptic.

In no case was it definitely stated that urine or fæcal matter was found in the pleura in the many cases where the kidney or intestine had been injured by the same bullet; penetrating chest wounds where the same bullet had injured the kidney were not necessarily septic, and the prognosis was unexpectedly good.

Lodgment of Bullet.

When lodged in chest wall it caused little inconvenience.

Where the bullet lodged in the chest wall it usually caused little or no inconvenience. One case has been recorded where it lodged on the "inner side of the lower piece of the sternum," whence it was afterwards removed, but there were no symptoms of penetration of pleura; and generally it was considered, in the absence of hæmoptysis or loss of resonance, that the lung had not been injured. In another instance (Lieutenant-Colonel F., wounded 5th February, 1900) the bullet was extracted in 4th Brigade Field Hospital, from the centre of the sternum, through which half the length of the bullet had passed, without producing any serious symptoms. Bullets lodged in the

chest wall were usually removed. Several cases were recorded, and a few of them are of interest.

In only a few instances was it recorded that the bullet had lodged in the lung, cases in which there must have been but little residual force in the bullet. One is given in the records of 3 General Hospital where the point of entry was over the left scapula; the patient spat up blood and pus for a few days, there was a patch of pneumonia, the size of the palm, in the mid-axillary line low down, and the bullet was seen there by the fluorescent screen. Another very similar case was reported by the Imperial Yeomanry Field Hospital. Bullets lodged in the lung did not cause much discomfort, in most of the cases recorded, and, unless they do cause distress, there can be no valid reason for interference. The retention of the bullet did not apparently delay subsidence of symptoms, due to hæmothorax, &c. Hæmopytsis for one or more days, pointing to injury of the lung, was the only symptom noted in most cases.

When in lung it was not extracted as a rule.

In some instances the X-rays failed to locate the bullet, thus:—

Failure to locate bullet by X-rays.

Case 60.—Private H., wounded 28th November, 1899, at 450 yards range. Entry point of left shoulder; no exit. Immediate hæmoptysis, none afterwards; dulness up to left scapula behind, none in front. There followed hectic temperature; short dry cough. In following January a swelling formed at lower angle of left scapula; opened on 10th January, 1900; blood clot and pus evacuated; fracture of fifth and sixth ribs near angle, bare bone anterior surface of scapula; base of lung still dull behind, probably hæmothorax; cleared up. No trace of bullet found by X-rays.—(Hospital Records.)

Experience would suggest that the bullet probably lay in a region little suspected and not X-rayed, and in this respect it is suggested that there is little use in trying to arrive at a conclusion as to which direction the track runs in, and in what position the bullet has lodged, unless there be taken into the calculation the exact position and pose of the patient when hit. It is as well to make the patient, if able, reproduce his attitude, and then to get from him the direction from which the enemy's fire came.

In the following case the bullet was lodged behind the heart:—

Case 61.—Private P., wounded 18th February, 1900. Entry behind, at centre of line drawn from tip of left acromion to insertion of deltoid; no exit. No injury to humerus, and wound healed in 10 days; X-rays showed Mauser bullet in left chest, behind the heart; "no symptoms or physical signs whatever."—(Hospital Records.)

Bullet lodged behind heart with no symptoms.

A remarkably good result was obtained in Case 44 of the Imperial Yeomanry Hospital, where half a shrapnel bullet was removed from the lung in two stages; as pneumothorax developed at the first attempt, the wound was closed, and re-opened 12 days later, when adhesions had taken place, and the bullet removed.

Case of successful extraction from lung.

It was frequently noted, in the chest as in other regions, that though the wound had pursued an aseptic course, when the bullet was subsequently removed it was found lying in a small bed of pus-like substance, which was apparently sterile and possibly composed of decolorised blood clot; a considerable number of such instances was recorded.

Sterile "pus" in vicinity of bullet.

Case:—

Case 62.—Private L., wounded 18th February, 1900. Entry (shrapnel) fourth right space, one inch above and ½ inch to right of nipple; no exit (had also wound with fracture of right radius by Mauser). Comminuted fracture fourth right rib; much tenderness 2 inches below nipple; pyrexia; chest dull to percussion, back and front, to level of centre of scapula; breath sounds absent, as also voc. frem. On 9th March, 1900, by X-rays, shrapnel bullet seen 3 inches below level of wound, apparently in chest wall; comminuted fracture of rib also seen; on palpation, bullet felt; 16th April, 1900, removed under eucaine, "a little pus round bullet."—(Records No. 1 General Hospital).

Long Track.

Long tracks without symptoms.

So many instances of very long tracks of bullets were reported, and the facts were usually so interesting and instructive, that it seems reasonable to note a few of them, partly in order to draw attention to the fact that many regions may be traversed by a bullet with but little after-effects, whilst in some cases the injury in one region may be so severe as to completely overbalance the results of a long course in a neighbouring region. Also to emphasise the necessity for taking into consideration the pose of the patient at the moment of injury, especially in the case of a retained bullet, where only by realising the actual attitude of the person can blunders in X-ray examinations and reports be avoided. A great amount of interest could be excited by quoting a few dozen cases where the neck, chest, and abdomen; the head, neck, and chest; or the face, neck, and loin; or even chest, loin, and thigh were consecutively traversed, and occasionally with but trivial effect. An officer rode up to a medical officer's tent in Ladysmith, one afternoon, and said he had been grazed in the back by a bullet some hours previously, but had been fighting since. He was astonished, a few minutes later, when the bullet, which had entered in the left loin, was removed before his eyes, without anæsthetic, from the middle of the inner side of his thigh.

Cases:—

(1)

It must suffice to give only a few instances as types of a frequent occurrence:—

(2) Case 63.—Private F., wounded at Tugela 15th December, 1899. Thought at first to be two separate entrance wounds in arm and thigh, with exit in neither case. Entry left upper arm, on outer side, passing through deltoid; supposed to be lodged somewhere near joint; the second wound (exit—supposed entry) upper part of thigh, below iliac crest. 3 General Hospital 14 days later, "complains of certain amount of uneasiness in chest; difficulty of breathing; no other unfavourable symptoms; both wounds are aseptic and call for no special comment"; neither of the supposed bullets traced.—Note, 1st January, 1900: "On more careful examination it is now seen that he only received one wound; was lying down at the time he was hit, the left arm thrown forward, holding his rifle." He had severe hæmoptysis for two days, "blood on the first day constantly welling up into his mouth, and nearly choking him; the bullet undoubtedly passed down, through the thorax, through diaphragm, along lumbar region, without presumably wounding kidney or other important organs, and emerged in thigh, where it was at first supposed a second bullet had entered. 11th January, 1900, discharged to light duty.—(Major Nichol, R.A.M.C.)

(3) Case 64.—Lieut.-Colonel McD., admitted to 1 General Hospital. The bullet entered "just below right costal margin, and emerged just above right clavicle, fracturing the bone"; there was some hæmothorax, and slight "enteritis"; no evidence of injury to liver. Discharged well.—(Hospital Records.)

(4) Case 65.—Private S., wounded 15th December, 1899; admitted to 4th Brigade Field Hospital. Bullet entered at "tubercle of spine of left scapula," and was extracted from the inner surface of the right thigh, 2 inches below Poupart's ligament, after apparently passing through the trunk from above downwards, and from left to right; no serious symptoms.—(Hospital Records.)

(5) *See* also Case 7.

(6) Case 66.—Corporal P., wounded 7th June, 1901. Was carried in ambulance for a week; admitted 12 General Hospital 18th June, 1901; was lying down, firing, when hit from behind, at 80 yards. Entry 2 inches outside left tuber ischii; exit larger than entry, in fifth intercostal space, ½ inch inside left nipple. No hæmoptysis at first, or hæmaturia, or melena; temperature on admission 103·8° F.; cough; blood-stained expectoration; typanitic note on percussion left chest; respiration short and quick. Temperature remained up for a week, then fell to normal; breath sounds cleared up. 26th June, 1901, well; doing hospital duty.—(Hospital Records.)

Mr. Stonham mentioned a case in Imperial Yeomanry Hospital report where the entry occurred below middle of right clavicle, and the exit in right lumbar region, 2 inches from spine. The only signs produced were slight emphysema at exit wound, and slight hæmoptysis immediately on receipt of the wound. (7)

Ecchymosis.

Ecchymosis was but seldom noted; it was, when present, usually limited to a minute ring surrounding the points of entry or exit, or both. It was more often seen when the direction of the bullet had been oblique to the skin surface. Even in lacerated wounds it rarely exceeded an inch or so in width. Two or three isolated instances of widespread ecchymosis were found, but they were cases where there was a large wound, such as would have been caused by a ricochet; or, in case of exit wound, by fragments of bone driven onwards by the bullet. Ecchymosis usually limited.

Thrombosis.

Only one instance of this complication was found recorded, and it followed an operation for hæmothorax :—

Case 67.—Private G., wounded at Senekal 7th March, 1902; was then carried by wagon 80 miles to Kroonstad. Entry base of left lung, at eighth rib, behind; exit just below third left rib, in nipple line; pyrexia from the first; 103·6° F.; marked dulness whole of left chest up to second rib in front; dyspnœa and marked anæmia. 7th April, 1902, incision in fifth space, in axillary line, gave exit to large quantity of blood; put in large tube. 8th April, 1902, tube left out; temperature normal. 18th April, 1902, no fever since operation; incision healed, but to-day has thrombosis in veins of left thigh and leg. 1st May, 1902, swelling in leg subsiding; chest filling up again; cough, pain, and pyrexia. 5th May, 1902, fluid in chest; heart apex one inch from right nipple; incision reopened, rib resected, drained. 20th May, 1902, apex beat in normal site; iodine solution, then perchloride of mercury (which soon caused gums to become sore), then chlorinated soda used for irrigation.—(Records 10 General Hospital.) Case of thrombosis.

Gangrene of Lung.

Only two cases were recorded of anything resembling gangrene of lung :— Gangrene of lung rare and doubtful.

Case 68.—Private F., wounded at Braklaagte 30th October, 1901, by Mauser; admitted to 20 General Hospital 4th November, 1901. (1) Flesh wound, thigh; (2) flesh wound, arm; (3) penetrating wound, chest. Entry through fifth left rib, in front, at anterior fold of axilla; exit 3 inches to left of spine, perforating ninth rib; dyspnœa; offensive purulent discharge from posterior wound. Two days later discharge very offensive, suggesting gangrene of lung; incision made from exit wound forwards, along ninth rib; resected 1 inch, and evacuated a pint of very fœtid pus; died same night. No *post mortem*.—(Hospital Records.) Cases :— (1)

Case 69.—Lieutenant C. S., entrance at back of shoulder joint; exit immediately in front of it, at slightly higher level. Wounds healed in ten days, and pain and swelling had almost disappeared; became very ill; death on 32nd day, "from rapid gangrene of lung." *Post mortem*, humerus found to be completely united and shoulder joint healthy.—(Harrismith Stationary Hospital.) (2)

Wound of Œsophagus.

In only one case was any mention made of symptoms pointing to wound or injury of the œsophagus, though many wound tracks passed near the course of this structure; the probable explanation is that the œsophagus, by its position, escaped injury unless at the same time the spinal column was damaged, in which case the severity of the spinal symptoms overbalanced those due to damage to the œsophagus, which accordingly was not referred to in the notes. Case of suspected wound of œsophagus.

Case 70. Gunner B., wounded at Colesberg 1st January, 1900, at 500 yards range, in cross fire; rode 200 yards after being hit. Entry ½ inch below outer end left clavicle; exit back of right shoulder, about 1½ inches above axilla. Bullet probably wounded apex of left lung, bruised subclavian artery, and, passing behind trachea, bruised œsophagus; vertebral column apparently not touched; can move head freely; had severe dyspnœa first three days; swallowed a small quantity of blood when first hit, after that certain amount of pain on swallowing. Now only little dysphagia, not able to take solid food; still dyspnœa, tenderness and pain both sides of chest; dyspnœa more marked when trying to lie on left side. 10th January, 1900, distinct high-pitched murmur heard, especially in left supra-clavicular region; this space is fuller than corresponding one on right side. Murmur synchronous with pulse; no difference to be detected in the two pulses; no difference in pupils; marked pleurisy right base; absence of vocal fremitus on left side; the murmur resembled a pressure murmur, and was not propagated up the neck. Difficult to estimate the mischief done. May only be a hæmotoma over the subclavian; apex of left lung probably wounded; distinct signs as above of small amount of fluid in left side.—(Major NICHOL, R.A.M.C.)

Wounds of Larger Vessels.

Theory of escape of vessels.

Wounds of the larger vessels was seldom noted in hospital records, as most of such would be immediately fatal. In not a few cases, where there was no indication of such injury, it seemed difficult to account for the escape of the vessel, unless the (very probably true) explanation of free mobility of the vessels and elastic character of their coats be accepted.

Pulmonary artery in bullet track; no symptoms.

CASE 71.—Private McL., admitted 4 General Hospital 14th October, 1901. Entry 3½ inches to left of fifth dorsal spine, ½ inch outside, and opposite middle of base of scapula (with arms hanging down); exit in front, 2 inches to left of mid-line, over second rib, 2 inches above and 1 inch inside left nipple; no symptoms indicating wound of large vessels.—(Major S. F. FREYER, R.A.M.C.)

Attention may be called again to Case 41, where there were signs of occlusion of the subclavian artery, and to Case 70, where a supposed hœmatoma lying over the subclavian caused some speculation as to the actual condition present.

Paralysis of Muscle.

Muscular paralysis.

The latissimus dorsi was paralysed from injury to long subscapular nerve in the case of Lieut.-Colonel C. Entry over right acromio-clavicular joint; exit ½ inch to right of spine of ninth dorsal vertebra (9 General Hospital). No other instance of paralysis of voluntary muscle of chest was found recorded.

Shell Wounds.

Shell wounds followed by necrosis and sepsis.

Shell wounds varied from the most trivial contusions on the one hand, to instant destruction on the other. Even the most trivial shell wounds, causing breach of the skin, almost invariably possessed some features in common, viz., extensive tissue necrosis, sepsis, and tardy repair.

Shrapnel usually lodged.

Shrapnel bullet wounds belong to a class by themselves, apart from wounds caused by fragments of shell. In these sepsis was unusual; such bullets not infrequently lodged, and the wounds pursued an aseptic course. Some such were removed, one three years after receipt of the wound, and a considerable number undoubtedly still remain embedded in the tissues, causing little inconvenience, to the present day. Pieces of clothing, leather, &c., were not uncommonly found driven in by pieces of shell and by shrapnel bullets. Mr. Makins reports the successful removal by Mr. Abbott of a fragment of shell from the lung nine months after injury, an empyema having developed. Almost the entire surgical interest of the war is concentrated on small-bore high velocity bullet wounds, which in so large a number of cases produced unexpectedly trifling results, but even penetrating wounds of the chest caused by shrapnel or pieces of shell may similarly produce but little damage, thus:—

Fragments of clothing in wound caused sepsis.

Case of shrapnel wound.

Case 72.—Lieut. T., wounded at Magersfontein 10th December, 1899, by shrapnel bullet, which passed through right arm in upper third, then into chest between the third and fourth ribs. Hæmothorax; no hæmoptysis; some dyspnœa; shrapnel bullet localised, and removed by resection of 12th right rib, together with 20 ozs. of blood-stained serum. Recovered.—(Records 1 General Hospital.)

Revolver Wounds.

Revolver bullet wounds of chest.

Revolver wounds of the chest as such were seldom recorded; doubtless there was little to distinguish them from wounds inflicted by small-bore rifle bullets at very long range, or from soft-nosed or ricochet bullets. At the same time, it was common experience that some cases of very severe injury to other parts of the body had been caused by revolver bullets. Even in the chest the amount of damage done was very variable; thus Case 73, Captain B., wounded by revolver 1st April, 1902. Entry at back, 1 inch to left of mid-line, at level of inferior angle of scapula; no exit. "Had some lung trouble on right side, which passed off; no other symptoms." X-ray shadow showed bullet in right axilla near fourth rib. 18th May, 1902, operation; bullet removed from fourth right space; wound healed by first intention; returned to duty.

Cases:—

(1)

Compare the above with Case 86, where fatal primary empyema followed a small revolver bullet.

(2)

Wounds by Small Shot.

Wounds by small shot.

Only one case was recorded of wounds by small shot, and the description of the appearance is worth recording:—

Case:—

Case 74.—Private McL., wounded 18th October, 1900, from the front, with buckshot, at 50 yards; noted on 20th October, 1900. "From left mid-axillary line, across the front of the thorax to right margin of sternum, is a broad band, on level of eighth and ninth ribs and spaces, over which are many small wounds made by shot. The wounds are small, mostly with small sloughy crusts and minute collections of pus; most closely resembling Herpes Zoster; some boggy swelling." Evening temperature, 101·2° F.—(Hospital Records.)

Wounds from exploded cartridges.

The effects of a cartridge exploding on the surface of the body are not unlike those produced by a shell wound.

Case:—

Case 75.—Sergeant C., wounded 8th December, 1901; caused by Boer bullet striking his bandolier, in which it exploded a cartridge just above the edge of the scapula, producing a wound size of a half-crown piece; a probe passed 4 inches towards the right, and there touched metal. By operation the thimble of a bullet was removed from within chest wall; fracture of second and third ribs, and comminution of spine of third dorsal vertebra. No sign of damage to spinal cord; had hæmopytsis for a short time only; lungs now healthy. Recovered.—(Records 14 General Hospital.)

Short Range.

"Explosive effects" not always found in chest cases.

Probably on no other point has there been such diversity of experience, and consequently of opinion, and such ingenuity exercised in trying to justify the latter, as in the matter of wounds inflicted at very short range, or "close quarters," by small-bore, high-velocity, mantled bullets. These divergencies are more marked in the matter of large bones, but a few instances of chest wounds at short range deserve record, and are of no little importance from medico-legal as well as from other points of view Such injuries often presented "type" wounds of entry and exit, and in such it was difficult to say, from mere inspection, which was entry and which exit respectively. Also the damage done internally varied much in extent: in some there appeared to have been nothing whatever in excess of what was found as the result of wounds inflicted at ordinary long range. Not a few of these cases were accidental wounds by Lee-Metford bullets where the range was beyond question.

Short range. Cases :—

(1) Case 76.—Trooper R., wounded 20th October, 1901, at two yards range, and admitted to 7 Stationary Hospital 31st October, 1901. Entry just above right nipple ; exit just to right of sternum, 1 inch higher than point of entry ; and final exit flesh wound of left arm. All four wounds "typical," and healed within three weeks.—(Hospital Records.)

As an instance of contrast to the foregoing the following is recorded :—

(2) Case 77.—Trooper P., accidentally wounded by sentry, a few yards off, on 23rd April, 1902 ; admitted to the General Hospital next day. Entry, right edge of sternum, opposite first space, through inner edge of left lung ; exit, 6 inches below top of left shoulder, and 2 inches behind and on level with apex of axilla ; died two hours after admission, or 13 hours after being wounded ; expectorated blood at intervals ; unconscious ; asphyxiated.

Post mortem.—Wound through sternum near right edge, opposite first intercostal space ; bullet passed obliquely through the bone, pierced inner edge of upper lobe of left lung, passed straight through the whole width of lung, piercing a rib, passing below and clear of shoulder-joint, and issued at a point as given above. Heart healthy and untouched, as also great vessels ; left pleura full of large clots ; lung adherent from old mischief at lower half. Track of wound was about ½ inch in diameter, and tore a hole at point of exit one inch in diameter ; some fragments of sternum carried into the lung.—(Hospital Records.)

Even at very close range explosive effects not always found.

There was no uniformity in the extent of damage done in very short-range wounds. From the evidence of several cases where "point blank" wounds were received it is certain that high-velocity small-bore bullets may cause, at only a few yards distance, no more extensive lesion than is often met with at medium and long ranges, or it may inflict wounds showing what was called "explosive effects," and this with undoubtedly undeformed missiles. In other words, very short-range bullets do not always merely "drill" even a soft bone like the sternum. The truth of this statement is evidenced by examination of the records of a number of accidental injuries. (*See* Case 30, absence of shock at very short range ; also Case 40.)

Cases :—
(1)
(2)

The following case is noted chiefly on account of the suggestion offered in the record that impact with the spinal column caused the retention of the bullet :—

(3) Case 78.—Private K., wounded at Driefontein, at 10 yards range. Entry below and outside right nipple—healed ; no exit. Severe hæmoptysis ; no scorching of skin ; behind, opposite the fourth dorsal spine, a hard foreign body felt ; cut down and found Mauser bullet, with large groove in side, exposing core. At time of injury and for some days afterwards there were some paraplegia and inability to micturate. It is doubtful whether the groove in the bullet and lodgment were caused by contact with spine.—(Records 6 General Hospital.)

It would seem more likely that the condition of the bullet was due to its striking patient's own or some other man's rifle.

(4) An important case was recorded in Imperial Yeomanry Hospital Report, where the entry, at close quarters, was at the level of the cricoid cartilage, and exit in ninth space, 3 inches to right of middle line behind.—(Private MacS.)

Pulsating Hæmatoma.

Case of pulsating hæmatoma from chest wound.

Only one case of this condition was met with in the records examined. It is sufficiently interesting, and probably unique :—

Case 79.—Private H., wounded 23rd October, 1900 ; admitted 18 Stationary Hospital five days later. Note on admission : Diffuse pulsating area 3½ inches by 3½ inches, with point of maximum intensity 2 inches internal to left nipple, and in same line ; no normal apex beat to be seen or felt ; swelling very tender on pressure, or on even slight handling. Heart sounds normal ; respiration, 40 ; pulse 104, regular and full ; great pain caused by even slightest cough ; had hæmoptysis quarter of an hour after being shot. Next

day, pulse 104; respiration, 32; spat up 5 ozs. blood. First felt the pulsation on 27th October, 1900, in swelling, which latter was felt to be the size of a walnut, and increased rapidly in size. 2nd November, 1900, very restless; respiration, 34 to 40; pulse 100, regular; both radial pulses seemed alike in strength and amplitude, synchronous; face cyanotic, flushed. No cyanosis of fingers or toes; pupils equal, mobile, not dilated. Temperature, 101° to 103·2° F. (evening), 99·4° to 102° F. (morning), suggests pus; occasional mild rigors; pain now very slight. Wounds: Entry (1) $\frac{3}{16}$ inch by 1 inch, situated $3\frac{1}{2}$ inches directly below tip of left acromion, on anterior surface of left upper arm; exit on same level as entry, $1\frac{1}{2}$ inches to its inner side; re-entry $\frac{3}{8}$ inch by $\frac{3}{8}$ inch, on outer edge of fold of left pectoralis major, 1 inch below anterior end of flexure of axilla; bullet presumably lodged in chest.

The swelling, originally seen and felt just below and internal to left nipple, has now spread towards axilla, with a secondary swelling more or less firm, resistent, and boggy, reaching to point of entry (at outer margin of left pectoral muscle). Precise measurements: Circular outline, diameter 4 inches, upper limit at upper edge of left third rib; lower limit, upper edge of left sixth rib; inner margin along left edge of the sternum; outer margin just outside left nipple; the secondary swelling extends along outer side for $2\frac{1}{2}$ inches. Pulsation visible and palpable, synchronous with cardiac pulse, with maximum intensity at centre, at a point internal to and below left nipple; resonant; auscultatory signs over pulsating area, whole precordium, and over both lungs, back and front, absolutely normal. No dulness anywhere; no cough.

Diagnosis; pyopneumothorax with fracture of one or more ribs, or torn pleura and intercostal muscles in left fourth space, with pus under pectoral muscle; or injury to pericardium and heart wall, with traumatic aneurysm of latter. 4th November, 1900, during night whole swelling collapsed, a large sanguineo purulent accumulation being evacuated by re-entry wound; area previously occupied by swelling gives impression of a gap between fourth and fifth ribs, where undue pulsation is still present; there is audible a coarse precordial "scrape" with both systole and diastole over extreme lower part of left axillary region, and forward as far as the outer and lower limit of the precordium; there is plainly audible a crepitant (extra pulmonary) rale at end of each inspiration; all else normal; no dyspnœa; temperature normal. 8th November, 1900, still slightly exaggerated pulsation over fourth space; no sign now remaining of either pericardial or pulmonary mischief. Pulse, respiration, and temperature all normal; allowed to sit up.—(Hospital Records.)

It will be apparent that the condition was one giving rise to very great anxiety in the first instance, and is of considerable interest.

Prognosis.

Recovery rapid as a rule.

The prognosis of penetrating chest wounds was decidedly good, and, unless extensive hæmothorax occurred, recovery was usually rapid; some few cases were recorded as being discharged from hospital within a few days. It was noted that persistent dyspnœa on exertion was not uncommon, and very few men who had any sort of pleural effusion, or even local hyperæmic change in the lung, were fit for the physical exertion incidental to active service for many weeks or even months after the receipt of their injuries.

Insignificant initial symptoms did not at all necessarily imply early or complete recovery; in many such cases, as well as in those with more urgent symptoms, late dyspnœa on exertion, rapid respiration, persistent pain on deep inspiration, &c., were complained of, after what had in the first instance appeared to be but trivial injuries.

Perforation with slight symptoms.

Very few cases were so fortunate as Case 80, Captain D., wounded 24th March, 1901. Entrance below right scapula; exit 3 inches below right nipple; admitted 20 General Hospital 5th April, 1901, wounds already healed; had hæmoptysis two days only; no other symptoms, returned to duty 13 days after admission.—(Hospital Records.)

Post-mortem Appearances in Chest Cases.

Bullet track closed as a rule.

Post-mortem appearances were seldom recorded, and as regards the results of chest injuries were chiefly those of recent fracture of ribs, often with the processes of repair in various stages already present, a variable extent of pleural adhesions, pneumonic consolidation of one or both lungs, and the presence or absence of pus. The bullet track was not usually apparent, unless made so by the presence within it of pus or extensive laceration. To the *post-mortem* appearances already given with a few of the cases, two more may be added :—

Cases :—

(1) Case 81.—Private T., wounded 15th December, 1899. Entry through sternum, at junction with first costal cartilage, obliquely downwards through right lung ; exit fifth space, 3 inches from mid-line behind ; was lying down when wounded ; died (date not given).

Post mortem.—Perforation of right lung ; in the track of the bullet serous fluid and recent blood clot ; both wounds in chest wall had closed ; right pleura full of blood clot (about 10 pints) ; heart pushed over to left side ; right lung soft and congested ; no solidification at any point ; pleura adherent, soddened, and thickened ; no damage to large vessels ; left lung compressed but healthy ; could not find any intercostal artery damaged.—(Civil Surgeon C. S. Ker.)

(2) Case 82.—Lieutenant W., wounded 10th October, 1901. Entry seventh right space, in posterior axillary line ; exit to left of centre of sternum, opposite second space ; died next day.

Post mortem.—Air in subcutaneous tissue over right side, down to scrotum ; right pleura full of blood ; lung collapsed and badly lacerated.—(Lieut.-Colonel Westcott, R.A.M.C.)

Treatment.

Only required rest as a rule.

By far the greater number of gunshot wounds of the chest required no treatment beyond rest in bed, the apertures in the chest wall having been occluded, after thorough sterilisation, by means of gauze and wool pads, or with thin layers of gauze wet with collodion. When more severe symptoms occurred they were treated on usual surgical principles. As a rule the treatment of hæmothorax was expectant, but aspiration was recorded in 44 cases ; in some of these it was done on two or more occasions ; sometimes the blood was not found at the first or even second attempt, whilst later a very large collection was evacuated. Generally, convalescence was greatly accelerated, permitting early return to duty, a definite improvement with fall of temperature setting in at once. But subsequent pyothorax was too often met with, and it is questionable whether aspiration should be done in field hospitals unless for the relief of very pressing mechanical effects ; for the purpose of diagnosis it should only be done when suppuration is suspected. The experience of different surgeons as to the advisability of aspiration of an uncomplicated hæmothorax seems to have varied widely. In the hands of some pyothorax often followed, and several such were recorded ; though with usual precautions, rigidly observed, it is difficult to see how such a lamentable, and occasionally fatal, result should occur. It should be a stringent rule not to operate unless the signs of the effects of mechanical pressure become apparent, and the local circumstances are such that this small operation can be performed with perfect aseptic precautions ; the more so since frequently perfect recovery with apparently complete absorption occurred in the absence of all surgical interference. But on the other hand, given perfect surgical arrangements and pressure symptoms, there can be no question but that complete and reasonably-timed evacuation is the best treatment. This should be done by aspiration in the first instance, thoracotomy only being employed when the blood has become purulent and empyema has developed. The latter was sometimes done early, but the results were not always encouraging, doubtless from surgical uncleanliness ;

Pyothorax frequently followed aspiration for blood.

but a number of instances were recorded where thoracotomy produced perfect results, as in the following case :— Thoracotomy practised in a number of cases.

Case 83.—Private L., wounded 11th December, 1899, at 500 yards range ; admitted 2 General Hospital a few days later. Entry ½ inch below centre of spine of right scapula ; exit (1 inch by ½ inch) one inch below right nipple ; rib not fractured ; hæmoptysis ; dyspnœa ; small weak pulse ; temperature, 102·4° F. ; chest dull, up to second rib in front ; 20 days later chloroformed ; resected 2½ inches of fifth rib, in mid-axillary line, and removed "enormous amount of grumous blood and clot" ; not washed out ; drainage tube ; temperature then fell ; breathing easier ; discharge of large amount of blood and clot through tube ; remained aseptic throughout ; lung expanded ; wound healed by 10th February, 1900. 31st March, 1900—invalided, with almost complete expansion of lung ; no abnormal dulness on either side.—(Hospital Records.) (1)

Cases have been quoted where the necessity arose, by reason of recurrence of a hæmothorax, for repetition of aspiration even more than once, and the earlier aspiration was performed the more certainly did the blood re-accumulate. Recurrence of the hæmorrhage was invariably accompanied by renewal of the pyrexia. (*See* cases 18 and the following) :— When recurrence took place after aspiration it was accompanied by pyrexia. Cases :— (1) (2)

Case 84.—Lieutenant M., admitted 11 General Hospital 11th March, 1902. Entry through sternum, in middle line, at level of fifth rib, passing backwards and outwards ; exit at external border of right latissimus dorsi, and then through right arm ; temperature, 102° F. ; respiration, 24 ; pulse, 108 ; pain and dyspnœa urgent on making the slightest exertion or movement ; not allowed to talk ; right lung dull at base behind. Explored chest six days later, with negative result. 19th March, 1902, explored dull area, without anæsthetic ; no result. 20th March, 1902, under chloroform explored ; removed 53 ozs. blood. 21st March, 1902, temperature, 99° F. ; respiration, 20 ; feels, and is breathing, better. 26th March, 1902, again evidence of fluid in right side, and rise of temperature, 27th March, 1902, chloroform and ether ; aspirated, removed 12 ozs. dark fluid.—(Hospital Records.)

Case 85.—Captain H., wounded 10th March, 1901 ; admitted 2 General Hospital 31 days later. Entry and exit through upper part right chest ; wounds already healed ; right thigh also fractured ; right chest quite dull ; temperature, 102° F. 11th April, 1901, aspirated 30 ozs. dark blood. 22nd April, 1901, temperature again up ; aspirated 22½ ozs. dark fluid blood ; improvement began at once, and was maintained ; no further collection ; fair expansion followed.—(Hospital Records.)

Pyothorax.

Pyothorax was treated on ordinary surgical principles, and thoracotomy was performed in practically every case recorded as such. Several were fatal. Recovery from empyema must be considered very fortunate, in the presence of wounds of the colon and kidneys, such as occurred in the case of a Boer, reported by 9 General Hospital, where an empyema developed five weeks after admission. The entry wound was in the right mid-axillary line, 1¾ inches above the costal margin ; the bullet was removed from the right of the third lumbar spine ; symptoms pointed to wounds of the liver, colon, and right kidney. Recovery also was obtained in the case of another Boer for whom rib resection was performed on three separate occasions (Case 28). For purposes of irrigation in empyema, various fluids were used. Colonel Sylvester says in 2 General Hospital Report, "Ordinary Aq. Menth. Pip. (B. P.) with hot water was used in all cases of empyema requiring washing, with good results ; it renders the discharge sweet very quickly, and is not irritating." Several of the hospitals used iodine in solution ; some tried bichloride of mercury, but found the gums quickly affected ; chlorinated soda was used by some, and others preferred to omit all irrigation, and the results in cases so treated seem to have been equally satisfactory. Thoracotomy. Irrigation fluid used.

Hæmoptysis.

Hæmoptysis required no treatment.

Hæmoptysis does not seem on any occasion to have been severe enough to have called for special treatment.

Before leaving the subject of treatment, a reference must be made to the question of immediate or too early removal from the field. There can be little doubt but that harm may be, and often unavoidably was, caused by too early "collecting" of wounded from the actual field of battle. The converse was seen in some of these cases where, intentionally or otherwise, the patients were left undisturbed for a number of hours where they fell, prior to removal. This is well instanced in Case 57, which conveys a strong hint as to the best possible treatment summed up in one word—"rest." The opinion offered by Mr. Makins may be again referred to as to the effects of early transport on the incidence and recurrence of hæmothorax.

Bullet extraction at the front a mistake.

There is another important point, in connection with the extraction of retained bullets, which requires mention. Several instances were met with where this had been done simply because the bullet was lying just under the skin, or in some other such easily-accessible position. When under unfavourable circumstances, viz., at the front, the bullet was removed too early, *i.e.*, before the track had had time to heal and so become shut off from, say, the pleura or other important area, surgically disastrous results not infrequently followed. Experience very strongly dictates that the bullet should not be interfered with for some days at least. Certainly it should not be removed on the field, or in an advanced field hospital, where the arrangements are necessarily imperfect, and suppuration is likely to occur.

Medico-Legal.

Case of self-inflicted wound with toy pistol.

The following case is quoted solely for its medico-legal interest as showing the possibilities of self-inflicted (accidental) wound :—

Case 86.—Private V., wounded 18th July, 1901 ; admitted 7 General Hospital next day. Entry immediately below, and to inner side of angle of left scapula ; no exit. Patient stated several times emphatically that when amusing himself shooting at a target with a toy revolver, in the act of passing the revolver to his friend behind him, without troubling to turn round, he accidentally fired the pistol in removing his finger from the trigger guard, at a distance of 2 or 3 inches from his own back ; he had hold of the pistol by the muzzle and guard. Within a day or two of admission there was hyperpyrexia, heart pushed over to right of sternum, apex beat 1 inch clear to right of the bone. Pus being obtained on aspiration, thoracotomy was done, a long clot of blood removed from between the upper and lower lobes, and drainage established. Died 6th August, 1901.

Post mortem.—Universal left pyothorax, lung crepitant everywhere ; track, full of pus, led past suppurating bronchial gland ; a small pure lead toy pellet, with cupped base, found embedded in anterior chest wall, between the two intercostal muscles, in fourth space, close to anterior axillary line.

There was no reason whatever to doubt repeated assertion that the wound of entry in the back was self inflicted, accidentally, and the evidence of his companion was to the same effect.—(Major Holt, R.A.M.C.)

Statistical Notes.

The Imperial Yeomanry Field Hospital Report stated that in 36 chest wounds, 14 were flesh wounds only ; in 7 there was fracture of rib, and in 3 the bullet lodged.

In 7 General Hospital, 29 chest wounds, of which 11 were penetrating.

In 2 General Hospital, 189 chest wounds, of which 122 were penetrating.

In the records examined of 30 fatal cases (out of a total of 214) of penetrating wounds, pyothorax occurred in 10, hæmothorax in 11, collapse of lung in 5, pneumothorax in 5, pneumonia in 3.

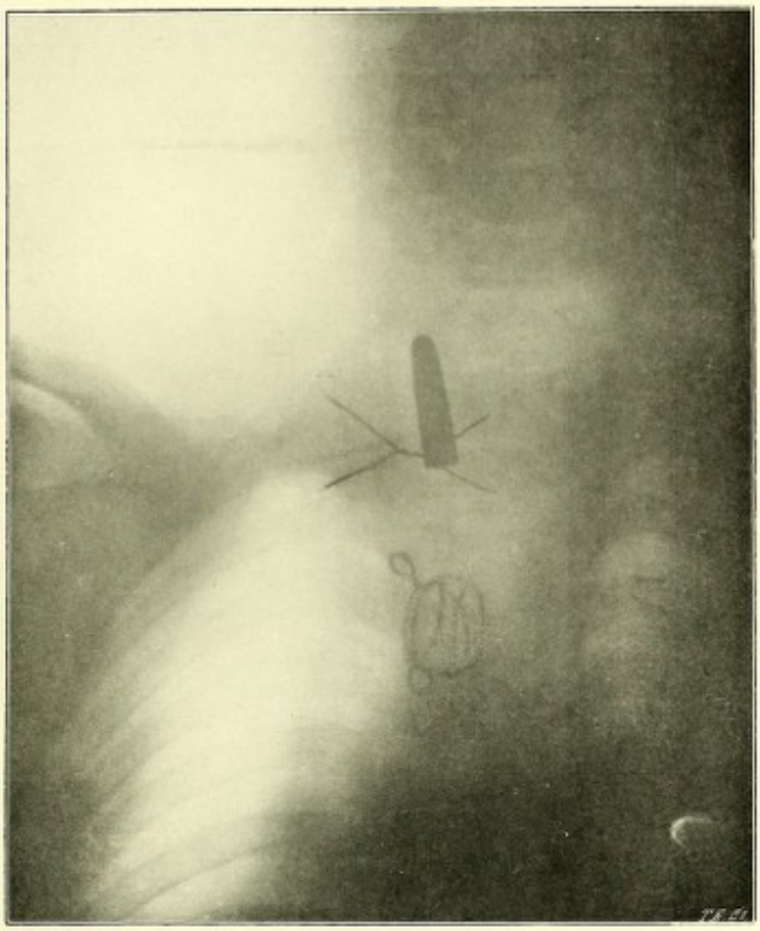


FIG. 22.
Bullet Lodged in Neck above Clavicle: no symptoms —(Skiagraphed at Netley.)

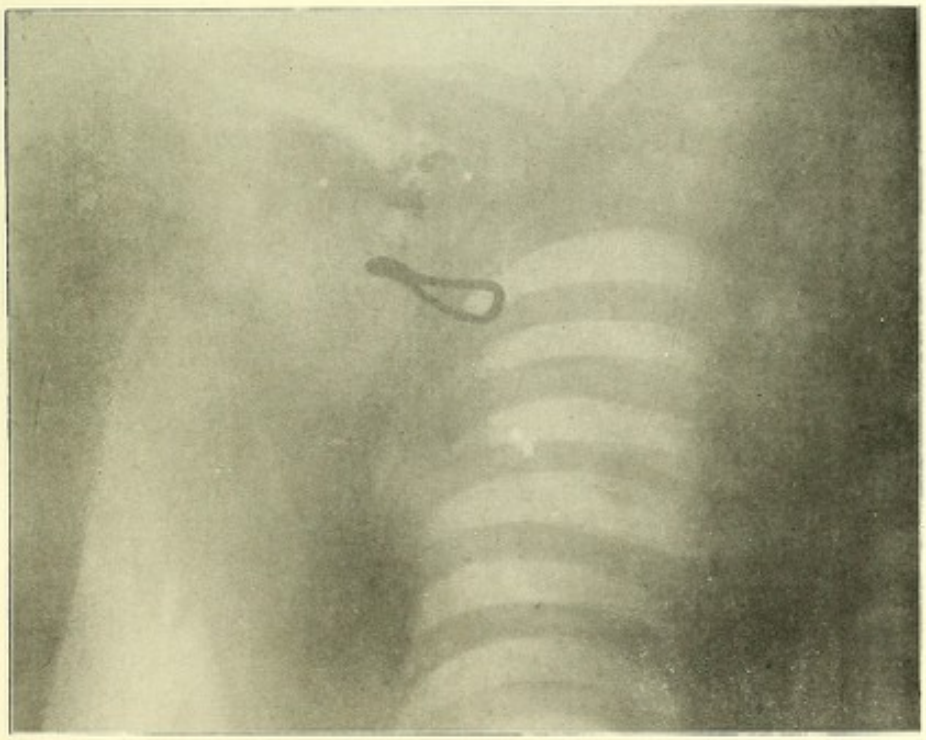


FIG. 23.
Buckle and Small Ring of Haversack and fragments of Bullet Lodged in Supra-spinous Fossa; removed.—(Skiagraphed at Netley.)

FIG. 24.

Many Fragments of Bullet lodged and removed: clavicle fractured.—(Skiagraphed by Sergeant-Major A. HARWOOD, R.A.M.C.)

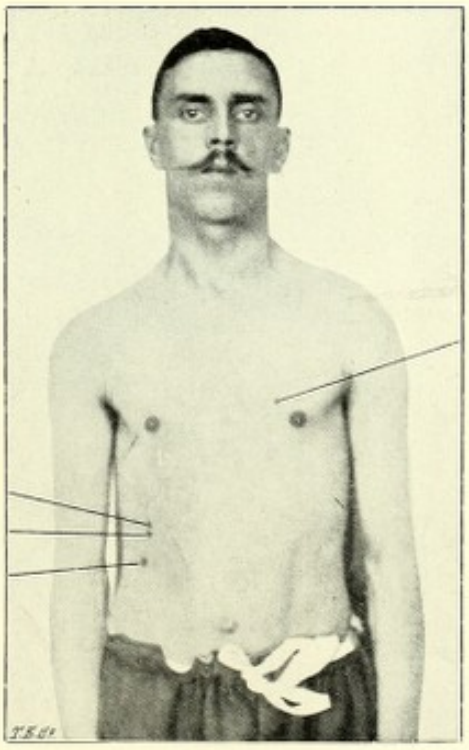


FIG. 24A.

A curious Case of Bullet Track under the Skin.—(Photographed at Netley.)

In the records of 214 cases of penetrating gunshot wounds of the chest, the symptoms were noted as follows :—

TABLE 13.

Total cases.	Hæmoptysis.	Dyspnœa.	Fever.	Dulness.	Hæmathorax.	Pain.	Pyothorax.	Collapse or shock.	Surgical (extensive) emphysema.	Severe cough.	Friction rubs and pleurisy.	Chest movement deficient.	Cyanosis.	Pneumothorax.
214	116	80	69	67	62	51	32*	22	21	19	16	16	12	11
Per cent. ..	54	37	32	31	28	23	14	10	9	8	7	7	5	5

* This included cases of pyothorax after aspiration.

Aspiration was performed in 44 cases, thoracotomy in 30. Died, 30; recovered in South Africa, 50; invalided, &c. 134. Death-rate = 14·0 per cent.

SECTION VI.

By Major Holt, D.S.O., R.A.M.C.

WOUNDS OF NECK.

Classification of wounds of the neck.

In summarising the records of a considerable number of wounds in this region, it is necessary to differentiate those in which none of the important structures were damaged from those in which the clinical signs pointed to definite lesion of one or more of these parts, and, amongst these latter, to severally specify the structures injured. For these purposes it will be obvious that a purely anatomical basis is practically useless; for in no small number of instances recorded most important structures apparently lay in a direct line drawn from the point of entry to that of exit in any possible position of the part, and yet no clinical evidence pointed to their having been damaged. These cases must be noted as simple flesh wounds, no matter how unlikely, from solely anatomical considerations, such a diagnosis may appear to be.

Escape of certain structures due to their mobility.

The conclusion has been irresistible, and almost unanimous, that the only possible explanation of the miraculous escape of certain structures is that they have sufficient mobility and elasticity to permit of their being pushed aside during the transit of even the highest-velocity bullets, as frequently happened in the case of the low-velocity round bullets of former times.

The records mostly from fixed hospitals.

As the summary here given has been obtained from such case-books and reports as were sent in from the larger fixed hospitals, the records of many important cases were necessarily often short; many died very shortly after arrival in hospital, and probably still more died on the field after being attended to by the surgeon in the fighting line, who had no opportunity of recording his experiences; and these last would include most of the wounds of the large vessels of the neck.

Only the less severe cases seen.

As a rule, the cases of neck wounds received into the hospitals were not serious. In 2 General Hospital Report, Colonel Sylvester says: "51 cases of wounds of the neck were treated, but no serious wounds of this region have come under my notice," and he confirms the general experience, viz., that the cases that lived were mostly of slight severity, the others having been rapidly fatal.

Here, as in other sections, many of the wounds implicated at the same time adjoining regions. Where the symptoms were serious and important, it is impossible to omit reference to them in dealing with each of the regions as they severally come under review, an exception being made in the matter of wounds of the spinal cord, since the latter injury caused effects quite overbalancing all other considerations, and as these have been dealt with collectively in a separate section.

Wounds of cervical spine not included in this section.

In the matter of injury to the large nerve plexuses of the neck, it is much to be regretted that records of the later history of these cases have not been available.

Flesh Wounds of the Neck.

Simple flesh wounds of the neck probably caused more wonder and interest than those of any other part. Here the most vital structures are crowded together within a very small space with but little connective tissue between them, and yet cases have been recorded by the dozen where bullets rapidly threaded their way amongst them without apparent harm, leaving only small dry scabs over the points of entry and exit, with, perhaps, the sole addition of some temporary stiffness of the region for a day or two; just as though it had been possible to drag a lighted match through a barrel of gunpowder

Bullets passed close to important structures without injuring them.

without result. The wonder excited varies directly with the practical familiarity with the region in the living subject on the part of the reader. A few instances are quoted below.

Some bullet tracks quite short; Others through whole thickness of neck.

Sometimes the flesh wounds were of very short extent; thus in one instance, the bullet entered at the anterior edge of the sterno-mastoid and emerged at the posterior border of the same muscle and at practically the same level, but in others, the whole thickness of the neck was traversed from front to back, from side to side, or from end to end in the long axis of the body, quite harmlessly.

Cases showing this. Cases of flesh wound.

Case 1.—Gunner T., wounded 29th March 1901, at 700 yards; Mauser. Entry at level, and to right of first dorsal spine; exit in front, $\frac{1}{8}$ inch to right of mid-line, at level of cricoid cartilage—both wounds healed on admission to 3 General Hospital. "The exit is just over line of right common carotid; a hard cicatricial mass leads down to the pulsating artery. No apparent ill-effects, except indefinite pain in region of shoulder; radial pulse and hand grasp equal and good on both sides." Was 14 days in hospital.—(Civil Surgeon A. Young).

Case 2.—Private G., wounded 27th July, 1900; Mauser; 800 yards; admitted 7 General Hospital, 8th August, 1900. Entry at left scapular spine, 4 inches from second dorsal spine; exit 2 inches above middle of left clavicle. Wounds healed; no evidence of injury to large vessels or nerve trunks.

Case 3.—Corporal S., wounded 7th June; Mauser, 800 yards; admitted 3 General Hospital eight days later. Entry $1\frac{1}{2}$ inches to right of mid-dorsum, at level of third cervical spine; exit $3\frac{1}{4}$ inches to left of mid-line, at same level ($\frac{3}{4}$ inch below mastoid process). On admission, both wounds healed; neck stiff; movement painful; no sign of damage to spinal cord or other structures.—(Civil Surgeon A. Young.)

Case 4.—Corporal O., wounded 7th June, 1900; Mauser. Entry over posterior border of right sterno-mastoid, 2 inches from tip mastoid process; exit at an almost identical spot on left side. 14th June, 1900, almost quite well; no symptoms.—(Imperial Yeomanry Field Hospital).

Case 5.—Lance-Corporal O., wounded 6th May, 1901, at 20 yards; admitted 12 General Hospital next day. Entry $\frac{1}{2}$ inch to right of first dorsal spine; exit left cheek, 1 inch below malar bone. Swelling and tenderness behind angle of jaw; no pulsation; no loss of sensation in face. 22nd May, wounds healed. 3rd June, discharged quite well.—(Hospital Records).

Shell injuries sometimes slight.

Even fragments of shell may produce comparatively trivial damage, as in a case (Private H., 9 General Hospital), where a piece of shell $\frac{3}{4}$ inch long entered the right submaxillary triangle, above the level of the crown of the hyoid bone, and was removed from a spot 1 inch lower down.

Flesh wounds of neck sometimes followed by stiffness and deformity.

A few notable exceptions to the insignificance of the damage done to the neck in some of the flesh wounds were seen in certain cases where subsequent stiffness, wry neck, or even complete fixity of the head, followed with the attendant discomfort, deformity and disfigurement. These conditions in the neck were more noticeable and distressing to the patient than a similar loss of mobility would be elsewhere, and in this respect only did wounds of the muscles assume any importance; a similar result not infrequently followed even localised suppuration.

Shock.

Shock varied in extent, from nothing on the one hand, to unconsciousness for several hours on the other; and with severe injuries some patients managed to ride, or even walk, considerable distances.

Case 6.—Reported by Imperial Yeomanry Hospital. An officer wounded 26 days previously; admitted 18th August, 1900; Mauser; 500–800 yards. Entry through belly of left sterno-mastoid muscle, $\frac{1}{2}$ inch

above cricoid; exit through right sterno-mastoid, 1½ inches higher than entry; both carotids undamaged; knocked down; unconscious for 16 hours; profuse hæmorrhage; difficulty in swallowing or speaking for several days, and for 24 hours paralysis and anæsthesia of left arm. Both movement and sensation returned suddenly. Ecchymosis reaching to front of chest lasted one month. Bullet supposed to have passed in front of the vessels of the left side, and behind the pharynx and vessels of the right side.—(Hospital Records).

Sepsis.

Sepsis.

When suppuration was present in small-bore bullet wounds of the neck it was observed almost invariably to depend upon direct contamination from lesions of the mouth, pharnyx, œsophagus, larnyx, or trachea; but, on the other hand, wounds of these structures were not invariably followed by sepsis. In some cases the spread of infection was rapid, extensive, and fatal; in others it was limited more often to the actual vicinity of the mouth wound, and this indifferently whether the entry or exit had occurred by the mouth, though the latter event would be the more easily intelligible. On the other hand, it is not a little remarkable that a bullet should have entered by the mouth, and then have followed a long course through the neck without producing sepsis in any part of its track; and yet this not infrequently was the course of events. The following cases are quoted in a definite order, exemplifying the three different gradations as affecting wounds implicating the mouth and neck; those concerned with wounds of the œsophagus, trachea, &c., will be found under their respective headings:—

Wound through mouth; no sepsis.

Case 7.—Corporal S., wounded 18th February, 1900, at 200 yards, when kneeling; admitted 3 General Hospital four days later. Entry in mouth; carried away both left central incisors, broke both left lateral incisors, then through floor of mouth and neck. Exit 3¾ inches to left of mid-line, one inch below spine of scapula, at level of second dorsal spine. Wounds of mouth and back quite healed; spine of scapula shattered; absolute paralysis and already partial atrophy of left deltoid and supra spinatus, and less distinct atrophy of infra spinatus; power of forearm and fingers quite good; shoulder cannot be elevated or arm raised on scapula; had free hæmorrhage at time of wound. Rhomboids, serratus magnus, pectorals, and trapezius all normal; no alteration of sensation in region of shoulder. A previous note of this patient from the records of 6 General Hospital, where he was admitted on 27th February, 1900, states, "spat up much blood at time of wound; on admission no pulmonary complications; had difficulty in swallowing solids, but no great trouble with liquids or soft solids." Wounds healed on 16th March, 1900.—(Civil Surgeon A. Young.)

Sepsis in case of wound of mouth.

Case 8.—Private P., wounded 14th February, 1900, at 300 yards. Entry roof of mouth, which was open at the time; furrowed left side of roof of mouth, penetrated left alveolar ridge, and carried away second upper and lower molars. Exit by wound ¾ inch long, parallel with mid-dorsal line, at level of sixth cervical vertebra; about three weeks later, incision made from third to fifth cervical vertebra to evacuate pus; no pain on left side of neck, but great pain and stiffness on right side; head and neck are kept stiff and immobile. Admitted to 3 General Hospital 22nd March, 1900.—(Civil Surgeon A. Young.)

Ditto

Case 9.—Boer, J. J. A., wounded by Lee-Metford at 200 yards on 6th November, 1901; admitted 3 General Hospital two days later. Entry left side of lower lip, smashing mandible (extensive laceration of gum and tongue); exit upper part of vertebral border above spine of left scapula. There were marked fetor and extensive inflammation of mouth, with discharge of a sequestrum from mandible, but no trouble with that part of the track which traversed the neck. This bullet passed from an area swarming with bacteria, and yet did not carry any, or at any rate enough, bacteria to successfully infect the neck.—(Hospital Records.)

Sepsis in case of wound of mouth.

CASE 10.—Sergeant F., wounded 11th June, 1901; Mauser, 600 yards. Entry through gap left by absence of upper bicuspid and molar teeth, penetrating left lateral border of tongue and floor of mouth to left of frenum linguæ; exit on right side of neck, at level of upper border of thyroid cartilage, and vertically below angle of jaw. Lower down are three superficial grazes, two in neck and one over middle and outer thirds of right clavicle. Entrance wound small, with slight serous discharge; tongue wound $\frac{3}{8}$ inch diameter, with lacerated edges; wound in floor of mouth oval, with much ecchymosis. Exit wound irregular, $\frac{5}{8}$ inch diameter; upper edge undermined, lower edge bevelled. Extensive discoloration of neck and on right side of upper third of thorax anteriorly; sinus led up to floor of mouth; free discharge of pus, evacuated by forceps. Iodoform gauze drain inserted; not able to masticate. 30th June, 1901, tube left out; discharge almost ceased. Mouth wound already cicatrised. 7th July, neck wound almost healed; discharge only from surface granulations.—(Records 7 General Hospital.)

Septic case—Died.

CASE 11.—Private W., wounded 4th November, 1900. Entry in left upper lip; fracture lower jaw; through neck; exit above left scapula. Suppurating freely from mouth. 27th November, 1900, opened abscess in neck communicating with mouth wound. 2nd December, 1900, suppuration extends downwards, reaching nearly to chest; pain in chest; pleurisy. In a few days he began to expectorate pus; hyperpyrexia. 18th December, 1900, died.

Post mortem.—Comminuted fracture of mandible; suppurating area in neck; left pleurisy; abscess in upper lobe left lung. Probably bullet had wounded apex of lung, though it was not possible to assert this owing to the condition of the parts.—(Records 2 General Hospital.)

Ditto.

CASE 12.—Boer, P. B., wounded 18th November, 1900; admitted 2 General Hospital two days later. Entry through mouth, fracturing lower jaw at angle; exit above left scapula. On admission was very septic; foul discharge from mouth; hyperpyrexia; pulse and respirations rapid. Constant irrigation had no good effect; almost entirely unable to swallow. Died on 26th November, 1900.

Post mortem.—Comminuted fracture mandible; track passed behind larynx, through pharynx and deep muscles of neck; suppuration of track nearly to clavicle.—(Colonel SYLVESTER.)

Retained Bullets.

Several cases in which missiles lodged in the neck were recorded, but generally this accident was of little importance. The necessarily low rate of velocity in these cases would seem to have conduced to the pushing aside of structures by the bullet in its passage, judging by the small amount of damage so frequently recorded. In some instances fragments only of the bullet lodged. Usually the bullet was removed by operation, but in some, as no inconvenience was caused, it was left undisturbed. No anatomical consideration apparently stood in the way of this operation, which was rendered easy by precise localisation with X-rays. The most common effect of a retained bullet necessitating its removal was a certain degree of wry neck.

Cases of lodged bullets.

CASE 13.—Private R., wounded at Magersfontein. Entry $1\frac{3}{4}$ inches to left of Pomum Adami; extracted from posterior margin of scapula (right), almost at extreme lower angle. Healed per primam. (3 General Hospital.)—(Civil Surgeon A. YOUNG.)

CASE 14.—Private L., wounded at 2,000 yards range. On admission to 6 General Hospital on 7th April, 1900, marked wry neck; fluctuating swelling over upper third of left sterno-mastoid. Opened latter; free escape of pus; hard foreign body felt towards sub-occipital triangle, removed, and found to be an undamaged Remington. *See* also Case 17, under "Wound of Trachea, &c.," and a case given in Imperial Yeomanry Hospital Reports, where the bullet was removed from behind the pharynx. (Case 15, Imperial Yeomanry Hospital.)

Case 15.—Trooper B., wounded in attack on train; admitted 26 Stationary Hospital 21st July, 1901. Entry at seventh cervical spine; passed upwards and outwards towards right ear. Shot from left side at distance about 30 yards. 26th July a piece of bullet removed from back of neck, and another on 31st July. 5th August, large piece of nickel mantle much torn and bent, and a $\frac{3}{8}$-inch copper cap similar to Eley's No. 12 primer, all removed. 9th September discharged to duty. It was assumed that the bullet had passed through the railway truck.—(Imperial Yeomanry Hospital Report.)

An unusual case of re-entry and final retention was reported by Colonel Bruce:—

Case 16.—Lance-Corporal, wounded 30th October, 1899; admitted Ladysmith same day. Entry (Mauser) in left shoulder, 4 inches from mid-line, and 1 inch above spine of scapula; exit $3\frac{1}{2}$ inches further on, in upward and inward direction, $1\frac{3}{4}$ inches from mid-line; re-entry posterior aspect of neck, near middle line; travelled under skin, and lodged 2 inches below occipital protuberance. Bullet removed, and patient re-transferred to field hospital.—(Hospital Records.)

Bullet extraction—Preliminary tracheotomy—Recovered.

Case 17.—Private H., wounded 7th August, 1900; admitted 4 General Hospital, Mooi River, four days later. Entrance (normal Mauser) in right upper maxilla, just above and outside angle of jaw; healed. Bullet passed through the bone, knocking out some teeth, perforated soft palate, and lodged deeply behind pharynx, where it was shown by X-rays. Probe passed to a great depth from palate wound, which was discharging pus. Operation two days later; preliminary tracheotomy and pharynx plugged; incision along ant. margin of sterno-mastoid, from lobule of ear for 3 inches; int. carotid artery exposed, and bullet found lying behind and beneath it; a transverse incision enabled dissection to be carried deeper. Bullet lay against inner side of transverse process of atlas, which was also gripped by the forceps, thus preventing extraction by this route; another forceps introduced from mouth wound now seized, and removed a normal Mauser bullet. Tracheotomy tube removed next day; some broncho-pneumonia followed, and severe occipital neuralgia accompanied convalescence, but this latter was passing off when he was invalided to England. A small sinus in external wound, through which fluid food regurgitated, had then also healed.—(Civil Surgeon Stanley Copley.)

Short-Range Wounds.

The points raised in the controversy over the extent of damage done by small-bore bullets, at very close quarters, apply to this region only so far as concerns the soft tissues. As an instance of the small amount of local disturbance that may follow a wound of this nature, the following is quoted:—

Wound at short range.

Case 18.—Private H., accidentally wounded at 5 feet distance, by Lee-Metford, on 9th October, 1900. Entry in front of left side of neck, $\frac{3}{4}$ inch above sterno-clavicular joint ($1\frac{1}{4}$ inches to left of mid-line, just at inner edge of sterno-mastoid), 2 inches in diameter; exit $1\frac{1}{4}$ inches by $\frac{3}{8}$ inch (oblique), $3\frac{1}{8}$ inches behind entry ($2\frac{3}{8}$ inches above left scapular spine, and 4 inches to left of mid-line). Symptoms slight, save pain on movement of left sterno-mastoid; pupils equal. No sign of damage to carotid or brachial plexus.—(Imperial Yeomanry Hospital Report. *See* also Case 22.)

Wounds of Larynx and Trachea.

Injuries of this class were frequently followed by (*a*) septic broncho-pneumonia, with usually a fatal result, which latter was commonly directly ascribed to cardiac failure; (*b*) hæmoptysis; and (*c*) surgical emphysema of more or less extent. Occasionally it was found necessary to insert a tracheotomy tube for a few days, and on one occasion this was done to limit increasing surgical emphysema. The following few cases illustrate these points:—

Cases of wound of the air passages.

Case 19.—Quoted from Imperial Yeomanry Field Hospital. Private C.; Mauser, entry just above inner end of left clavicle, with considerable surgical emphysema over left side of neck, from upper margin of ear, extending down over chest, to upper part of abdomen. Wound slightly enlarged upwards; bubbles of air immediately escaped, indicating wound of trachea; bullet had severed sternal head of sterno-mastoid, and passed transversely across neck, but it was not detected (exit wound not mentioned). No bleeding. Died from cardiac failure, no pulmonary complications; date not given.—(Hospital Records.) Wound of trachea—Died.

In the next case hæmoptysis was the only clinical evidence of wound of the trachea.

Case 20.—Private B., wounded 13th December, 1901. Entry in middle line, at upper margin of sternum; exit 1½ inches below centre of spine of right scapula. No anæsthesia, or paralysis; voice hoarse; spat up a little blood at time of injury. Has persistent laryngeal cough. Probable injury to right recurrent laryngeal nerve.—(Captain Walton, R.A.M.C.)

Case 21.—Private W., wounded 23rd January, 1900; admitted 4 Stationary Hospital two days later. On admission swallowing impossible, as food entered air passages, and caused paroxysmal cough; starving; restless; very anxious and weak. Wounds (1) small, on left side of chin; (2) small, over carotid vessels, at level of thyroid cartilage, on left side; the latter was wound of entry, no corresponding wound of exit. Larynx very tender, broadened and flattened, in fragments, which crepitated; distinct surgical emphysema; left pupil contracted to a point, from injury to sympathetic nerve. Voice a husky whisper, due to fracture, or to injury to left vagus. 26th January, 1900, nutrient enemata retained well; but at 7 a.m. nearly fatal dyspnœa from tracheal obstruction; became cyanosed; crowing stridor; gradually relieved whilst tube being fetched. Mr. Treves, having done preliminary tracheotomy, explored wound over carotid; bullet detected, but larynx found to be completely disorganised; œsophagus torn, and communicating by an opening with the trachea; as the finger was withdrawn there was a violent hæmorrhage from left internal jugular vein, which caused great relief and improvement in general condition. Rather weaker next day; nutrient enemata continued; purulent discharge from tracheotomy tube; on attempting to swallow food i came through tube; died the day following.—(Hospital Records.) Wound of Larynx—Died.

Case 22.—Private C., wounded 2nd May, 1902, accidentally by comrade. Entry front of trachea, at level of third ring; exit ½ inch internal to vertebral border, and just below root of spine of right scapula. Tracheotomy tube put in at the time and used for 10 days; complete paralysis right arm. On admission to 20 General Hospital both wounds scabbed. 31st May paralysis steadily improving; has power of flexion and extension of fingers and wrist, and, to less extent, of elbow. Anæsthesia upper arm, but sensation normal below elbow; not able to abduct arm. 12th June paralysis still further improved. Sent to Base. Though not so stated, this was probably Lee-Metford wound at very short range.—(Hospital Records.) Wound of trachea—Recovered.

Case 23.—Dr. K., wounded at 1,000 yards range. Entry anterior border of right trapezius; exit through trachea. Tracheotomy, by enlarging exit wound, done at the front, for laryngeal spasm; entry wound healed on arrival in 1 General Hospital (date not given); exit wound healed two days later; some areas of hyperæsthesia in distribution of brachial plexus. Recovered completely.—(Hospital Records.) Ditto.

Wounds of Œsophagus.

Wounds of the œsophagus were accompanied by a very high rate of mortality, this apparently being due almost solely to extensive sepsis, the fatal result often being very rapid. Occasionally on *post-mortem* examination the œsophagus was found in a gangrenous condition. Dysphagia occurred when there was no other evidence of lesion of the œsophagus or pharynx, and it was also noted as a sequel to sepsis within the neck when, presumably, the œsophagus was not wounded in the first instance. These points are illustrated severally in the following cases :—

Wound of the œsophagus—Died.

Case 24.—Trooper C. Entry right angle of mouth (fracture of horizontal ramus of jaw) ; no exit. Admitted 20 General Hospital 4th November, 1901. Discharge of foul pus from mouth ; some dyspnœa ; temperature, 102° F. 4th November coughed up some blood ; rapid respiration. Given ergotine injection ; also calcium chloride for hæmorrhage. Heart sounds and lung sounds normal. Died.

Post mortem.—Bullet had scored side of tongue at back, pierced right side of epiglottis, then went through œsophagus, down neck, entered apex of right lung ; track then lost ; bullet not found. Œsophagus black and gangrenous ; no wound of any large vessel.—(Hospital Records.)

Wound of pharynx (?)—Recovered.

Case 25.—Entry right side, 3 inches above clavicle (through right sterno-mastoid ; horizontal track) ; exit immediately behind posterior border of left sterno-mastoid, at slightly higher level Seemed that it must have injured pharynx, but no lesion obvious on examination ; some suppuration, and an abscess had been opened above right clavicle ; after admission some difficulty in swallowing ; could take fluids only ; slight contraction right sterno-mastoid, on account of which was sent home.—(Imperial Yeomanry Hospital Records.)

Reference may be made to Case 34 for another instance where dysphagia was the only symptom pointing to some lesion of the œsophagus, and to Case 21 for an instance of extensive damage to the œsophagus and trachea.

Wounds of Large Vessels of Neck.

Wounds of the vessels of the neck.

Although the majority of these must of necessity have been very rapidly fatal, a considerable number of cases of arterio-venous aneurysm in this region were found recorded. Mr. Makins, in his "Surgical Experiences," has entered fully into this subject, giving quite a large number of instances. Probably the most surprising feature in connection with this condition was occasionally the small amount of inconvenience caused by it.

It is not always necessary to operate in these cases, and the question of operation was not an easy one to decide, as the aneurysm sometimes subsided, records of the gradual decrease in the size of the tumour having been met with.

Cases of arterio-venous aneurysm.

Case 26.—Captain D. had been wounded in blockhouse some time previously by ricochet bullet off stone, which spattered him (*a*) in upper third of right arm, and (*b*) in right side of neck ; had profuse hæmorrhage ; used six first field dressings, and had a large swelling in the neck. On admission to 10 General Hospital 6th March, 1902, had suppurating wound in arm, and a small scabbed wound in neck, below the cricoid, ¼ inch in size, and of irregular shape ; considerable swelling with thrill over whole right side of neck ; loud bruit, heard up to the ear and down to the clavicle ; no discomfort beyond hearing the bruit when lying on that side, and some headache ; with fluorescent screen could see, and on palpation feel, a small piece of bullet in the neck. A piece of bullet and some clothing (khaki) removed from arm wound. 11th April, 1902, transferred to Base.—(Hospital Records.)

Carotid and internal jugular.

Case 27.—Major K., admitted 10 General Hospital with varicose aneurysm of left carotid and internal jugular ; expansile tumour below and

behind angle of left jaw, size of a pigeon's egg; thrill present; became slightly smaller, "but no sign of natural cure." Common carotid tied; pulsation disappeared; in a week wound healed, still slight pulsation and thrill, but tumour almost gone; subjective symptoms almost entirely disappeared.—(Hospital Records.)

Case of secondary hæmorrhage.

One case of secondary hæmorrhage from a large vein was recorded, and it is to be noted that in this case no definite statement was made as to the presence or otherwise of sepsis in the track of the bullet:—

Case 28.—Private L., wounded at Paardeberg 19th February, 1900. Entry left side of mouth (passed through pharynx); exit behind the posterior border of left sterno-mastoid. "The external jugular vein was bruised, and eventually sloughing of its wall took place"; consequent hæmorrhage severe; the vein was tied. Neck wound nearly healed; also injury to facial nerve with paralysis.—(Records 3 General Hospital.)

Temporary occlusion of axillary.
Ligature of common carotid.

Temporary occlusion of the axillary artery was recorded in Case 31. In one instance of septic wound of the face the common carotid was tied for secondary hæmorrhage of the internal maxillary; the patient eventually died from extension of sepsis (20 General Hospital.)

Wounds of Large Nerves of Neck.

These injuries will be considered as far as possible as lesions of individual nerves or plexuses.

Injuries of the vagus.

The great majority of cases of injury of the vagus were ones with symptoms indicating lesion of the recurrent laryngeal branch. In a few, however, acceleration of the pulse was taken as an indication of injury to the nerve trunk. In others, where the track lay well above the point of origin of the recurrent nerve, laryngeal symptoms were still the only indications of damage to the main trunk. The symptoms more commonly noted were hoarseness; complete aphonia; constant distressing laryngeal cough; and occasionally vomiting or stridor.

Case of injury to recurrent laryngeal.

Case 29.—Dr. T., wounded 13th December, 1901; admitted Imperial Yeomanry Field Hospital three days later. Entry circular, 1½ inches vertically above right sterno-clavicular articulation; exit 2 inches above spine of right scapula, in line with vertebral border. Sensation unimpaired; unable to fully flex elbow joint, or to raise arm from side; some hoarseness, pointing to partial damage to right recurrent laryngeal nerve; no dyspnœa; little swelling round neck; no evidence of damage to bones.—(Major E. C. Nicholl, R.A.M.C.)

Compare Case 20; also a considerable number of other cases quoted where symptoms pointed to injury of this nature.

Brachial Plexus.

Injuries to the brachial plexus.

A large number of cases of injury to this plexus were met with, of which a few are noted below. It would have been advantageous to give a complete history of some at least of these cases, but unfortunately there were no records of their later history available, as they passed into other hands, usually on transfer home. It was possible, however, in a few cases to distinguish the immediate effects of section or bruising of some of the constituents of the plexus from those more remote effects due to scar contraction. The observations were merely brief records of such conditions as anæsthesia, hyperæsthesia, pain, or more or less complete paralysis, affecting a greater or less extent of the distribution area of the plexus. This sometimes referred to one or more groups of muscles, or cutaneous areas, and in many instances it was recorded that such disturbance was only temporary; or one group recovered perfectly, whereas another remained affected, and while still in this condition they passed from observation.

Lesion doubtful without exploration.

Very rapid wasting of muscles, with absolutely no indication of commencing recovery, even during the short period under notice, would suggest primary section of the nerve; but, in other parts of the body, exactly similar results were found to follow severe contusion, or local transference of vibratory motion, and disappeared without operation.

Cases:—

(1) Case 30.—Private D., bullet entered left side of neck, high up, and lodged. Tingling pains in hand and forearm; some loss of power in forearm.—(Major Nicholl, R.A.M.C.)

2 Case 31.—Private C., wounded 18th February, 1900, Paardeberg; admitted 3 General Hospital 33 days later. Entry 1 inch external to angle of right scapula; exit 2½ inches below clavicle (*i.e.*, 1½ inches from centre of humerus as arm hangs by side). Bullet passed along floor of axilla; wounds healed on admission. "There is no pulse in brachial artery, which is felt as a cord all down the arm; radial and ulnar pulses absent; extra pulsation under clavicle; a bruit can be heard; much ecchymosis there, and over deltoid; paralysis of extensors of wrist (wrist drop), and, though other muscles were at first paralysed, he can now use all but these." On 6th April, 1900, pulsation was returning in brachial and radial arteries.—(Hospital Records.)

(3) Case 32.—Private C., wounded Paardeberg 18th February, 1900. Entry 2 inches external to sternal end of right clavicle, which was fractured; exit just below spine of scapula, traversing infra spinous fossa. Wounds healed on admission. Upper cord of brachial plexus reported to have been injured. A 5-inch incision had been made over clavicle, by operation, the nature of which was not notified. On admission to 3 General Hospital, paralysis of musculo-cutaneous distribution, viz., biceps, brachialis anticus, and coraco-brachialis. No flexion of elbow; diminished sensation over deltoid area, and numbness in hand; otherwise normal. 31st March invalided to Base.—(Civil Surgeon J. W. Smith.)

Mr. Smith, in his address at Manchester on 5th December, 1900, quoted the following case:—

(4) Case 33.—Private McK., wounded 24th February, 1900. Bullet passed obliquely through lower part of neck and upper part of thorax. Entry centre of left sterno-mastoid; exit right posterior axillary fold 1 inch external to angle of scapula. It is difficult to imagine how the great vessels escaped; "chief injury was to brachial plexus, and, when I saw him, though the muscles were weak and atrophied, some motor power had returned to all, except the group supplied by the muscle cutaneous."—(Captain Walton, R.A.M.C.)

(5) Case 34.—Gunner G., admitted 8 Stationary Hospital 7th April. Entry (1) 2 inches below tip of left acromion process; exit (1) 1 inch below and 2 inches from acromial end of left clavicle. Entry (2) 2 inches above acromial end of left clavicle; exit (2) 4 inches above right clavicle, in line of outer border of sterno-mastoid. Little power in left shoulder muscles or arm; pain on movement of shoulder or elbow; no atrophy of muscles; tingling pains in outer 3½ fingers. Skiagram shows no fracture; for two days after wound had some dysphagia; cannot find any signs of injury to vessels of neck.—(Captain Walton, R.A.M.C.)

Further instances of symptoms indicating injury to the brachial plexus will be seen in Cases 22, 23, 36 in this section, and Cases 11 and 17 in the section on the chest, and Case 6 in Imperial Yeomanry Hospital Report.

Cervical Sympathetic Nerve.

Several interesting cases of wounds of this nerve were met with. The three most prominent symptoms noted were (1) suppression of sweating; (2) myosis; and (3) pseudo-ptosis on the injured side.

"Ptosis" was mentioned as a symptom in three of the cases, though in one of them the condition was, in a later paragraph, defined as narrowing of the palpebral fissure, and this no doubt would be the more correct description of the condition; for this reason the symptom has been referred to as "pseudo-ptosis." The signs of section of the cervical sympathetic are so very seldom met with in the human subject that the four cases referred to are of quite unusual interest, and it is a matter for great regret that the "extraordinary train of symptoms" referred to in Case 37 were only mentioned as being of that character, but were not recorded in even the briefest detail. The erratic pyrexia in the assured absence of malaria or sepsis might possibly be attributable to sympathetic disturbance, though it was not noted in the remaining cases. Pseudo ptosis.

In addition to the above, marked cardiac rhythmic disturbance and sub-conjunctival hæmorrhage were ascribed to injury of this nerve. As in the case of other nerves, symptoms due to immediate section must, where possible be distinguished from those more remote due to pressure from scar tissue. It was suggested by Mr. Makins that death on the field in not a few instances may have been due to section of the sympathetic or of the vagus. As the question of damage to the cervical sympathetic is of much interest, it will be advantageous to note the following places, amongst others, where reference to this point may be made:—Fuch's, "Ophthalmology," second edition, page 333. Schafer, "Physiology II," pages 619, 657. Ch. Bastian, "Sympathetic, in Quain's Dict. Lang. Encyclopedia. Med. III," page 401. "Swanzy," fifth edition, page 505. "Norris and Oliver III," page 606.

The following cases are quoted:— Cases of suspected injury to the sympathetic.

Case 35.—Private B., admitted to 20 General Hospital from Convalescent camp for X-ray examination. 15th November, "fluorescent screen showed a bullet lying above left clavicle, ¼ inch below point of entry." Complained of pain in left shoulder and arm, and that when he took exercise he sweated only on the right side; left pupil smaller than right, re-acted only slowly to light; ptosis of left eyelid. Accurately localised, the bullet was found to be lying with its point ⅜ inch, its base ⅝ inch, from the surface, and point 1 inch, base ¾ inch, from the mid-line. On 25th November, at an operation for removal of the bullet, the internal jugular vein was accidentally injured, and ligatured, but the bullet was not found.—(Colonel Bruce, R.A.M.C.) (1)

Case 36.—Captain P., wounded 26th December, 1900; admitted Howick General Hospital. Entry right side, 3 inches below apex of mastoid process, at posterior border of sterno-mastoid; exit just behind posterior axillary line on right side at level of angle of scapula. Hæmyptosis; cough; no evidence of injury to large vessels; looks ill; pain in back of right arm and forearm; some temporary paralysis of right arm; has ptosis right eyelid; right pupil much smaller than left; complains of difficulty in reading; palpebral fissure narrower on right side; anæsthesia over area of distribution of musculo-spiral nerve; marked loss of power of extensors and prenators of forearm (*sic*); has other areas of hyperæsthesia in arm and forearm; dulled vocal resonance at right base; moist rales; slight dulness to percussion.—(Hospital Records.) (2)

Case 37.—Civil Conductor G., admitted 38 Stationary Hospital 31st July, 1901; had been wounded whilst walking on column. Entry "carotid sheath between artery, internal jugular vein and vagus; passed between longus colli and rectus capitis anticus major; hit sympathetic nerve in front of spinal column; entered left lung; exit left side at back below angle of scapula. Symptoms various, and due to irritation of middle cervical ganglion, through which latter being injured the extraordinary train of symptoms occurred": had some hypostatic pneumonia; temperature during first 11 days varied from 99·6° to 105°, then fell to normal.—(Hospital Records.) (3)

See also Case 21, where a pinpoint pupil was noted on the side injured; and 38, where ptosis was noted.

Phrenic Nerve.

Injuries to the phrenic in the neck.

In several cases of wounds of the neck temporary dyspnœa was noted, and it has been suggested that this may have been due to lesion of the phrenic nerve. In a case quoted in the Imperial Yeomanry Hospital Reports, the patient was admitted 60 hours after being wounded. The entry was immediately internal to the sterno-mastoid, at the level of the cricoid cartilage, and the exit in mid-line, behind, at level of fourth cervical spine. The only symptom was dyspnœa for a few hours.

Other Nerves in the Neck.

Other nerves.

Attention may be drawn to the nerve symptoms in Case 7, where the elevators of the scapula escaped, whilst the deltoid supra and infra spinatus did not. No cases of neuralgia due to injury to the nerves of the neck were recorded. Some cases of unilateral paralysis of the tongue, due to damage to the hypoglossal in the neck, were recorded.

Case 38.—Trooper H., wounded by Mauser, 27th May, 1901; admitted to 15 Stationary Hospital same day. Entry at back, ½ inch to right of fifth dorsal spine; exit through cheek, 1 inch below, and ½ inch external to malar process; both wounds same size and healed by first intention. Ptosis right side; right-sided paralysis of the tongue; difficulty in articulation; alteration in tone of voice, being small, sharp and lacking in resonance; discharged 6th August, 1901; still with some ptosis and right-sided paralysis of tongue. Three months later tongue had not improved; ptosis almost gone; voice stronger.—(Hospital Records).

Statistical Note.

In the Imperial Yeomanry Field Hospital, of 13 cases of gunshot wounds in neck, 6 were flesh wounds. The brachial plexus, the recurrent laryngeal, and the trachea were wounded each in two cases, and in 1 there was fracture of clavicle.

SECTION VII.

By Bt. Lieut.-Colonel S. Hickson, R.A.M.C.

GUNSHOT INJURIES OF LONG BONES AND JOINTS.

THE following short report on gunshot injuries of the long bones and joints observed during the late South African War has been prepared from notes of cases kept in the official case-books by officers of the R.A.M.C. and Civil Surgeons attached to the troops. Completed cases only have been included in this Report, that is, those which have been followed to their termination in recovery, death, or invaliding. Very many notes were taken for so short a period, or so briefly, as to be of no service. This was unavoidable owing to the necessary evacuation of wounded from the front, sudden moves of medical officers, and other conditions inseparable from active service. Had the incomplete cases been included, the numbers dealt with would have been more than doubled. Naturally, the greater number of notes have been supplied by surgeons attached to the General or Stationary Hospitals, as the nature of the duties in the field, and the necessity of moving wounded, rendered continuous observation and the noting of cases practically impossible for those employed in field units. The great majority of rifle wounds were caused by the Mauser or Lee-Metford service pattern bullets, but other small-arm projectiles were also employed by the Boers, such as the different varieties of expanding Mauser or Lee-Metford bullets, Martini-Henry, Snider, Guedes, &c. A considerable number of shell wounds have also been reported, including the Vickers-Maxim and some shrapnel and revolver wounds, the latter being mostly accidental cases. Taking the regulation Mauser as the standard, the varieties of wounds ranged within very wide limits, from extreme shattering and pulverization to simple perforation without solution of continuity; and, broadly speaking, this noticeable diversity depends on two factors—(*a*) the part of the bone involved and the resistance it offered, and (*b*) the velocity of the bullet. In the shafts of long bones the density of the compact tissue offers a resistance to the passage of the bullet which is absent in the softer cancellous structure of the epiphyses; hence, in the former, the type of fracture is generally comminuted to a greater or lesser degree, while in the latter simple perforation or grooving is more usual. The degree of destruction caused in the shaft of a long bone depends mainly on the velocity of the projectile at the moment of impact; or, in other words, the range of fire, the closer the range the greater being the injury. In cancellous bone, on the other hand, perforation occurred at all ranges, mere perforations at short ranges being exceptional and unexpected. No doubt other factors assist in determining the different varieties of fractures met with, such as the direction of the bullet with regard to the sectional area of the bone at the point of impact; for instance, a bullet striking a bone so as to pass through the middle of the medullary cavity will inflict injuries which the same bullet at the same velocity will certainly not cause should it strike the bone at a tangent. The angle of impact, whether perpendicular or oblique to the long axis of the bone, must also be taken into account, the former tending to cause a somewhat tranverse form of fracture with great local comminution into minute fragments; the latter to oblique fractures with the formation of long fragments and fissures. It is probable also that the density of the long bones varies in different individuals, and this certainly contributes to variations of type in fractures of the shaft at similar ranges.

Nature of report.

Deals mostly with Mauser wounds.

Comminuted shaft, and perforated epiphyses.

Influence of range.

Direction of bullet.

Angle of impact.

Fractures of the Shafts of Long Bones.

Comminuted fractures.

Comminuted Fractures.—This is by far the commonest form of fracture of the diaphysis, and we meet with, I think, three types varying in intensity with the range of fire :—

Short-range type.

I. *The short-range type*, caused at a range, say, up to 200 yards, by the impact of a hard-cased bullet travelling at a high velocity, and crossing the centre or near the centre of the medullary cavity. This is the most severe form, and presents somewhat the following appearances. The aperture of entry in the skin is small, circular, and equal in diameter to the bullet; exit,

Character of wound.

larger, generally irregular in outline, sometimes with ragged edges; it may be very large, two or three inches or more in diameter, and from this area the skin is absent, or exists only as a thin bridge. A high degree of communition of the bone is present; the number of fragments may often be reckoned by the dozen; generally they are small in size, and in the actual track of the bullet the bone is often reduced to mere powder, and presents a complete gap of perhaps two or more inches. In addition to local shattering, the bone is generally the subject of extensive fissures, radiating from the point of impact, sometimes causing complete separation of long fragments from the shaft.

So great is the force of impact that the fragments, receiving a certain amount of energy from the bullet, are forced into the surrounding tissues, or even completely out on the exit side, or they may be thrust through the skin and so make secondary apertures of exit. A large, somewhat conical cavity is formed in the limb (the apex being at the point of entry) containing blood, fragments and *débris* of bone, and torn shreds of the soft tissues. In bones not well covered with muscle, such as those of the lower half of the forearm or

Explosive type.

the tibia, this type of wound is generally known as the "explosive," and is characterised by a very large, irregular aperture of exit, from which protrudes jagged ends of muscles or tendons. It may also be seen in the arm, where masses of the biceps or triceps may form large protrusions; but in a deeply covered bone, such as the femur, although the destruction to the bone itself may be just as great, the strong muscles surrounding it prevent any great increase in size of the wound, or protrusion of muscles and other tissues. Sepsis

Generally suppurate.

is the rule in this type in consequence of the size of the wound and its lacerated condition.

The following examples of *short-range wounds* are taken from reports on cases by various officers R.A.M.C., and civil surgeons :—

Examples :—

Femur.

Case 1.—L. C. A. R., aged 22, wounded near Springfontein 24th September, 1901. Projectile, Lee-Metford; range, 50 yards. Taken to Boer Farm for 24 hours, then removed in ambulance to 12 General Hospital. Left thigh; small circular entrance wound 3½ inches below and in line with

Bone deeply placed, comparatively small exit wound.

trochanter major; femur fractured at junction of upper and middle third. Exit wound size of halfpenny piece; on inner aspect of left thigh, ragged, everted, exuding dirty, sanious fluid. Bullet then entered right thigh at upper and inner part; entry size of shilling piece, and was retained in thigh. X-rays showed almost transverse fracture of left femur at upper third, with two large splinters. No fracture in right thigh, but bullet broken up. Septic. Both thighs explored, some loose bony fragments removed from left, and bullet from right thigh. Drainage tubes in left; frequent irrigation. Splint with weight extension to limb. Subsequent removal of sequestra. Pieces of clothing came away from right thigh. Result—union with about ½ inch shortening. Invalided to England.—(Major Lougheed, R.A.M.C.)

Bone superficial, large exit wound. Radius.

Case 2.—Private W., aged 27, wounded accidentally by comrade on 18th May, 1902. Range, 1 yard. Wound of entry small and round, at posterior aspect forearm, over radius, 3 inches from elbow. Exit on anterior surface forearm 6 inches by 2½ inches in diameter, and from this area skin completely absent. Radius greatly comminuted near insertion of pronetor radii teres; fragments of bone lying in track; protrusion of muscles and tendons; profuse primary hæmorrhage; field dressing, with tourniquet to brachial. Admitted same day to 40 Stationary Hospital. Wound packed. Cyanide dressings; splints. Complete paralysis of median and radial nerves,

the widely separated ends of which were seen in the wound. Removal of loose fragments of bone. Subsequent union of bone, and granulation of wound. Transferred, as hospital closed. No return of nerve power.—(Lieutenant BABINGTON, R.A.M.C.)

CASE 3.—Private D., aged 27, wounded at Zerspruit 25th February, 1902. Mauser, at short range. Entry small, at lower angle of scapula; bullet passed through axilla, and emerged outer aspect arm about deltoid insertion. Exit wound size of half-crown piece. Treated 20 General Hospital. Exploration 28th February, 1902; no fragments removed; arm put up, away from side; sepsis. 24th March, 1902, arm refixed and counter openings made. 3rd May, 1902, union by bridging callus. Several sequestra subsequently came away. Wrist drop from implication of musculo spiral. 13th June, 1902, invalided. Still small sinus and wrist drop.—(Civil Surgeon GAIRDNER.) Humerus.

II. *The medium-range type.*—This differs in degree from the first type, being less severe. It is produced at a longer range, say from 300 to 800 yards, and the conditions are modified by the lower velocity of the bullet. When caused by an undeformed bullet, the "explosive effects" on the soft parts are often absent; the exit is still considerably larger than the entrance wound, but the soft parts are not lacerated to the same extent. The bone is highly comminuted, but not forced out of the tissues as in the former variety; neither is it broken up into so many or such small fragments. This is the range, I believe, which commonly causes the "butterfly" type of fracture, *i.e.*, a pure stellate form, with the four fissures forming the star running a short course to the circumference of the bone. Medium range type. Character of wound.

The following two cases are taken from notes supplied by Civil Surgeon Irvine:— Examples:—

CASE 4.—Captain M. S., wounded at Pieter's Hill 27th February, 1900. Probably Mauser. Estimated range about 300 yards; admitted Base Hospital, Pietermaritzburg, two days later. Entrance wound; normal Mauser in right fold of buttock, 1 inch below ischial tuberosity. Exit large, 1 inch by ½ inch, in front of thigh, in middle line. Severe fracture of femur. Enormous swelling of thigh. Antiseptic dressings; Liston's long splint, with internal and posterior splints; weight extension. Aseptic union in six weeks, but some tilting of upper fragment. On ninth week, plaster case to thigh, with waistband. Invalided to England in May.—(Hospital Records.) Femur.

CASE 5.—Entry small and circular; exit larger, size of two shilling piece. Humerus comminuted, with fissuring upwards and downwards. Suppuration with subsequent non-union, for which condition ends of bone were refreshed and brought together with silver wire. Musculo-spiral nerve, which had been completely divided by bullet, was sutured. Result—Union and invaliding.—(Hospital Records.) Fracture of humerus of similar type to above.

CASE 6.—Private O., admitted 13 General Hospital 18th April, 1902. Entry behind; exit larger, in front. Bone greatly comminuted, but not completely divided. A small piece remaining intact on outer side. Septic. Removal of loose fragments; drainage tubes. Several pockets of pus subsequently incised, and some necrosed bone removed. Progress favourable on 30th August, 1902, when transferred to 20 General Hospital.—(Civil Surgeon MANSEL.) Tibia.

III. *The long-range type* may be considered to occur from any range of over 900 yards. In this variety we find the severity of all the signs steadily diminishing as the range increases. The entrance and exit wounds tend to approximate in size and, at the longer ranges, are about equal in diameter. The soft parts are not injured to any marked extent, and, although the bone is comminuted, there is less tendency to complete separation of fragments, and these are few in number, although they may be large in size. The "buttress" or "wedge" fractures are common at this range, and the bullet often lodges either in the bone or soft tissues. Suppuration should not often occur in this Long-range type. Character of wound.

Sepsis not so common.

type, but the first dressing will determine the course of the wound in this respect.

Examples :—

Ulna.

Case 7.—Pieter du P., a Boer prisoner, wounded near Winburg. Range unknown. Projectile, Lee-Metford. "Treated" in a laager for one week. Dressed with dirty wet rag moistened from neighbouring "spruit." Taken to 34 Stationary Hospital. Entrance wound small at middle of flexor surface of forearm, near inner border; ulna fractured. No exit; bullet retained in extensor muscles. The whole limb gangrenous from finger tips to elbow. Amputation of arm below deltoid insertion. No sutures. Suppuration of stump, followed by pleurisy and suppurative phlebitis in leg. Recovered.—(Captain Goddard, R.A.M.C.)

Humerus.

Case 8.—Corporal M., wounded 16th February, 1900. Projectile, Mauser. Estimated range 1,000 yards. Entry small, over middle of shaft humerus, outer side of arm; exit slit-like, about 1 inch long at corresponding position on inner side; admitted 1 General Hospital 28th February, 1900. Comminution of shaft. Remained aseptic throughout. Rectangular splints, internal and external. Good union. Discharged hospital 18th March, 1900.—(Civil Surgeon W. Squire.)

Humerus.

Case 9.—Private B., slightly comminuted fracture of humerus, lower third. Projectile, Mauser; estimated range 1,000 yards; exit ½ inch diameter. Aseptic throughout. Treated by plaster of Paris case; admitted hospital 5th March, 1900. Transferred to Base 26th March, 1900. Result—Firm union in good position.—(Civil Surgeon John H. Pegg.)

Perforations. Rare in shafts.

Perforating Fractures.—In the cancellous tissue of the epiphyses, perforation is the rule, but it is comparatively rare in the shafts of long bones on account of their density and resistance. It, however, does occur, mostly at medium or long ranges, and may perhaps be explained by the structural peculiarity of the individual bone, in addition to the low velocity of the bullet and its rotatory motion. The apertures of entrance and exit are generally similar in size, and as a rule these injuries heal readily, the perforation being often only suspected from the direction of the bullet track. Skiagrams do not always give a clear representation of the injury. These fractures of the diaphyses are seldom pure perforations, *i.e.*, cleanly drilled holes, as a small piece of compact tissue is often detached from the aperture of exit, or small radiating fissures extend from the track to the circumference, causing some comminution, with or without displacement.

Character of wound.

Examples :—

Partial perforation of middle of femur, with slight splintering; bullet embedded in bone.

Case 10.—Private D., aged 27, wounded 19th March, 1900, at Paardeberg. Projectile, Mauser; range unknown. Sensation of receiving "sledge-hammer" blow; admitted 6 General Hospital 4th April, 1900. Entry healed, ·3 inches in diameter, on antero-external aspect right thigh, about middle. No exit; no symptoms. Discharged hospital same day; no skiagraph taken. Re-admitted 20th April, 1900; pain in thigh; hard body felt at middle of posterior aspect; X-rays showed bullet projecting from posterior surface of femur, with flat piece of bone, detached from shaft, lying behind tip of bullet; bullet deformed to right angle, removed along with splinter of femur. Patient recovered quickly. Transferred to Base 6th May, 1900.—(Civil Surgeon Newington.)

Perforation of shaft tibia, with slight splintering.

Case 11.—Private B., wounded 7th June, 1900, at Rhenoster Spruit; admitted 3 General Hospital 15th June, 1900. Entry 8¼ inches below right patella, ⅜ inch outside tibial ridge. On admission both wounds healed; no clinical sign of fracture; pain over entry; X-rays showed perforation of tibia, with incomplete splintered fracture; no splints required; good recovery.—(Civil Surgeon A. Young.)

Impure perforation of tibia.

Case 12.—Trumpeter M., aged 25, wounded near Standerton, 8th February, 1900; range unknown; admitted 16 General Hospital 19th February, 1900. Entry at outer aspect, upper third of calf. Exit through

inner half tibia, middle leg, 2 inches diameter. Entry healed. Exit very septic. Secondary hæmorrhage posterior tibial. Popliteal artery tied. No splints, as tibia not completely fractured. Later, removal of some necrosed bone. Result good. Invalided to England.—(Notes not signed.)

Shaft of ulna.

Case 13.—Private P. wounded Golden Gate, 28th July; projectile, Mauser; range unknown. Entry 4 inches below external condyle right humerus, on posterior aspect forearm. Exit 4 inches below internal condyle, on inner side forearm. Both wounds small. X-rays showed perforation of ulna at site of wounds; much callus around perforation; some splinters. Not a complete fracture; no splints used. Healed aseptically "in quite a short time"; movements good.—(Civil Surgeon Kirkman.)

Gutters: Nature and causation.

Gutter, Grooved or Notched Fractures.—These only require a brief notice in this report. They are of the nature of incomplete perforations, *i.e.*, a tunnel wanting the roof, and are rare in the diaphyses, though not uncommon in the epiphyses in connection with wounds of the joints. Some notched fractures are considered by Mr. Makins to be slight degrees of wedge fractures. Gutters are generally produced by glancing blows near the periphery of the shafts, and are not unlike similar fractures of the cranial vault.

Examples:—

Examples :-

Shaft of tibia.

Case 14.—Sergeant S., aged 33, wounded while stepping from train at Ganna Bridge during Scheeper's attack on train; range 30 yards—21st July, 1901; admitted same day Hospital Beaufort West. Entry inner side tibia, below tuberosity. Track passed upwards and outwards for about 3 inches, ploughing furrow through bone; wounds separated by narrow bridge of skin. Suppurated. Track laid open. Small splinter removed. Healed, but took considerable time.—(Captain Evans, R.A.M.C.)

Shaft of tibia.

Case 15.—Private G. Range 400 yards. Entry small. Exit a little larger. Bullet passed through interosseous space, grooving tibia. Remained aseptic. Gauze dressings. No splint. Admitted to hospital 1st December, 1900. Discharged 31st December, 1900.—(Civil Surgeon Wright.)

Treatment of Fractures of the Shafts in General.

Sepsis the cause of death and of amputation.

The most important measure in the treatment of all gunshot injuries of bones, whatever their nature and position, is the prevention of septic changes in the wounds. It is the occurrence of suppuration that threatens the life of the patient and necessitates amputation in the vast majority of cases requiring that operation. Everything else sinks into insignificance beside it, and a fracture presenting the highest degree of comminution is, if aseptic, of less moment than a trivial one in which suppuration has occurred. Not only does suppuration cause delay in union and lead to necrosis, but it is only too often the precursor of acute infection and general septicæmia, and, occasionally, of septic osteomyelitis. Unfortunately, owing to the conditions attendant on service in the field, suppuration occurs in a considerable number of comminuted fractures; the wounded often lie for hours without skilled assistance, exposed to all the dangers of infection; the first field dressing is often inadequate, or applied with dirty hands. Long journeys, rendering efficient dressing impossible, have often to be undertaken before a hospital is reached, and the nature of the wound, even if properly attended to at the moment of its infliction, lends itself to the unfavourable issue. Fractures of the close-range type, from the extensive comminution, laceration of the soft parts, large exit wounds, and accompanying hæmorrhage, are peculiarly liable to suppuration, and it is, I think, the experience of all surgeons who have served in South Africa that aseptic fractures of this severe type are exceptional. All agree that the most rigid antiseptic precautions should be taken on dressing wounds for the first time, and, when means are at hand, thorough sterilisation of a large area around the wound with soap, razor, nail brush, ether or turpentine, and a free use of some reliable antiseptic lotion, is imperative.

Causes of suppuration.

Exploration and removal of loose fragments.

On the subject of the advisability of exploring comminuted fractures and removing loose fragments of bone, differences of opinion seem to exist. Some surgeons in their reports are strongly opposed to this practice, and others as firmly convinced of its necessity. The truth seems to lie between the two extremes; and the nature and condition of the fracture, as well as the possibility or otherwise of aseptic work, should, I think, decide our action. If the fracture be septic and highly comminuted, the exit wound should be explored (being increased by incision if necessary) and all loose fragments removed. It is useless and dangerous to leave them *in situ;* they are detached from the bone, probably denuded of periosteum, and will later necrose and lead to prolonged suppuration, and require removal by operation at a subsequent date. Should the fracture be aseptic and badly comminuted, with fragments of bone separated from their attachments and lying loose in the surrounding tissues, they should also, I think, be removed, after careful sterilisation of the neighbourhood of the wound, surgeon's hands, instruments, dressings, &c. If the fracture be aseptic, the comminution not very severe, and the fragments not much displaced, nothing is to be gained by interference, and harm may result. It is sufficient, in the latter case, to sterilise the wound and its neighbourhood, apply antiseptic dressings, and place the limb on suitable splints. The following case illustrates the injury a sharp fragment of bone is capable of producing :—

Severe injury caused by fragment.

Case 16.—Driver S., wounded at 50 yards range (Mauser); admitted 3 General Hospital 30th October, 1900. Entrance wound small, at middle posterior surface thigh. Exit same level on inner surface, 1½ inches by 1¼ inches diameter; wound dressed. Plaster of paris case (Croft's with zinc strengthening) applied to limb. Loss of circulation and sensation in limb; amputation, middle third thigh. Femoral artery found divided by splinter of bone; stump suppurated. Some necrosed femur subsequently removed. Granulation and recovery. Sent to Base 19th January, 1901.—(Notes not signed.)

The following four cases of severe comminution of the femur are quoted as offering contrasts between septic and aseptic wounds of the same bone :—

Examples of septic and aseptic comminutions of femur.

Aseptic.

Case 17.—Prisoner of war, W. C., wounded near Ladysmith 23rd April, 1902. Entry and exit large; femur shattered as high as its middle, and into knee joint; femoral artery wounded. Admitted 19 Stationary Hospital 30th April, 1902. Thigh and leg intensely swollen, and throbbing pain unbearable; limb sterilised; femoral artery ligated in Scarpa's triangle. Wounds healed aseptically; bone united. Only complications were small slough on outer side leg, and persistent pain in ankle on walking. Invalided.—(Lieut.-Colonel S. Westcott, R.A.M.C.)

Aseptic.

Case 18.—Captain N., wounded Magersfontein 10th December, 1899; admitted 1 General Hospital, Cape Town, 14th December, 1899. Comminution middle third femur. Bullet retained; splints, with weight extension; removal of bullet from opposite side of thigh; large amount of callus; firm union; no shortening detected.—(Civil Surgeon Watson.)

Septic.

Case 19.—Private C. H., wounded Alleman's Nek. Entry, middle anterior surface thigh. Exit behind, at level of gluteal fold. Admitted 4 General Hospital 27th June, 1900. Entry healed; exit septic; exploratory incision through exit; comminution and overlapping of ends of femur; extension on inclined plane; no union. On 17th July, 1900, amputation at seat of fracture; secondary hæmorrhage; wound reopened, and vessels secured; healed.—(Captain Martin, S.A.C., and Major Freyer, R.A.M.C.)

Septic.

Case 20.—Private H., wounded 13th December, 1900; admitted to 2 General Hospital. Bullet had traversed thigh from before backwards, shattering the femur just below trochanters; great swelling; very septic; foul pus and gas escaping from wounds; exit very large. High fever; wounds opened up; pus evacuated; fragments removed; drainage tubes. Liston's long splint, with weight extension; no union; remained septic.

Ends of bone overlapping; some inches shortening. Ends of bone visible through large posterior opening. Amputation of seat of fracture; did well. Invalided.—(Lieut.-Colonel SYLVESTER, R.A.M.C.)

Process of union.

The course of healing is generally prolonged in comminuted fractures, and union is attended by the formation of large masses of callus. Perforations, and the various incomplete fractures without complete solution of continuity of the bone, heal readily if aseptic. Necrosis of fragments is the chief cause of retardation of union, and is the rule in septic fractures, but may also occur in aseptic cases, as in the following example :—

Necrosis in an aseptic case.

CASE 21.—Trooper R., accidentally shot in arm. Projectile, Lee-Metford; range "close"; entry immediately below axilla; exit very large, involving a great part of arm; humerus "shattered to fragments." Admitted 19 Stationary Hospital. Limb sterilised at once; remained aseptic throughout; bone healed well. On passive motion scar broke down and some necrosed fragments removed, although no suppuration had occurred—(Lieut.-Colonel S. WESTCOTT, R.A.M.C.)

Chronic necrosis.

The following cases illustrate the chronic nature of the necrosis following comminution, and the length of time which may elapse before operative measures can be dispensed with :—

CASE 22.—A Boer prisoner. Faulty union of femur. Fracture below great trochanter. Upper fragment flexed, and rotated outwards; union in that position; shortening 4½ inches. Treated by Boer "surgeon," who made patient sit on bed while limb was dressed. Wounded January, 1901; admitted 2 General Hospital July, 1901. Osteotomy; limb put up straight. Chronic osteitis persisted. Some pus and necrosed fragments removed 28th August. On 8th September a cavity evacuated behind fracture, containing pus and several large fragments of necrosed bone "evidently remaining from original injury." Result, union in good position.—(Lieut.-Colonel SYLVESTER, R.A.M.C.)

Fractured femur, above the middle.

CASE 23.—Wounded Brandfort 8th August, 1901. Splints and usual dressings; no removal of fragments. January, 1902, wound not healed; sequestrotomy; four subsequent sequestrotomies. Sinus still remained in October, 1902, 14 months after original injury.—(Captain FAICHNIE, R.A.M.C.)

In this connection a case of my own is of interest. The patient suffered from a comminuted fracture of right humerus at lower third not involving the elbow-joint, from which I removed a number of loose fragments in Kimberley in March, 1902. Union was strong, and he was invalided with fair movement in elbow. A few days ago he was admitted to the Royal Herbert Hospital, to the wards under my charge, for operation for the removal of necrosis at the site of fracture, nearly two years after the infliction of the injury.

Secondary hæmorrhage in fracture cases.

Secondary Hæmorrhage.—In dealing with septic comminuted fractures, secondary hæmorrhage will naturally sometimes occur. Many such cases have been noted during the war, some treated by ligation at the seat of injury or of the main artery of the limb, and others by amputation. From the number of cases treated successfully by the former methods it is reasonable to conclude that they ought to be given a trial in suitable cases before the drastic measure of amputation is adopted. Cases Nos. 17 and 70 are to the point, as are also the following :—

Treatment.

Examples :—
Right humerus—Explosive type.

CASE 24.—A trooper of Mosley's Scouts, wounded near Pretoria 15th October, 1901. Projectile unknown; range, 60 yards. Wound of entry over insertion left deltoid; exit middle of triceps, size of five-shilling piece. Admitted 2 General Hospital day after injury. Severe comminution of humerus; free suppuration; removal of fragments and packing with iodoform gauze; internal angular and small side splints. On third day severe hæmorrhage from exit wound (superior profunda artery); ligation of third stage axillary artery; irrigation with carbolic lotion. Recovery, with about 1½ inches shortening. Seen nine months afterwards; could ride, drive, and play

billiards; extension of forearm not complete, owing to damage of triceps.—(Civil Surgeon Evans.) (*See* No. 17, "Gunshot Wounds of Blood Vessels.")

Right tibia.

Case 25.—Lieutenant D., aged 20, wounded at Klip River Drift 7th March, 1902; Martini-Henry, range unknown; admitted 11 General Hospital 11th March, 1902. Entry 4 inches above internal malleolus; exit opposite side, large. Comminution of tibia; fibula intact; anterior tibial artery divided; wound very septic; foul smell; still bleeding from artery. Ligation in continuity 2 inches above wound; carbolic irrigation; McIntyre's splint; boric fomentations; removal of fragments; irrigation with sublimate solution, 1 in 2,000, for three weeks; sloughing of tendons, union of bone. Skin grafting 30th July; invalided; subsequent long stay in Lady Dudley's Home. Complete recovery; not lame; can run.—(Colonel Hickson, R.A.M.C., and Surgeon-Captain J. K. Tomory, R.A.M.C. (V.).)

Tibia.

Case 25.—Trumpeter M., wounded Standerton 8th February, 1902. Entry outer aspect upper third leg; exit 2 inches diameter, at middle leg, track through inner half tibia. Admitted 10 General Hospital 19th February, 1902. Entry closed; exit very septic; bone not completely divided; secondary hæmorrhage from posterior tibial artery. Popliteal artery ligated; removal of necrosed fragments. Result good. Invalided to England. (Notes not signed.)

In the following case ligature of the main artery was successful in controlling the hæmorrhage, but it was followed by amputation, apparently on account of septicæmia:—

Femur—Secondary hæmorrhage—Ligature of superficial femoral—Amputation.

Case 26.—Private S. F., wounded Spion Kop 24th January, 1900; shrapnel, range unknown. Entry outer side upper third left thigh; bullet retained. Admitted 4 General Hospital 11th February, 1900; septic. Incision 3 inches long, inner side middle thigh; removal of bullet and three pieces of bone; drainage tubes; double inclined plane; suppuration continued. On 16th February, 1900, secondary hæmorrhage; ligation of superficial femoral artery by Sir W. Stokes. Extensive suppuration and fever; amputation by Sir W. Stokes, below small trochanter. Died a fortnight later of exhaustion.—(Civil Surgeon H. Porteous.)

Secondary hæmorrhage, treated by amputation of thigh.

Case 27.—No. 3165, Private P., aged 32, wounded near Vryburg 11th November, 1900; transferred to 11 General Hospital 11th December, 1900. Had some fragments of bone removed at Vryburg. Projectile unknown; range 200 yards. Entry and exit wounds on either side of left thigh at lower third: exit about 2 inches diameter. Femur highly comminuted; very septic; splints and drainage. Secondary hæmorrhage; packing. Further hæmorrhage; amputation at middle thigh. Shock; intravenous saline infusion. Died. Lower end of femur extensively shattered.—(Civil Surgeon H. Hunter.)

Amputations.

Primary amputation; indications for it.

I. *Primary.*—Cases requiring primary amputation were not common. The chief indications for this proceeding were extensive wounds of the soft parts, shell wounds being responsible for the majority. As to the results of primary amputations, it may be said that the flaps nearly always suppurated when the operations were performed in the field, and this is not to be wondered at when the conditions under which they had to be done and the necessity for immediate transport are considered. Long journeys, begun perhaps immediately after the operation, exposure to clouds of dust or drenching rain, crowded transport wagons, soiled clothing, and insufficient means of efficiently dressing the stump, are amongst the evils which have to be faced by the subject of a primary amputation undertaken in the field. Primary amputations cannot always be avoided, but the results in the late war have certainly been unfavourable, and whenever a wounded man can be moved without endangering his life, operative measures of this description

Unfavourable conditions.

Primary amputations to be avoided if possible.

should be deferred until a stationary hospital is reached. The following examples will emphasise the ill-effects following primary amputations :— Examples :—

Case 28.—Lance-Corporal L., wounded 18th February, 1900, at Paardeberg. Primary amputation through knee-joint. Admitted 2 General Hospital 8th March, 1900. Flaps highly septic; removal of drainage tubes; fomentations. On 10th March, 1900, profuse secondary hæmorrhage. Tourniquet, and ligation of superficial femoral artery at apex of Scarpa's triangle; bleeding ceased; saline intravenous injections; strychnine, &c. Died two hours afterwards.—(Major Lougheed, R.A.M.C.) Amputation.

Case 30.—Private P., wounded 27th May, 1900. Projectile probably soft-nosed Mauser; range 400 yards. Two wounds, one of which shattered forearm, the other shattered arm above elbow. Primary amputation in field, 5 inches below shoulder joint. On reaching 12 General Hospital the stump was healed except at one corner. On 23rd June, 1900, stump very tender, suppuration over pectoralis major, pus evacuated; more abscesses formed; humerus found bare; fomentations. On 5th July, 1900, amputation through shoulder joint. Recovery; invalided 10th September, 1901.—(Major Lougheed, R.A.M.C.) Amputation and re-amputation.

Case 31.—Private H., wounded in foot by shell at Spion Kop 24th January; admitted 4 General Hospital 2nd February. Syme's amputation had been performed in a field hospital at Spion Kop; sloughing of flaps; re-amputation lower third leg by lateral flaps; healed per primam; invalided 13th March.—(Major Freyer, R.A.M.C.) Primary amputation through ankle; re-amputation.

Case 32.—Captain D., wounded at Vaal Krantz 27th January, 1900. Shell pitched on foot; primary amputation, Symes. Admitted 4 General Hospital 11th February, 1900. Stump very septic; sloughing flaps; leg infiltrated. Same day re-amputation at middle leg, lateral flaps; healed by first intention; invalided.—(Major Hackett, R.A.M.C.) Primary amputation through ankle joint; re-amputation.

II. *Secondary amputations* were comparatively common, and, as a rule, were required for septic conditions, septicæmia accounting for the majority of both amputations and deaths. Amongst other causes leading to secondary amputations may be mentioned secondary hæmorrhage, extreme destruction of bone, and useless limbs consequent on extensive nerve injury. Secondary amputations.

Some examples of secondary amputations will be given when dealing with injuries of particular bones.

Operative fixation by means of screws or wire was seldom required. The most suitable cases would seem to be aseptic oblique fractures in which the ordinary means of fixation by splints had failed to keep the bones in good position. Fixation by wiring was undertaken in a few septic comminuted cases in which union had not taken place, but the results, as a rule, were not very encouraging. Better results would perhaps be obtained if the operation were postponed until suppuration had entirely ceased, and all sequestra had been removed, when, other measures having failed, the ends might be fixed as in a simple ununited fracture. Examples of fixation operations :— Operative fixation. Examples :—

Case 33.—Boer prisoner, P. N., aged 39, wounded Belmont 23rd November, 1899. Oblique fracture lower end of right femur; bullet retained. Admitted Orange River Hospital 25th November, 1899. Wounds healed except for small sinus at entry. 1st December, 1899, extraction of bullet near tubercle of tibia; oblique fracture of femur, just above condyles; lower fragment projected on outer side knee; could not be reduced. On 8th December, 1899, long incision outer side thigh; mass of vastus externus removed from between fragments; fragments screwed together by two steel screws. Result—uneventful recovery, except for small abscess at upper end of incision.—(Civil Surgeon C. S. Richardson.) Screwing.

Case 34.—Gunner T., wounded 16th February, 1900, at Klipdrift; projectile, shell. Entry inner side left forearm; both bones fractured, radius more severely; shell fragment lodged and was removed at Jacobsdal. Admitted 6 General Hospital 5th March, 1900. Large wound inner side Ivory pegs.

forearm; much loss of skin; very septic and foul; much splintering of bone; improved under carbolic arm-bath. On 12th March, 1900, fragments of radius removed, ends of bone 2 inches apart; incision over fracture in ulna, 2 inches removed; ends of both bones trimmed and kept together by ivory pegs; interrupted rectangular splint and shaped hoop iron; profuse discharge; daily dressings; stitches removed; carbolic bath. 21st April, 1900, small sequestrum removed. Result—last note states "patient progressing very favourably."—(Civil Surgeon BRINKER.)

Wiring femur.

CASE 35.—"Glass," a native, wounded Colesberg, 15th April, 1902; projectile Lee-Metford; range 40 yards. Entry small at back of right thigh; exit in front, 1 inch diameter; femur shattered in upper third; considerable primary hæmorrhage. Admitted 10 General Hospital, 15th May, 1902. Removal of fragments; counter openings; irrigation; outside splint; weight extension; some oozing, no pus. On 15th June, 1902, no union; X-rays showed upper fragments displaced upwards and outwards. Attempt to wire failed, as chloroform taken very badly, but ends of bone squared and wounds closed. On 17th June, 1902, completion of wiring. Some suppuration and œdema of thigh; irrigation; daily dressing. On 3rd July, 1902, limb put up flexed, as upper fragment still tends to tilt. On 20th July, 1902, callus forming. On 22nd July, 1902, X-rays showed wire undone and bones much apart; plaster of Paris case; callus complete; much shortening. August 31st, union not quite firm; gets about on crutches. 138 days in Hospital.—(Captain FAICHNIE, R.A.M.C.).

Wiring ununited fracture humerus.

CASE 36.—C. du P., a Boer prisoner, aged 22, ununited fracture left humerus, over three months old; admitted 10 General Hospital, 10th September, 1901. Three sinuses in arm, four wire splints applied. Sinuses closed, but re-opened on 3rd October, 1901, and abscess incised. On 14th October, 1901, large interval existed between ends of bone. Dead bone removed, ends of bone squared and put up as before. On 27th October, 1901, some sepsis, wound opened and drained. On 19th November, 1901, wounds healed. No union; bone exposed, ends sawn off. Fibrous tissue removed, ends of bone wired; splints. On 25th November, 1901, septic, ½ inch separation in bone; drainage tubes; angular splint, daily dressing and irrigation. On 18th December, 1901, bony union, but sinuses still remained on January 8, 1902, when he was transferred to Bloemfontein.—(Captain FAICHNIE, R.A.M.C.). (*See* also Cases 82 and 84).

Bones of the Lower Extremity.

The femur.

The Femur.—More cases of injuries of the femer have been noted than of any other long bone. It is one of the most frequently wounded, but, apart from this, the gravity of gunshot fractures of this bone induced more careful observation and record of cases. In all, 170 cases have been collected of undoubted fracture; but a number of others, so hurriedly written that it was not clear whether the bone had been injured or not, have been omitted from this report. Fractures of every description and from all sorts of projectiles have been reported, most of them severe in type. The above number does not include injuries to the epiphyses, which have been classified as wounds of the neighbouring joints, but refers only to the diaphyses.

Comparatively high mortality.

Fractures of the femur cause the highest mortality of all the injuries to the limbs, and the transportation of cases from the front to a Stationary or Base Hospital is one of the most difficult problems of military surgery. It is extremely difficult to keep the wound aseptic, and the fracture properly fixed; the patient is put to great suffering, satisfactory dressings are almost impossible, and primary amputations, if recovered from, are nearly certain to suppurate. In the Stationary and General Hospitals, the results of treatment were, generally speaking, very good. The most favoured method of immobilization was Liston's long splint, often bracketed to facilitate dressing, and fitted with weight extension. This method seems to have answered very well in all fractures, except those near the upper and lower extremities of the bone, and for these varieties, Hodgen's splint has been very highly spoken of. It is easily applied and comfortable; extension and counter-extension can be

applied with it; it greatly facilitates the application of dressings, and gives excellent results, its shape tending to obviate the displacements of the upper and lower fragments forwards and backwards respectively. In some cases sand bags alone have been used without any splint, and the long outside splint has in many cases been supplemented by short thigh splints of various materials. In the later stages plaster of Paris casing to the limb was commonly employed, but not in recent cases.

Site of Fractures.—Out of a total of 170, 54 fractures occurred in the upper third, 50 in the middle, and 29 in the lower third; in 37 cases the region of injury has not been stated.

Sepsis.

Septicity.—Unfortunately, suppuration was the rule. It is to be regretted that in every case a note was not made with regard to the condition of the wound in this respect; thus out of a total of 170 cases, 101 are described as septic, 42 as asceptic, and in the remaining 27 cases no note has been made of the condition. Leaving out the last series, and only taking into consideration the 143 cases of which a note has been made, we find that 70·6 per cent. were septic. The above estimate of the percentage is not free from error, and is probably placed too low, as it is reasonable to suppose that most of the 27 cases alluded to were in reality septic; and had their condition in this respect been noted, the above large percentage of septic cases would have been still greater. (Table 14.)

Removal of fragments.

As a general rule, loose fragments were removed from badly comminuted fractures; thus in over 80 of the above cases there is a note to this effect, and in most of the remaining cases it is inferred by such expressions as "many loose fragments," "explored under an anæsthetic," &c. The cases in which this procedure was not carried out were generally aseptic fractures without much comminution.

Mortality.

Mortality.—Out of the total number of 170 cases, 29 died, giving a percentage mortality of 17; the immediate cause of death being amputation in 24 cases, septicæmia in 4 cases considered too weak to justify an operation, and 1 from crupous pneumonia; but in this last case the wound was not responsible for the issue, as it is described *post mortem* as being "healthy."

The relative mortality of wounds of various parts of the bone is as follows:—Upper third, 27·7 per cent.; middle third, 14 per cent.; lower third, 10·3 per cent.; and in cases where the region is not specified, 10·8 per cent. (Table 15.)

Sepsis the chief cause of death.

Although the majority of casualties has been attributed to amputations, a review of the condition of the wounds shows very clearly that sepsis was the real cause of the mortality. Thus, out of the 29 deaths, in 24 the wounds are described as septic, and in 3 only as aseptic; in the remaining 2 the condition is not mentioned. The cause of death in the 3 aseptic cases was shock, consequent on amputation for primary hæmorrhage; in one case the femoral artery, and in another the femoral vein, had been wounded, and the third is described as having "bled profusely." The two cases in which the septicity or otherwise has not been noted may fairly be classed as septic, as they both died of secondary hæmorrhage following amputation. It is evident, then, that out of a total mortality of 29 cases, sepsis was primarily responsible for no less than 26 deaths, or 89·6 per cent.

Amputations

Amputations.—In the whole series of 170 cases of fracture of the femur, amputation was performed 45 times, that is to say, in 26·4 per cent., or, roughly, about one in every four cases. Of these 45 amputations, 24 died, a percentage of 53·2. The indication for amputation was, as stated above septic infection in all cases, except in 3 of severe primary hæmorrhage.

Mortality

The relative mortality for amputation at various sites was—disarticulation at the hip joint, 12 cases, of which 8 proved fatal, a mortality of 66·6 per cent.; through the upper third of the femur, 18 cases, with 10 deaths, or 55·5 per cent.; through the middle third, 9 cases, of which 3 died, a mortality of 33·3 per cent. In the 6 remaining cases the region was not specified; of these, 3 died, being a mortality of 50 per cent. The above death-rate following amputations of the thigh, although high, cannot be accounted unduly so when all the circumstances are considered. The patients were, as a rule, the subjects of acute necrosis of the femur, were worn out and emaciated by septicæmia, had undergone privations and hardships for months, and had in many cases suffered from primary or secondary hæmorrhage. (Table 16.)

The following cases are quoted as illustrating different points in the nature and treatment of various fractures :—

Examples :— Osteomyelitis.

Case 37.—Private M., wounded near Lake Chrissie 6th February, 1901. Projectile and range unknown. Fracture at junction of upper and middle third. Transferred from Standerton to 18 General Hospital 1st May, 1901, with Liston's splint applied; great emaciation; entry septic; no union; excessive callus; ends of bone rough and sharp; several inches bare bone; great sepsis. On 16th April, 1901—chloroform; several dead fragments removed; counter openings; drained; Liston's splint for one month; no union; hectic; copious discharge. 1st July, 1901, amputation in upper third. Death from shock.

Post mortem.—Fibrinous union, two abscesses in cancellous tissue.—(Civil Surgeon F. Napier.)

Comminuted fracture with gangrene—Disarticulation at hip joint—Died.

Case 38.—Sergeant G., wounded 24th April, 1900; admitted to a temporary hospital two days later. The femur was badly fractured (Express bullet) about mid-third, and there was a very large exit wound on front of thigh. "That evening gangrene set in, and amputation at hip joint was performed by racket method." In spite of transfusion and strychnine, &c., he died at 8 p.m.—(Captain F. J. W. Porter, R.A.M.C.)

Comminuted fracture with recurrent hæmorrhage—Disarticulation at hip joint Recovered.

Case 39.—Private K., wounded 5th January, 1900; admitted 11 Field Hospital. Entrance (Mauser?) at mid-thigh posteriorly. Exit on outer side of thigh near great trochanter. Recurrent hæmorrhage from exit wound, which was temporarily checked by plugging; wound examined under anæsthetic 57 hours after injury; large ragged cavity in bullet track, studded with spicules of bone; loss of bone to the extent of 1 inch; free oozing of blood. Amputation at hip joint by transfixion was carried out at once. Strychnine freely given to combat shock. Recovered after two attacks of secondary hæmorrhage and considerable suppuration.—(Captain F. J. W. Porter, R.A.M.C.)

Septic fracture with comminution and hectic—Disarticulation at hip joint—Recovered.

Case 40.—Private W., wounded 6th January, 1900; admitted 4 General Hospital, Mooi River, 79 days later; had been under treatment at Intombi in the interval. Entrance (Mauser) in front of left thigh, about middle. Exit at back of thigh, upper third—both septic. Lower fragment protruding for 1½ inches through post. wound; upper showing in ant. wound; extreme emaciation and hectic. Exploratory incision by the late Sir William Stokes; comminution and bare bone found too extensive for conservatism, so Sir William amputated at hip joint, by modified Furneaux Jordan. Profound collapse followed, but he rallied and wound healed by first intention. Recovered.—(Major S. F. Freyer, R.A.M.C.)

Septic fracture with comminution and hectic—Disarticulation at hip joint—Died.

Case 41.—Private H., wounded 27th February, 1900; admitted 4 General Hospital, Mooi River; three days later. Entrance (Mauser) a little posterior to left great trochanter. No exit. There was a septic comminuted fracture of femur, with marked crepitus; and loose bone felt with probe, which latter passed down towards adductor tubercle. Incision made on inner side of thigh, over latter point, and loose bone removed here, and from entrance wound; drainage tube passed from entrance into incision wound. After this another operation was found necessary for evacuation of pus pent around hip joint, but, in spite of free drainage and every care, he lost ground steadily, and amputation at hip joint had to be performed on the 64th day, by external racket method. Died from shock one hour after operation.—(Major S. F. Freyer, R.A.M.C.)

Primary hæmorrhage.

Case 42.—Gunner B., aged 22, wounded 24th February, 1900, accidentally, by discharge of own carbine while pressing down barbed wire. Lee-Metford. Range few inches. Admitted 2 Stationary Hospital same day. Collapse; femoral vein cut by bullet; femur smashed up to its head; splinters removed; vein ligatured; very blanched; intravenous infusion; too collapsed for amputation; died same day.—(Civil Surgeon Stuart.)

Femur; severe comminution; septic.

CASE 43.—A sergeant, wounded at Tafel Kop, 20th December, 1901. Projectile unknown; range 40 yards. Entry small on postero-external aspect right thigh; exit, size half-crown, on antero-internal aspect. Oblique fracture with great comminution; admitted to Hospital, Norval's Pont, 27th December, 1901. Septic, greenish foul-smelling pus; removal of fragments, and as extremities of bone were denuded of periosteum, resection of ends of bone.

Irrigation and drainage. Opening and drainage of secondary abscesses. On 55th day wounds healed. Result—Union; invalided. When sent home had 2½ inches shortening.—(Captain FAICHNIE.)

Acute Osteomyelitis.

CASE 44.—Private W., wounded Paardeberg 18th February, 1900. Some days journey in wagon after injury; admitted 2 General Hospital, Cape Town, 8th March, 1900. Entry small; just behind, and slightly above, trochanter major. Exit, inner side thigh 4½ inches from ramus of ischium. Projectile and range unknown; temperature, 101° F.; much swelling and discoloration of thigh; sand bags weight extension. On 13th March, 1900, pus bagging behind entry; temperature higher. On 16th March, 1900, entry enlarged, evacuation very foul pus and small splinter bone; irrigation; drainage tubes; condition very bad; much swelling and œdema thigh and buttock. On 23rd March, 1900, enlarged exit, evacuating stinking pus; drainage tubes. Died 24th March, 1900.

Post mortem revealed osteomyelitis upper part shaft. Gangrene of tissues of thigh; bullet had tunnelled cancellous tissue of great trochanter, entered medullary cavity and shattered upper part shaft.—(Major LOUGHEED.)

Aseptic union.

CASE 45.—Private B., aged 20; admitted 13 General Hospital 5th April, 1902, "for gunshot wound of thigh causing compound fracture at junction of middle and lower third." Range and projectile not stated. Bones put in position; antiseptic dressings; Liston's splint with extension. Remained aseptic, dressed only a few times. Result very good, only about ¼ in h shortening; not lame on walking. Invalided 26th July, 1902.—(Civil Surgeon MALCOLM.)

Shrapnel, retained.

CASE 46.—Private P., wounded Potgieter's Drift 5th February, 1900. Projectile shrapnel; range unknown; admitted 4 General Hospital 8th February, 1900. Entry close to left spermatic cord; sinus leading towards trochanter minor, where rough bone felt with probe. Septic; drainage bad. X-rays showed small trochanter broken off, and pulled up 1 inch by ilio-psoas, with bullet, free, near it. On 20th February, 1900, incision through gluteus maximus, outside line of sciatic nerve; nerve drawn aside; cut through strong fascia below quadratus femoris. Shrapnel removed, and few splinters bone; drained; rapid improvement; wound healed; invalided 16th April, 1900.—(Major FREYER.)

Large perforation of femur, without complete fracture—Drained—Recovered.

CASE 47.—Private C., admitted 4 General Hospital, Mooi River, 19th February, 1900, for gunshot wounds of thigh and face. Entrance of thigh wound on front of lower third—a large hole, apparently due to shrapnel; exit directly opposite behind, at upper end of popliteal space. Although the finger passed back readily into popliteal space, through large ragged hole in femur, the bone was not completely fractured across, for the patient could bear his weight on it; also there was no evident damage to large vessels or nerves. Removed spicules of bone, and drained through popliteal space; recovered; invalided to England 39 days later.—(Major S. F. FREYER, R.A.M.C.)

Perforation of femur—Subperiosteal star fracture, and comminution.

CASE 48.—Examined upper end of disarticulated femur after amputation at hip joint. A second bullet—normal Mauser apparently—had perforated the head of the bone. As the perforation seemed to be a clean one, and the late Sir William Stokes wished to have the specimen, we had it put into quicklime for him. When examined afterwards it had fallen to pieces—a stellate fracture becoming evident when periosteum was thus destroyed.—(Major S. F. FREYER, R.A.M.C.)

Gunshot Fractures of the Diaphyses of Long Bones.

Fractures of the Femur.

Table 14.—Total Cases from all Projectiles (170 Cases).

——	Total cases.	Recovered.	Died.	Septic.	Remarks.
Fractures of the shaft of the femur..	170	141	29	101*	Aseptic in 42 cases. * Condition noted in 143 cases.
ates per cent.	—	82·9	17·0	70·6	

Table 15.—Showing results of Fracture in the different situations of the Diaphyses.

——	Total.	Recovered.	Died.	Results per cent.	
				Recovered.	Died.
Fractures of the Femur—					
Upper third	54	39	15	72·2	27·7
Middle third	50	43	7	86·0	14·0
Lower third	29	26	3	89·6	10·3
Not specified	37	33	4	89·1	10·8
Totals	170	141	29	82·9	17·0

Table 16.—Showing results of Amputations at different situations.

——	Total cases.	Recovered.	Died.	Results per cent.	
				Recovered.	Died.
Amputations for fractures of the femur—					
At the hip joint	12*	4*	8	33·3	66·6
Upper third	18	8	10	44·4	55·5
Middle third	9	6	3	66·6	33·3
Lower third	—	—	—	—	—
Not specified	6	3	3	50·0	50·0
Totals	45†	21	24	46·6	53·3

* Another case appears under "Injuries of the Knee."
† This gives amputation in 26·4 per cent. of the 170 cases of fracture.

Fractures of the Bones of the Leg.

Reports have been collected of 137 cases of injuries to the leg, not implicating joints, comprising wounds of tibia and fibula, 48 ; wounds of tibia alone, 72 ; wounds of fibula alone, 17.

I.—*Tibia and Fibula.*

Tibia and fibula.

Injuries of this class are noticeable for a very high degree of comminution, and furnish many examples of the explosive type in its worst form. Although not specially dangerous, as far as life is concerned, it is a very formidable injury to the limb, and furnishes a very high percentage of

amputations. Thus in 48 cases it was found necessary to amputate in 25, or 52 per cent. Septicity was marked—in fact, almost universal—as would be expected from the great comminution and extensive injury to the soft parts. Of the 48 cases no less than 38 are described as septic, only 3 as aseptic, and in the remaining 7 the condition is not mentioned. Omitting the last class, we find that sepsis occurred in 92·6 per cent. of the recorded cases. Although the septicity of the wounds and the necessity for amputations, in this class of injury, were exceptionally high, the results, as judged by mortality, are not unfavourable. Of the series of 48 only 7 terminated fatally, or a percentage of 14·5. (Table 17.)

Amputation common.

Septicity high.

Mortality.

Treatment.—One case of operative fixation has been reported, and was successful in spite of suppuration, but the necessity or desirability of this method of treatment must be extremely exceptional. Immobility was obtained by the splints ordinarily in use, the more generally employed being back splints with foot and side pieces, McIntyre's splint, Cline's splint, &c.; plaster of Paris was also applied frequently, but generally in the later stages.

Treatment.

The three aseptic cases recovered without any operative measures being required.

Of the 23 cases not treated by amputation, loose fragments of bone were removed in 11 instances, and in the remaining 12 no mention is made of any operative measure, except that in some cases incision was required for the evacuation of pus.

Amputations.—The usual sites of amputations were at the seat of election and through the knee-joint, Stephen Smith's method being usually in favour for the latter. In four cases re-amputation was found necessary through the lower part of the femur, on account of suppuration of the flaps of amputations performed at a lower level.

Amputation.

Three of the amputations were primary, for hæmorrhage, one of which underwent re-amputation at a later date; the remainder were secondary, necessitated by septic conditions or secondary hæmorrhage.

Of the 25 amputations, 7 died, being a mortality of 28 per cent. (Table 18.)

In the following cases some typical wounds are described by various medical officers, with the treatment and results :--

Examples.

Case 49.—Sergeant L., aged 31, wounded at Heilbron 16th July, 1900. Projectile (?) expanding; range 50 yards. Admitted 1st August, 1900, 3 General Hospital; for six days at farmhouse without treatment. Bullet had ploughed through right tibia from right to left; extensive comminution and splintering at middle third; rupture of (?) anterior tibial artery; fracture of fibula, probably due to fall; very septic; "leg bagged out with pus"; patient very weak. On 2nd August, 1900, explored; fragments of bone and *débris* were removed; irrigation and drainage; Cline's splints. On 7th August, 1900, amputation, Lister-Carden; pus seen oozing from sciatic sheath; large focus at back of femur; drainage and counter openings. Recovered, with good stump; invalided 1st October, 1900.—(Civil Surgeon A. Young.)

Severe comminution; septic.

Case 50.—Private J., aged 22, wounded Zerspruit on 25th February, 1902, at "short range"; projectile unknown; admitted to 2 General Hospital 28th February. Entry through fibula, 1 inch above malleolus, size of shilling piece; exit opposite, on inner side leg, large, irregular; muscles protruding. Comminution of both bones; septic; stinking discharge; cellulitis of leg; redness to middle of leg. Amputation at seat of election; equal lateral flaps. Result—Healed aseptically; invalided.—(Civil Surgeon Gairdner.)

Ditto.

Case 51.—Private R., wounded Paardeberg 24th February, 1900. Projectile expanding; range unknown. Admitted 13th March, 1900, to 2 General Hospital. Entry outer side left leg about middle, size of shilling piece; severe comminution of both tibia and fibula; exit on inner side of leg, size five-shilling piece; the bullet then entered right leg at same level; entry size of palm of hand, comminuting both bones, and lodged under skin on outer side fibula. All wounds highly septic; fragments of bone and bullet removed. On 14th March, 1900, removal of more bone and metal; temperature 103° F.; wounds very foul. On 23rd March, 1900, profuse bleeding during dressing

Very severe comminution of both tibiæ and both fibulæ.

from right leg; tourniquet; amputation, Stephen Smith's, at knee-joint. 26th March, 1900, flaps sloughing; opened and fomented. 30th March, 1900, fluid in supra-patella pouches. 31st March, 1900, left knee freely opened, lateral incisions; pus evacuated; drainage tubes; free discharge. During above time left leg was healing, no more bone came away; cavity in front to tibia filling up. In right leg pus burrowed up back of thigh; incisions, drainage; gradual healing. Plaster of paris case to left leg. Result—Slow but good recovery. Invalided in June, 1900.—(Major Lougheed.)

Shattering by a normal bullet—Amputation—Secondary hæmorrhage—Re-amputation—Osteomyelitis—Died.

Case 52.—Boer prisoner, J., wounded 27th February; admitted 4 General Hospital, Mooi River, three days later. Entrance over mid-third of fibula—a large septic wound, with upper fragment of tibia, which was comminuted also, projecting through skin; no exit, but great shattering of bones seen by X-rays, and afterwards a normal Lee-Metford bullet was found in muscles at back of knee joint. Conservative treatment at first, as he was in good condition, and had no fever. Limb became œdematous, and the 18th day amputation was decided on, and after some difference of opinion as to whether a Stephen Smith's operation at knee joint was not necessary, a modified Farabœuf's operation, at seat of election, was performed. As outer flap had to be cut short, it was necessary to supplement it from inelastic and brawny tissue on inner side. Severe secondary hæmorrhage two days later; wound plugged. As he had lost much blood, and wound was very unhealthy-looking, amputation in lower third of thigh was performed at once. No attempt at union of flaps took place; fungoid medulla showing in stump; died of exhaustion 14 days later.—(Major S. F. Freyer, R.A.M.C.)

Septic; shell—Comminution, with suppuration of knee-joint—Amputation—Recovered.

Case 53.—Private B., wounded 24th February, 1900; admitted 4 General Hospital, Mooi River, 19 days later Patient said he was wounded by our own "common" shell. Left thigh wound healed. Both bones of right leg comminuted and septic, with extensive suppuration of knee joint, and lower end of femur. Latter only discovered under anæsthetic and exploration 23rd March, 1900, when arthrectomy was abandoned. Next day amputated, by Syme's modified circular method, in mid-thigh. Healed by first intention, so that only the track of the drainage tube remained open 12 days later, when invalided to England.—(Major S. F. Freyer, R.A.M.C.)

Septic comminuted fracture—Amputation—Recovered.

Case 54.—Private R., admitted 4 General Hospital, Mooi River, 12th February, 1900, for gunshot fracture of leg. Both tibia and fibula extensively comminuted in septic wound; tissues extensively lacerated; temperature, 103·4° F. Attempt made to save limb, but after eight days it was obvious that amputation was necessary. This was performed by the late Sir William Stokes after his own method ("Stokes' supra condyloid amputation") above the femoral condyles. The wound healed by first intention, and resulting stump was shapely and excellent. Invalided.—(Major S. F. Freyer, R.A.M.C.)

Re-amputation.

Case 55.—Private J. B., wounded Pieter's Hill 23rd February, 1900. Projectile and range unknown. Lay for two days on veldt, having no food and little water, then removed to 4th Brigade Field Hospital, where the leg was amputated at seat of election. Transferred to 4 General Hospital 27th February. Stump very septic, flaps sloughing, very foul discharge. Temperature, 102·6° F. Douching with warm carbolic lotion, iodoform dusting, stimulants, &c.; no improvement. Amputation above knee by Sir William Stokes. Healed per primam. Invalided 6th April, 1900.—(Civil Surgeon W. Ross Kemp.)

The Tibia alone.

Comparison with fractures of both bones.

Fractures of tibia alone offer a pleasing contrast to injuries implicating both bones of the leg, as is evidenced both by mortality and the number of amputations. We have seen that when both bones were injured the mortality was 14·5 per cent., and the percentage of amputations reached the high figure of 52; whereas in fractures of the tibia alone the mortality of recorded cases was only 1·4 per cent., and the percentage of amputations only 9·7; 72 cases

of injury to the tibia alone have been reported, including 3 cases in which both tibiæ were injured, and of the total number of wounds of this bone, 19 are described as perforations and 7 as grooves. The comparative slightness in the character of the wounds accounts in a great measure for the insignificant mortality and small numbers requiring amputation. The large amount of cancellous tissue in the epiphysis, especially in the upper one, favours perforation, but some cases of perforative wounds of the diaphyses have also been noted.

Septicity.—In 62 cases a note of the septicity or otherwise of the wounds has been made, leaving 10 in which the condition has not been described. Of the 62 cases, 39 were septic and 23 aseptic, a septicity percentage of 62.9.

Removal of fragments.

Removal of Fragments.—In 27 cases a note has been made of the removal of loose fragments, all these cases being septic with the exception of two, in one of which no mention is made of this condition, and in the other one the wound is stated to have been aseptic. In 38 cases no record has been made of any such removal, the great majority of them being aseptic, and requiring nothing further in the way of treatment than the ordinary measures of fixation on splints.

Amputation.

Amputation.—Of the series of 72, amputations were performed in 7 cases, an amputation percentage of 9·7, all of which recovered. The site of amputation was—supra-condyloid in 2 cases, through the knee joint 2, one at the seat of election, one at the middle of the leg, and in one case the site is not mentioned.

Very low mortality.

Mortality.—Only one case had a fatal termination in the total number of 72, the patient being a Boer prisoner who had been kept without treatment by his friends at a farmhouse for a fortnight, and was afterwards conveyed to a General Hospital, where he shortly died of embolism. A very brief note of his case is given, and probably had he from the first received proper surgical aid, no death would have been recorded from the class of injury now under review. These figures show a death-rate of 1·4 per cent. nearly. The majority of wounds of the above class were inflicted by Mauser or Lee-Metford bullets, but wounds from projectiles of all descriptions—shell, shrapnel, revolver, &c.—are included. Two cases of slight injuries caused by soft-nosed bullets, presumably at long ranges, are given below.

No case of operative fixation for fracture of this bone has been placed on record, and the splints employed in their treatment were of the same class as those used for fractures of both bones of the leg.

Tibia Alone.—Examples of Various Injuries and Treatment.

Examples:—Aseptic.

Case 56.—Trooper H., wounded 8th March, 1902. Projectile, Lee-Metford; range, short; admitted 10 General Hospital six hours after injury. Entry at inner aspect of calf, passed forward, and emerged at inner side of leg, 6 inches below knee joint; leg much swollen; had bled much; irrigated; cyanide dressings and lateral splints; remained aseptic throughout. Result—Excellent union; no limp; no shortening. Discharged 9th May, 1901.—(Civil Surgeon Key.)

Soft-nosed Mauser, retained; septic.

Case 57.—Sergeant M., aged 30, wounded Lindley 25th May, 1900; range, 900 yards; projectile, soft-nosed Mauser; posture, standing. Entry 10 inches above internal malleolus, ¾ inch inside crest tibia; bullet lodged ¾ inch outside crest; bullet extracted 4th July, 1900. Pus evacuated; bony fragments removed; gauze drain; bullet much expanded, base outwards. Long stay in hospital; several necrosed pieces of tibia removed; recovered; invalided.—(Civil Surgeon A. Young.)

Ditto.

Case 58.—Trooper J., aged 35, wounded 13th May, 1901; projectile, soft-nosed Mauser; admitted 20 General Hospital 19th May. Entry inner border of tibia; bullet lodged; bone fissured, bare, septic; incisions for drainage and removal of bare bone; bullet found embedded in tibia, partly in medulla, wedged in compact tissue; range unknown. Result—Recovered; sent to Convalescent camp 10th August, 1901.—(Civil Surgeon Donald.)

Aseptic—Perforation of shaft.

CASE 59.—Gunner B., wounded 12th March, 1900, at Driefontein; admitted 1 General Hospital 19th March. Entry, about ¼ inch diameter, in front of right fibula, 3 inches above external malleolus, 1 inch behind tibial crest; exit, same size over inner surface tibia, 2½ inches above internal malleolus; aseptic; projectile, Mauser; range, 600 or 700 yards. X-rays on 30th March, 1900, showed tibia cleanly drilled through about 2 inches above malleolus. Treatment—Antiseptic dressings; wounds completely healed 14th April, 1900, when invalided.—(Major BURTON, R.A.M.C.)

Aseptic—Perforation of tibial head.

CASE 60.—Sergeant D., admitted 3 General Hospital 25th January, 1900. Clean perforation of head of tibia; entry and exit about ¼ inch diameter; projectile probably Mauser; estimated range about 1,000 yards; aseptic; dry gauze dressings; some periostitis resulted round exit wound; healed; aseptic throughout.—(Civil Surgeon STUART.)

Both tibiæ—Aseptic.

CASE 61.—Corporal G., admitted 11 General Hospital 17th December, 1900; projectile, Mauser; posture, riding; range, 50 yards; bullet entered shaft of left tibia, causing perforation with slight comminution; passed through horse; entered shaft of right tibia, causing clean perforation; all wounds about diameter of Mauser bullet, and aseptic; splints and usual dressings. Result—Healed. Transferred 9th February, 1901.—(Civil Surgeon H. HUNTER.)

Comminution—Septic.

CASE 62.—Sergeant L., wounded 16th July, 1900; projectile, "expanding"; range, 20 yards. Entry and exit, one common wound; bullet ploughed through tibia below tubercle, from right to left, extensive comminution and splintering of whole extent of middle third of tibia; foully septic; leg channelled with pus; free drainage; fragments and necrosed bone removed. On 6th August, 1900, no sign of recovery of parts; amputation at knee joint; uninterrupted recovery.—(Civil Surgeon A. YOUNG.)

Ligature of popliteal.

CASE 63.—Private M., wounded 8th February, 1902; admitted 16 General Hospital 19th February. Incomplete fracture of tibia; septic; projectile and range not recorded. On 22nd February, 1902, secondary hæmorrhage from posterior tibial artery; ligation of popliteal artery; subsequent removal of necrosed bone. Result—Union. When transferred to Base had almost full use of leg.—(Civil Surgeon TWEEDIE.)

(*Vide* Case 20, "Injuries of Blood Vessels.")

Perforation of lower end of tibia.

CASE 64.—Gunner H., wounded 6th July, 1901; admitted hospital, Bloemfontein, 17th July, 1901. Bullet had passed through lower part of tibia, from before backwards without causing complete fracture. Both wounds quite healed on 26th January, 1901; up all day; walks without limp; sent to Convalescent camp 2nd February, 1901.—(Hospital Records.)

Fractures of the Fibula Alone.

Small number of recorded cases—The fibula alone; septicity.

Very few cases of this class of injury have been noted. Naturally, it is comparatively rare, and I have collected notes of only 17 cases, 3 of them having been accidentally inflicted. Of the 17 cases, 9 are described as septic, 4 as aseptic, and of the remaining 4 no mention has been made in this respect. In 8 cases a record has been made of the removal of loose fragments, and in one case amputation was performed through the knee joint for secondary hæmorrhage. Two cases terminated fatally, one from some acute septic infection (case quoted below), the other from shock following amputation through the knee joint. This gives a mortality of 11·7 per cent., but the number of cases is so small that no general conclusion of any value can be drawn, and there is no reason why the mortality should be any higher than in fracture of the tibia alone, where it was only 1·4 per cent. in a comparatively large number of cases. The fixation of these fractures was carried out by means of the splints in common use, and no record has been made of any operative fixation.

Examples:—Septic—Amputation.

CASE 65.—Private W., wounded 13th December, 1900, was prisoner in hands of Boers for four days; admitted 2 General Hospital 17th December, 1900. Entry 1 inch below head left fibula, large exit two inches above internal malleolus, 3 inches in length. Leg much swollen and septic. On night of admission, severe secondary hæmorrhage; amputation through knee joint. Died from shock and loss of blood. Posterior tibial artery found divided at origin and calf muscles torn to pieces.—(Lieut.-Colonel SYLVESTER, R.A.M.C.)

Acute septic infection.

CASE 66.—Private W., wounded near Ladysmith, 7th November, 1901. Projectile, Martini-Henry; range 20 yards; admitted 19th Stationary Hospital same day. Entry large, over head of fibula; exit large, on inner side leg at same level; head of fibula smashed, great swelling of leg; oozing. Crepitation, due to gas in tissues round wound, appeared a few hours after injury. Sterilized and splinted. Next day temperature 104° F.; egg shell crackling; considered to be case of infection by bacillus of malignant œdema; wounds enlarged and irrigated with peroxide of hydrogen; large drainage tubes introduced. Died 36 hours after being wounded. A sterile needle introduced into tissues and afterwards into subcutaneous tissue of mouse caused death in 30 hours.—(Lieut.-Colonel WESTCOTT, R.A.M.C.)

Comminution and fissuring.

CASE 67.—Lieutenant D., admitted 7 General Hospital 12th June, 1900. Entry in front of lower third right fibula; exit postero-external aspect, same level; leg swollen and red; temperature 102° F.; septic. X-rays showed fibula split longitudinally, fragments of bone in tissues; exit enlarged; six fragments removed; drainage. On 25th June, 1900, drainage tube removed; union. Invalided 15th July, 1900.—(Captain BERRIDGE, R.A.M.C.)

Injury to external popliteal nerve.

CASE 68.—Sergeant H., wounded near Bloemfontein 3rd March, 1900. Transferred to 2 General Hospital. Entry 4 inches below knee, behind fibula, exit in front, near crest of tibia; fibula comminuted, fragments pressing on external popliteal nerve; entry enlarged, several fragments of fibula removed; wounds soon healed; limb put up in plaster of Paris; pain along course of nerve increased on pressure. Invalided 1st May, 1900; unable to stand on foot.—(Major LOUGHEED, R.A.M.C.)

Septic.

CASE 69.—Private P., aged 22; projectile (?) expanding; range 250 yards; admitted 11 General Hospital 26th August, 1900. Entry size of sixpenny piece at middle of inner side leg behind tibia. Exit same level on outer aspect, 6 inches by 3 inches; torn muscles protruding; fibula for about 1 inch "broken into splinters"; fragments lying loose in wound; septic; removal of many fragments; scraping, drainage, splints. Result—Good union. Invalided 4th October, 1900.—(Civil Surgeon H. HUNTER.)

Comminuted fracture—Secondary hæmorrhage—Ligature at site—Recovered.

CASE 70.—Private W., wounded 24th January, 1900; admitted 4 General Hospital, Mooi River, two days later. Entrance (Martini-Henry) on inner side and behind tibia, at junction of mid. and lower third; exit opposite, on outer side of leg—both very large and septic; comminuted fracture of fibula, with severe recurrent secondary hæmorrhage. For persistent and successful effort to ligature at site, and conservative after-treatment, *see* Case No. 10, "Gunshot Wounds of Blood Vessels."—(Major S. F. FREYER, R.A.M.C.)

Fractures of the Bones of the Leg.

TABLE 17.—Showing results in all Cases noted (137 Cases).

——	Totals.	Recovered.	Died.	Septic.	Results per cent.	
					Recovered.	Died.
Fractures of the leg—						
Both bones	48	41	7	92·6*	85·4	14·5
Tibia alone	72	71	1	62·9†	98·6	1·4 (nearly)
Fibula alone	17	15	2	69·2‡	88·2	11·7
Totals	137	127	10	—	92·7	7·3

* Not noted in 7 cases. † Not noted in 10 cases. ‡ Not noted in 4 cases.

TABLE 18.—Showing results of Amputation for the various kinds of Fracture.

——	Total cases.	Totals.	Recovered.	Died.	Results per cent.	
					Recovered.	Died.
Amputation for fracture of the leg—						
Both bones .. .	48	25*	18	7	72·0	28·0
Tibia alone	72	7	7	—	100·0	—
Fibula alone	17	1	—	1	—	100·0
Totals	137	33	25	8	75·7	24·2

* Including 3 primary for hæmorrhage, all of which recovered.

Percentage of amputations to cases—

Both bones = 52·0.
Tibia alone = 9·7.
Fibula alone = 5·8.

Fractures of the Bones of the Lower Extremity.

TABLE 19.—Showing results of all Cases noted.

——	Totals.	Results.		Results per cent.	
		Recovered.	Died.	Recovered.	Died.
Fractures of the bones of the lower extremity—					
Femur	170	141	29	82·9	17·0
Bones of the leg	137	127	10	92·7	7·3
Totals	307	268	39	87·2	12·7

Fractures of the Bones of the Lower Extremity.

TABLE 20.—Showing results of all Amputations in all Cases noted.

——	Totals.	Results.		Results per cent.	
		Recovered.	Died.	Recovered.	Died.
Fractures of the bones of the lower extremity—					
Femur	45	21	24	46·6	53·3
Bones of the leg	33*	25	8	75·7	24·2
Totals	78	46	32	58·9	41·0

* Including 3 primary for hæmorrhage.

Percentage of amputations to cases = 22·1.

FRACTURES OF THE METATARSAL BONES.

Fairly common.

Injuries to these bones, although fairly common, have not been generally noted, and only 27 cases have been collected. Many of these injuries were accidentally self inflicted, owing to carelessness in handling firearms. As a rule they suppurated, a result to be expected, as the bullet generally first penetrated a dirty boot and sock, and as the skin of the foot is seldom clean. Comminution was usual, although some cases of perforation have been recorded. Healing in septic cases was generally slow, pus having a tendency to burrow, and this necessitating frequent incisions; in these cases the foot bath and continuous irrigation have proved of great value. In 17 cases there is no record of removal of bony fragments, the usual line of treatment in the way of antiseptic dressings, fomentations, &c., having been sufficient. Six cases required removal of loose portions of bone, or removal of portions of the shaft, and in two cases amputation of the corresponding toes was carried out. Suppuration was sometimes prolonged owing to the presence of such foreign bodies as portions of the boot or sock. All cases recovered, but several are noted as unable to stand on foot owing to pain.

Usually septic and comminuted.

Examples of Various Injuries to Metatarsal Bones.

Examples :—

CASE 71.—Private B., aged 30; wounded Paardeberg 23rd February, 1900; projectile said to be from "sporting rifle"; estimated range 600 yards; admitted 3 General Hospital. Entry dorsum right foot, near heads of metatarsals; exit behind os calcis. While lying on stretcher was struck by another bullet, on same foot; entry at sole, and exit at dorsum, near bases of metatarsals. All wounds septic, much œdema of foot; removal of small fragments; McIntyre's splint; rigors; temperature, 105° F. On 17th March, 1900, a brass eyelet hole for boot lace extruded from posterior wound. 23rd March, 1900, incision, and removal of small sequestrum. 13th April, steady progress; recovered.—(Civil Surgeon STUART.)

Septic.

CASE 72.—C., aged 26, accidentally self inflicted on 30th July, 1901; admitted 20 General Hospital. Entry, dorsum over third metatarso-phalangleal joint; exit at sole 1½ inches behind web. Projectile, Lee-Metford; range, 1 foot. Septic; foot and leg swollen to knee; skin undermined to external malleolus. 14th August, 1901, third toe amputated; progress slow but favourable; invalided 5th September, 1901.—(Captain THOM, R.A.M.C.)

Aseptic.

CASE 73.—Private R., slightly comminuted fracture shaft fifth metatarsal. Exit wound small. Projectile, Mauser; range estimated at

1,400 yards. Aseptic, splint, dry dressings; union; recovery; to duty. Admitted to hospital 3rd December, 1899; discharged 2nd January, 1900.—(Major MACDONALD, R.A.M.C.)

BONES OF THE UPPER EXTREMITY.

(1) *The Humerus.*

Frequency of injury.

Although the humerus is perhaps the most frequently injured of all the bones, only 83 cases reported in more or less detail have been collected. The generally favourable issue of this class of injury may account for the comparatively few cases reported. The above number includes fractures of all varieties, and in every situation, except the epiphyses, which have been classified as wounds of the elbow or shoulder joints. Wounds from every variety of projectiles are represented, and the great majority of fractures have been comminuted to a greater or lesser extent; but a few cases of perforation of the diaphyses have also been noted. Wounds of this bone inflicted at short ranges afford well-marked examples of the "explosive" type, but the most noticeable feature is the frequency of nerve injuries, particularly of the musculo-spiral. In a few cases the nerve trunk has been actually divided by the bullet, but the commonest condition seems to be loss of function from pressure of callus or fibrous bands in the track of the bullet, or from contusion or concussion without pressure. Injuries to other nerves were also noticed, such as to the median or ulnar; but the musculo-spiral was by far the most commonly damaged. In the 83 cases under review this nerve suffered injury in 12 cases, or in 14·4 per cent.

Usually comminuted.

Injuries of musculo-spiral nerve.

Sepsis.

Septicity.—Of the 83 cases, 42 have been noted as septic, 19 as aseptic, and in 22 the condition has not been described; leaving the last class out of the calculation, the septicity amounts to 68·8 per cent.

Removal of Fragments.—In 22 cases a note has been made of the removal of fragments, but it is probable that this procedure was carried out in many more cases without a record having been made. Every case in which fragments were removed has been described as septic.

Amputations.

Amputations.—In the series of 83 cases, 13 amputations were carried out, or an amputation percentage of 15·6. The site of amputations was—Disarticulations at the shoulder joint, 7; amputations through the upper and middle thirds of the arm, 6. Of the 13 amputations 2 died, both disarticulations through the joint; being an amputation mortality of 28·5 per cent. for the operation through the joint, and of 15·3 per cent. for all amputations of the upper arm. Septic conditions were present in every case requiring amputation, the chief indication for removal of the limb having been extreme local destruction of soft parts accompanied by free suppuration. One case (No. 30, page 177) of primary amputation has been reported, but required disarticulation later on. One case of hæmorrhage in a septic comminuted fracture of severe type was successfully treated by ligation of the axillary (*see* Case 24, page 175).

Indications for amputation.

Mortality.

Mortality.—The mortality of injuries of this large and important bone, as calculated from the number of reported cases, has been decidedly low. Of the 83 cases only three died, giving a mortality of 3·6 per cent.; two of them died from shock resulting from disarticulation through the shoulder joint; the cause of death in the remaining case was gangrene of the lung 32 days after injury. In the last case death cannot be attributed to the wound, as the bone was found *post mortem* "completely united" and "the shoulder joint healthy."

Treatment.

Treatment.—In badly-comminuted septic cases removal of fragments was usual, but in slighter degrees of fracture and in aseptic cases was not, as a rule, carried out. Immobilization was secured by means of the splints ordinarily employed in surgical practice—three short splints with a narrow arm sling, rectangular splints, plaster of Paris casing, perforated zinc, &c., were the most commonly used. Operative fixation by means of wire has been carried out in two cases, but the necessity for this procedure seems to be quite exceptional. In cases of musculo-spiral paralysis the nerve has been cut down upon in several instances, and either sutured or freed from cicatricial bands of fibrous tissue; but the results of treatment have not been reported

Wiring.

in this Section owing to the length of time which must elapse before beneficial effects become evident.

Examples of Gunshot Fractures of the Humerus.

Examples:—Extensive comminution—Amputation.

CASE 74.—Private S., wounded Pieter's Hill 27th February, 1900. Projectile, Mauser; estimated range 500 yards; admitted 4 General Hospital, Mooi River, 7th March. Entry near tip of acromion process left arm; exit at postero-internal aspect of arm, junction of upper and middle thirds. Extensive comminution; septic; arm greatly swollen. On 11th March, 1900, exploratory incision, upper end of shaft; found too pulverised for excision; amputation at shoulder joint; several fragments of bone removed from the flaps; healed mostly by first intention; small sinus remained; invalided 5th April, 1900.—(Major FREYER, R.A.M.C.)

Musculo-spiral paralysis.

CASE 75.—Private G., aged 20, admitted 20 General Hospital on 4th November, 1901, for gunshot fracture right humerus, at junction of upper and middle third; good union resulted; contracted enteric fever, recovered; signs of musculo-spiral paralysis noticed. On 25th February, 1901, operation. Nerve freed from entanglement in cicatricial tissue and callus; nerve found divided; sutured, some slight suppuration, fomentations; healed; no return of nerve power when invalided 12th April, 1902.—(Major WHAITE, R.A.M.C.)

Necrosis and suppuration of stump.

CASE 76.—Private P., wounded Damplaats 27th May, 1901. Mauser (? soft nosed), range 400 yards, two wounds; one bullet shattered left forearm, and another shattered left arm. Primary amputation on the field at middle of arm; admitted 12 General Hospital; stump healed except at one corner; on 23rd June, 1901, stump very tender; pus evacuated over pectoralis major. More abscesses formed and humerus found bare; fomentations. On 5th July, 1901, amputation through shoulder joint; recovered; invalided 10th September, 1901. (This case also quoted above, Case 30, with reference to primary amputations.)—(Major LOUGHEED.)

Wiring.

CASE 77.—Private R., aged 22; wounded 16th April, 1901; admitted 20 General Hospital with comminuted fracture right humerus at junction of middle and lower thirds, fracture ununited. On 1st June, 1901, posterior incision, ends of bone turned out, all dead bone removed, ends refreshed, united by silver wire. 8th June, 1901, considerable discharge; irrigation. 13th August, 1901, abscess opened, dead bone removed, healing. 19th September, 1901, wound healed; invalided; bony union doubtful.—(Civil Surgeon DONALD.)

Gangrene.

CASE 78.—Private M., wounded at Springs 11th February, 1901; admitted 16 General Hospital 13th February, 1901. Had wandered about veldt for 24 hours after injury. Entry small, middle of inner side left arm; exit outer side, large, ragged; very foul; great swelling of whole arm and shoulder. 14th February, 1901, amputation at shoulder joint. 15th February, 1901, commencing gangrene of flaps, great collapse; transfusion; died.—(Lieutenant B. SMITH, R.A.M.C.)

Bones of the Forearm.

Bones of the forearm.

Only 60 cases of gunshot fractures of the bones of the forearm have been collected, none of which terminated fatally. These include wounds from every description of projectile, and although the number of cases is not large, still it is an indication of the favourable results of injuries in this situation. The above number is composed of:—Injuries to both radius and ulna, 15; of the radius alone, 27; and of the ulna alone, 18.

Fracture of Both Bones.

Both bones—No deaths—Sepsis.

Only 15 cases of fracture of both radius and ulna have been recorded, all terminating favourably as far as the patient's life is concerned, though in 3 the forearm had to be sacrificed. The explosive character of wounds of

these bones at close ranges was generally well marked, and septicity was usual. Thus, of the 15 cases in this series only 3 are described as aseptic. The removal of loose fragments was generally practised, except in slight or in aseptic cases. Immobility was secured by means of ordinary splints of different materials, straight forearm splints being generally applied; rectangular splints, and plaster of Paris were also frequently used. Operative fixation was not often required for fracture of the bones of the forearm, only 4 cases having been described. Limitation of pronation and supination was common after fractures of this type.

Amputations.

Three cases. One was required for injuries resulting from the accidental explosion of a shell in the hand. One for a septic wound of highly "explosive" type inflicted by an expanding bullet, and one case was the subject of re-amputation on account of sloughing flaps after a primary operation on the field.

Examples of gunshot fractures of both bones of the forearm :—

Examples:—Amputation.

CASE 79.—Private M., highly comminuted fractures of both bones in upper third. Very septic. Exit wounds greatly lacerated, size of palm of hand. Projectile, suspected soft-nosed. Range, 80 yards. Admitted No. 11 General Hospital 28th October, 1900. Amputation through middle third of arm. Result good. Discharged 12th December, 1900.—(Hospital Records.)

Amputation.

CASE 80.—Private J., wounded 7th August, 1900; both bones fractured. Amputation on field, just below left elbow. Had to be moved two days later. Admitted 4 General Hospital, Mooi River, 12th August, 1900. Delirium; "typhoid state"; very foul, sloughing stump; whole arm to axilla swollen and boggy. Flaps sloughed, exposing radius and ulna. Pus burrowed up to axilla, and was evacuated. Fomentations and irrigation. Sinuses laid open and scraped, and, ultimately, on 4th October, 1900, re-amputation at middle of humerus. Recovered. Invalided 4th December, 1900.—(Major FREYER, R.A.M.C.)

Aseptic.

CASE 81.—Private M., wounded Paardeberg; admitted 1 General Hospital 26th February, 1900. Fracture of both bones at centre of shafts. Comminution not severe; both wounds small in size; projectile, Mauser; aseptic; splints; no removal of fragments; union. Invalided 21st March, 1900.—(Civil Surgeon DUNLOP.)

Faulty union—Wiring.

CASE 82.—Trooper W., transferred from Winberg, where treated six weeks, to 9 General Hospital. Faulty union, both bones overlapping; bones cut down upon. Ends refreshed; some small loose pieces of bone removed; ends united with silver wire. Recovery, with much improved and useful limb.—(Captain BEGBIE, R.A.M.C.)

Aseptic—Ulna wired and radius only "set"—Satisfactory.

CASE 83.—Private McE., admitted 4 General Hospital, Mooi River, 9th March, 1301, for gunshot comminuted fracture of both bones of forearm, with much deformity. When wounds were aseptic, and there was still no union, the subcutaneous ulnar fracture was cut down on, placed in position, and wired; radius not wired, but deformity reduced by manipulation. Satisfactory result according to skiagraph (Fig. 74). Invalided to England 69th day, when firm union had taken place.—(Major S. F. FREYER, R.A.M.C.)

Septic—Ulna wired and radius only "set"—Satisfactory, though wire came away.

CASE 84.—Sergeant M., admitted 4 General Hospital, Mooi River, 3rd February, 1902, for gunshot wound of forearm. There was a septic, comminuted fracture of radius and ulna, at junction of mid and upper thirds, with great deformity. Loose fragments of bone removed; scraped and washed wound, and, as bones could not be kept in position, wired ulna (Fig. 75). The bones united in fairly good position, but, as union took place only by granulation, wire came away later. Invalided to England 19th April, 1902.—(Major S. F. FREYER, R.A.M.C.)

Fracture of Radius Alone.

The radius—Mortality nil.

Twenty-seven cases of this injury have been collected showing every variety of fracture from a pronounced "explosive" type to simple perforation. About 60 per cent. were septic, and there were no deaths. One case underwent amputation, not from causes arising from the fracture itself, but on account of gangrene resulting from injury to the brachial artery at its bifurcation.

Explosive type.

The explosive type of injury is best seen in fractures of the lower third of the bone, where it is least covered by soft parts. From an analysis of the reports it appears that loose fragments of bone were removed in about 40 per cent. of the cases, but I think it is likely that mention has not always been made of this proceeding, and the percentage should, in reality, be higher. Loss of function of various nerves, such as the median and radial, has been described more than once, as well as injuries to the radial artery. Ligation of the brachial artery was practised successfully in one case of secondary hæmorrhage in a septic, comminuted wound. Immobilization of the fractured bone was carried out by means of the usual splints, and in one case wiring for faulty union was resorted to.

The following cases are quoted as examples of different injuries :—

Examples :—Perforation lower epiphysis; aseptic.

Case 85.—Private C., aged 28, wounded Paardeberg 19th February, 1900; projectile Mauser; range unknown; admitted 6 General Hospital 25th February, 1900. Entry small, above wrist, posterior aspect; exit small, in front. Aseptic; not a complete fracture—only evidence was small amount of thickening at end of bone. Healed; discharged hospital 1st March, 1900.—(Civil Surgeon Brinker.)

Explosive type.

Case 86.—Shoeing-smith P., aged 29, wounded Dewetsdorp 17th April, 1901; projectile unknown; range 4 yards; admitted 12 General Hospital 19th April, 1901. Entry circular, about ½ inch diameter, over posterior surface radius, 1½ inches above wrist; exit large, ragged, in front of radius, same level. Spicules of radius protruding from exit, and radial artery divided. Septic; arm inflamed. On 19th April, 1901, removal of loose pieces of radius; ligation of artery; irrigation and arm-bath for three weeks by day, fomentations at night. On 7th May, 1901, abscess opened near artery. Result—Union, with stiff wrist.—(Major Lougheed, R.A.M.C.)

Unsuccessful primary closure of wounds.

Case 87.—Conductor W., aged 26, wounded 6th May, 1901, accidentally, self-inflicted; projectile, Lee-Metford; range, few inches; admitted same day 14 General Hospital. Entry 3 inches long, at inner aspect; exit 5 inches long, at outer aspect of left forearm. Wounds sutured; no drain. On 10th May, 1901, septic; pain up arm. Explored; radius found shattered; removal of fragments; irrigation; arm-bath; cyanide dressings. Result—Union; free movement of hand and fingers. Discharged 29th August, 1901.—(Civil Surgeon Napier.)

Wiring.

Case 88.—Private D., admitted 8 General Hospital. Comminuted fracture right radius, close to insertion of supinator brevis; splints for three weeks; massage. X-rays showed faulty union; radius exposed; splintered fragment removed; ends of bone drilled; united with silver wire. Result—Good union.—(Captain Begbie, R.A.M.C.)

Ligation of brachial artery.

Case 89.—Corporal W., 2nd Royal Highlanders; projectile unknown; range 80 yards. Transverse fracture of radius at junction of upper and middle thirds; very large wound, close to bend of elbow, 3 inches by 2 inches; septic. Drainage; splint. Secondary hæmorrhage; ligation of brachial artery above wound; union. Admitted hospital 15th December, 1899; invalided 25th January, 1901.—(Civil Surgeon Roberts.)

Fractures of Ulna Alone.

Ulna alone.

Considering the comparative frequency of injuries of the ulna, the number of cases recorded in detail is extraordinarily small. Only 18 cases have been collected, all of which recovered. Occupying the subcutaneous position it does, fractures of this bone at short ranges furnish examples of the explosive

type of wound, and, on the other hand, the size and structure of its upper epiphysis favour the occurrence of pure perforations. Only 2 of the 18 cases are described as aseptic, one being a perforation of the upper epiphysis, the other a slight comminution of the shaft; but the numbers are so small that no conclusion as to average septicity can be drawn from them.

Amputation.

Amputation was required in two cases, one (quoted above, Case 7, page 172) for gangrene resulting from neglect in a Boer laager, the other a primary amputation on account of extreme injury of bone and soft parts. The immobilization and general treatment was carried out on the same lines as in fractures of the radius, and no mention has been made of operative fixation.

The following cases are given as examples of wounds to this bone :—

Examples :—
Moderate comminution.

Case 90.—Private D., wounded Lindley 18th September, 1900; projectile, Mauser; estimated range 300 yards; admitted next day 3 General Hospital. Entry ulnar margin right forearm, 3½ inches above tip of ulnar styloid; exit on extensor surface, same level; both small and circular. Ulna comminuted; slight sepsis; radius intact, so no splints; wool, firm bandaging, and arm sling. Recovered; perfect union. Discharged to duty 22nd October, 1900.—(Civil Surgeon Young.)

Extreme comminution.

Case 91.—Private P., accidentally self-inflicted while cleaning rifle; projectile, Lee-Metford; range about 4 inches; admitted 2 General Hospital. Bullet passed through ulna side left forearm; extensive lacerated wound in middle third; torn muscles hanging out; 2 inches of ulna blown away; ulna artery wounded. Primary amputation, 3 inches below elbow-joint. Did well; invalided 5th February, 1901.—(Lieut.-Colonel Sylvester, R.A.M.C.)

Impure perforation of shaft.

Case 92.—Notes taken six weeks after injury; projectile Mauser (?); range unknown. Both wounds small, exit larger. X-rays showed hole through ulna, with slight comminution around it. Union with some deformity. Supination and pronation fair.—(Civil Surgeon Kirkman.)

Tables 21 and 22 give some details regarding gunshot fractures of the upper extremities.

Fractures of the Upper Extremity.

Table 21.—Showing the results of all Cases noted, including Amputations.

——	Totals.	Results.		Results per cent.	
		Recovered.	Died.	Recovered.	Died.
Fractures of the bones of the upper extremity—					
Humerus	83	80	3	96·3	3·6
Radius and ulna	15	15	—	100·0	—
Radius alone	27	27	—	100·0	—
Ulna alone	18	18	—	100·0	—
Totals	143	140	3	97·8	2·1

Table 22.—Amputations.

Humerus	13*	11	2	84·6	15·3
Radius and ulna	3	3	—	100·0	—
Radius alone	1	1	—	100·0	—
Ulna alone	2	2	—	100·0	—
Totals	19	17	2	89·4	10·5

* 7 disarticulations at the shoulder, and 2 died, or 28·5 per cent.

Percentage of amputations to cases for fracture of upper extremity = 13·2.

Metacarpal Bones.

Metacarpals.

Thirty-eight cases of injuries to the metacarpal bones have been reported, of which 5 were caused by shell. In 30 a note has been made as to the septicity or otherwise of the wounds, from which it appears that 26 were septic and 4 aseptic, giving the very high percentage of 86·6 septic. Comminution to a greater or lesser extent was usual, but 4 cases are described as grooves, and a few perforations have also been observed. In many cases fragments of loose bone were removed, and in some the greater part of the metacarpal bone was resected. In 5 cases amputation of the finger was carried out in addition to partial removal of the corresponding metacarpal. No case has been placed on record of the loss of the hand from wounds of this description. The continuous arm-bath was of great service in the treatment of septic wounds of the hand.

Usually comminuted.

TABLE 23.—Wounds of Metacarpals from all Projectiles.

Total number.	Septicity.	Removal of fragments.	Fingers amputated.	Deaths.
38	86·6	13	5	—

Examples of injuries to metacarpal bones :—

Examples :—

CASE 93.—Trooper D., wounded Malans Kraal; admitted 15 Stationary Hospital. Large wound back of right hand 3 inches square, palm burst open; half second metacarpal completely shattered, third and fourth fractured; removal part of second metacarpal, soft parts cleaned and brought together, forefinger pushed back 1 inch to approximate ends of metacarpal; little sepsis resulted. Result—Complete use of all fingers, except index, which was 1 inch short.—(Major HEUSTON.)

Extensive wound.

CASE 94.—Private C., shaft second right metacarpal; perforation; entry and exit both small; aseptic. Projectile, Mauser; range, 1,500 to 1,800 yards. Hand X-rayed to verify diagnosis; splints. Healed.—(Civil Surgeon YOUNG.)

Perforation.

CASE 95.—Private A., wounded 26th July, 1901. Entry near lower end ulna, passed through hand, shattering carpus and metacarpals; exit included greater part of back of hand; all metacarpals, except first, shattered; index finger, hanging by skin, removed; wound very foul; boric bath. On 30th July, 1901, chloroform; flexor tendons intact; extensors, mostly divided, were stitched to periosteum at proximal ends of phalanges; drainage tubes; removal of all loose fragments; did well; free discharge, drained well; inflammation did not spread up arm; invalided; flexion and extension improving under massage.—(Captain CAMERON, R.A.M.C.)

Extensive injury.

CASE 96.—Private B., wounded Magersfontein 11th December, 1899; projectile, shell; admitted 2 General Hospital. Large wound back of right hand; 1, 3, 4, and 5 metacarpals comminuted; septic; piece of shell removed from beneath 3, 4, 5 metacarpals; loose fragments removed; suppuration spread up arm; incisions; wrist joint involved, opened and drained. Result—All wounds healed. Invalided February, 1900.—(Major LOUGHEED, R.A.M.C.)

Shell wound.

The Clavicle.

Few cases reported.

Notes on only 5 cases of wounds of the clavicle have been collected, 2 being perforations, and 3 comminutions. In one case the bullet entered at the costal arch, traversed in an upward direction through the lung and fractured the clavicle at its exit; but beyond some transitory hæmoptysis, no serious symptoms arose, and the patient made a good recovery. The 2 cases of perforation were through the inner and outer thirds of the bone; both were caused by Mauser bullets, and the range of fire in the latter case is stated to

All recovered.

have been about 100 yards. The 5 cases recovered, and no operative interference, such as the removal of loose fragments, has been recorded. The following case is an example of perforation of the less compact tissue of the sternal end of bone :—

Example :— Perforation.

Case 97.—Private W. ; projectile, Mauser ; range not stated ; admitted Imperial Yeomanry Field Hospital 7th June, 1900. Entry ½ inch above centre of spine right scapula ; exit over sternal end of clavicle ; the clavicle was perforated ; slight ecchymosis ; complains of tingling down right arm from axilla affecting all fingers except thumb ; no motor paralysis. On 14th June, 1900, "all wounds healed ;" no further note.—(Surgeon-Major Openshaw, C.M.G., I.Y.)

The following Tables, 24 and 25, give the results of all cases of gunshot fractures of the shafts of long bones noted during the war :—

Gunshot Fractures of Long Bones.

Table 24.—Showing results in all Cases noted.

Bones fractured.	Totals.	Results.		Results per cent.	
		Recovered.	Died.	Recovered.	Died.
Femur	170	141	29	82·9	17·6
Both bones, leg	48	41	7	85·4	14·5
Tibia	72	71	1	98·6	1·4
Fibula	17	15	2	88·2	11·7
Humerus	83	80	3	96·3	3·6
Both bones, forearm	15	15	—	100·0	—
Radius	27	27	—	100·0	—
Ulna	18	18	—	100·0	—
Totals	450	408	42	90·6	9·3

Table 25.—Showing results of Amputation in all Cases.

Situation at which amputation was performed.	Number of amputations.	Ratio of amputations to cases.	Results.		Results per cent.	
			Recovered.	Died.	Recovered.	Died.
Hip joint*	12‡	7·0	4	8	33·3	66·6
Femur, upper third	18	10·5	8	10	44·4	55·5
„ middle third	9	5·3	6	3	66·6	33·3
„ lower third	—	—	—	—	—	—
„ not specified	6	3·5	3	3	50·0	50·0
Leg fracture of both bones† ..	25§	52·0	18	7	72·0	28·0
„ „ of tibia†	7	9·7	7	—	100·0	—
„ „ of fibula†	1	5·9	—	1	—	100·0
Shoulder joint*	7	8·4	5	2	71·4	28·5
Humerus†	6	7·2	6	—	100·0	—
Forearm fracture of both bones†..	3	20·0	3	—	100·0	—
„ „ of radius† ..	1	3·7	1	—	100·0	—
„ „ of ulna† ..	2	11·1	2	—	100·0	—
Totals	97	21·5	63	34	64·9	35·0

* Not for direct injury of the joints, but for fractures lower down.
† The exact sites at which these operations were performed are not given in the notes.
‡ One was also done for injury of the knee.
§ Three for primary hæmorrhage ; all recovered.

FIG. 25.
At Short Range: Mauser Bullet.—(Skiagraphed by Captain PRESCOTT, D.S.O.)

FIG. 26.
Gunshot Fracture of Femur.—(Skiagraphed at Netley.)

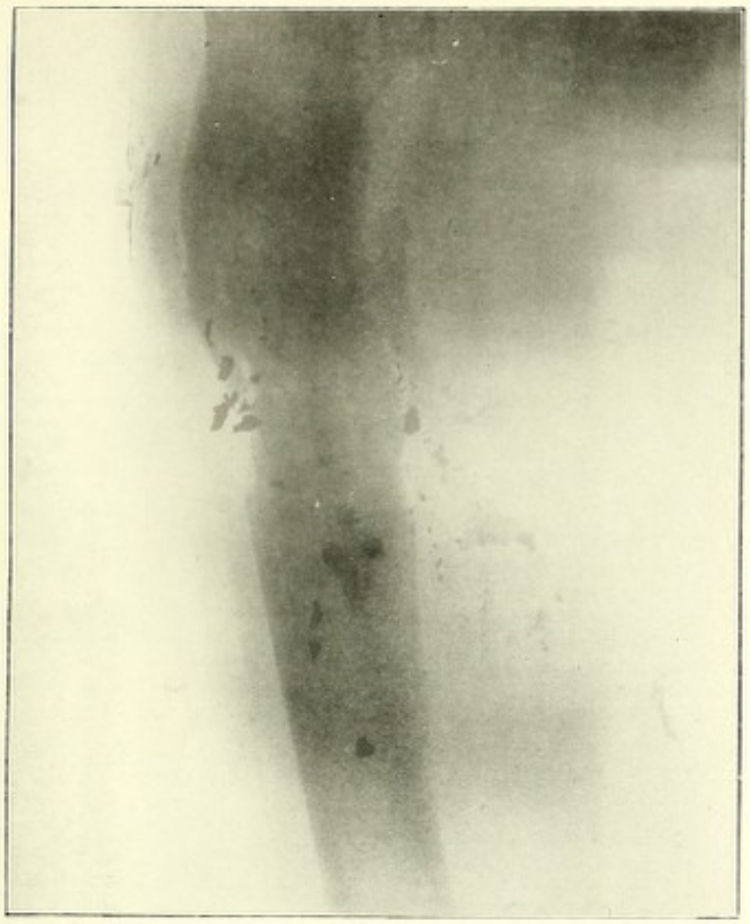


FIG. 27.

Gunshot Fracture of Upper Third of Femur: many fragments of bullet lodged. Iodoform and glycerine had been injected into the sinus, and is seen high up on left of picture and low down on right.—(Skiagraphed at Netley.)

FIG. 28.

Gunshot Fracture of Femur.—(Skiagraphed by Mr. CATLING.)

FIG. 29.
Severe Comminution of Femur; range, 40 yards.—(By Captain PRESCOTT, D.S.O.)

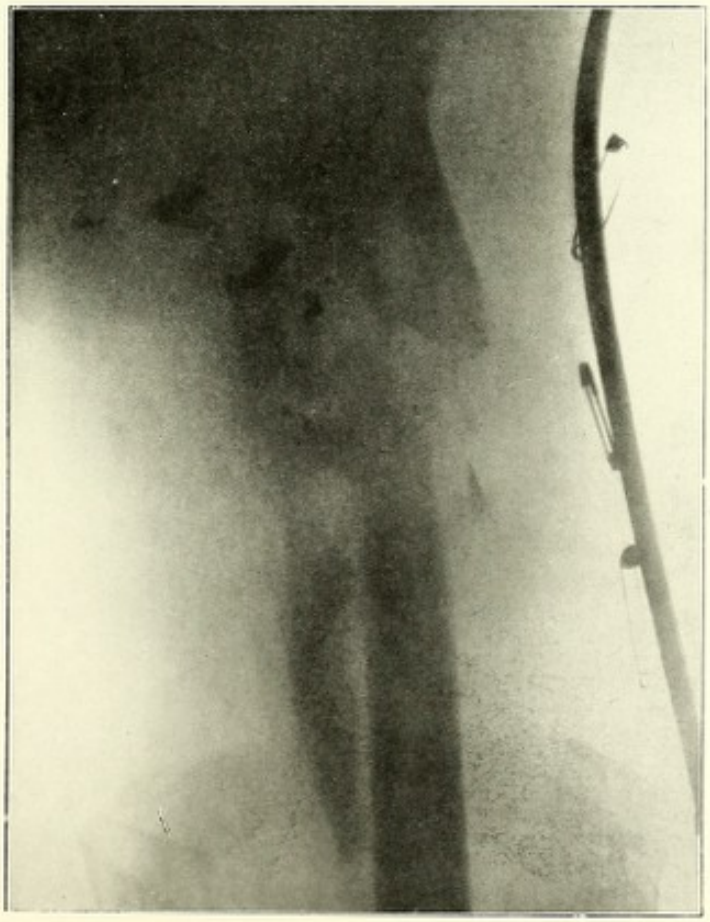


FIG. 30.
Severe Comminution of Femur; many fragments of bullet lodged.—(By Sergeant-Major HARWOOD, R.A.M.C.)

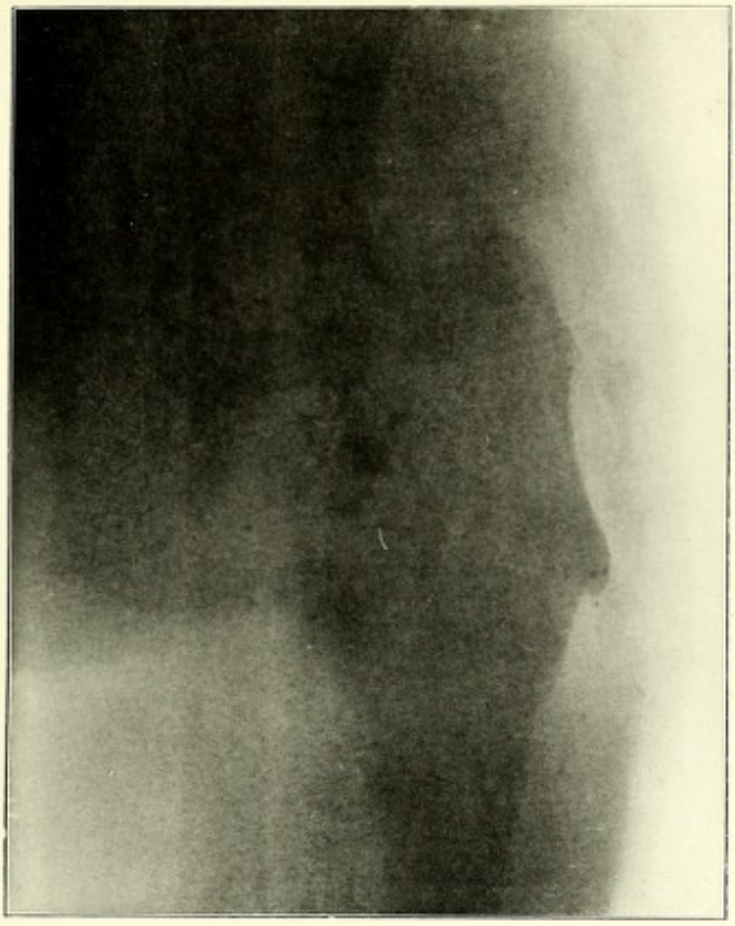


FIG. 31.

Severe Comminution of Femur ; great thickening of the bone from deposition of callus.—(Skiagraphed at Netley.)

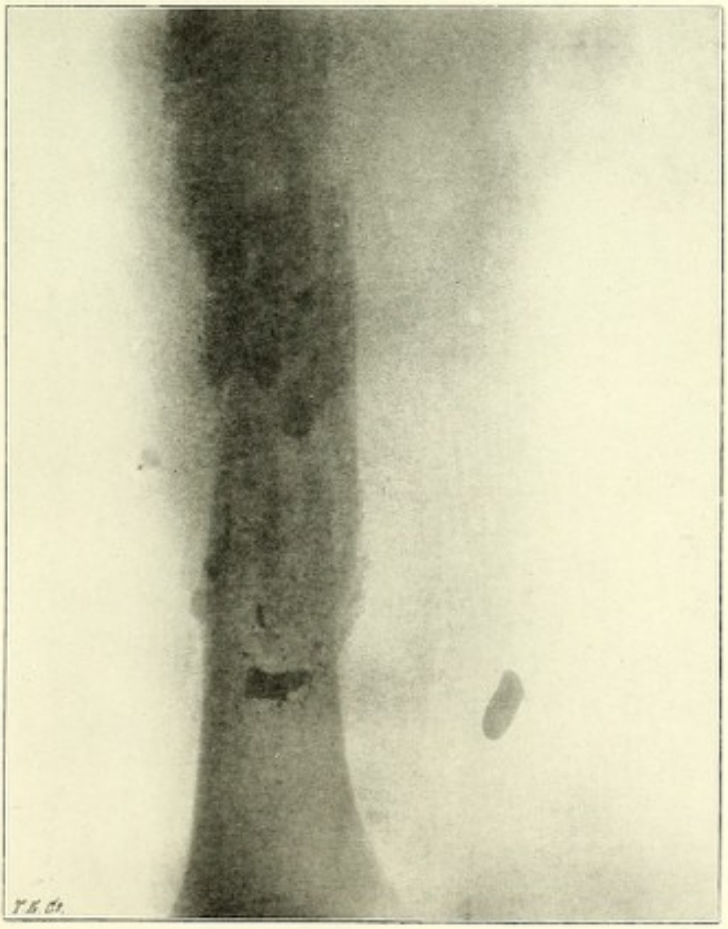


FIG. 32.

Gunshot Fracture of Femur.—(Skiagraphed at Netley).

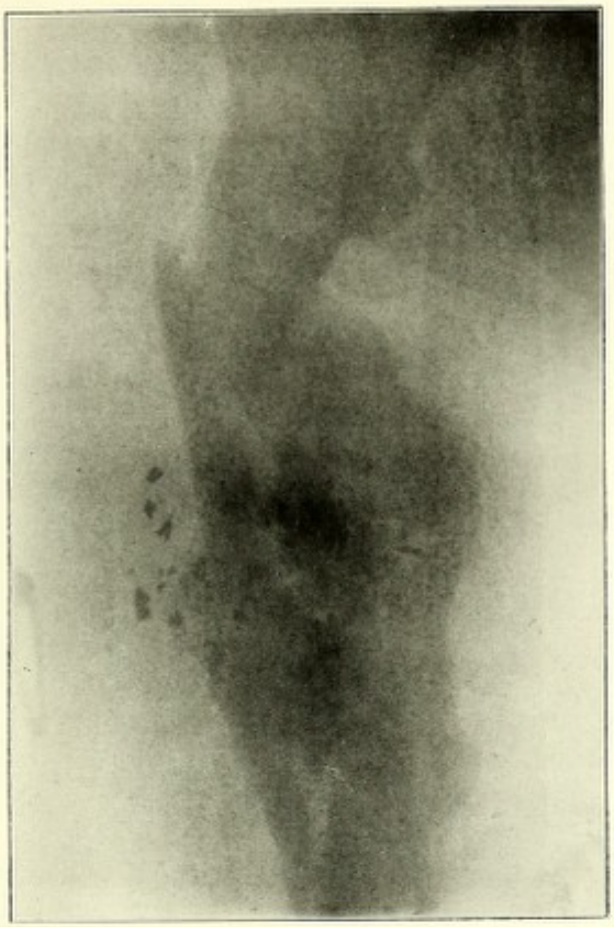


FIG. 33.
Severe Comminution and much Thickening of Femur.—(By Captain STAMMERS, R.A.M.C.)

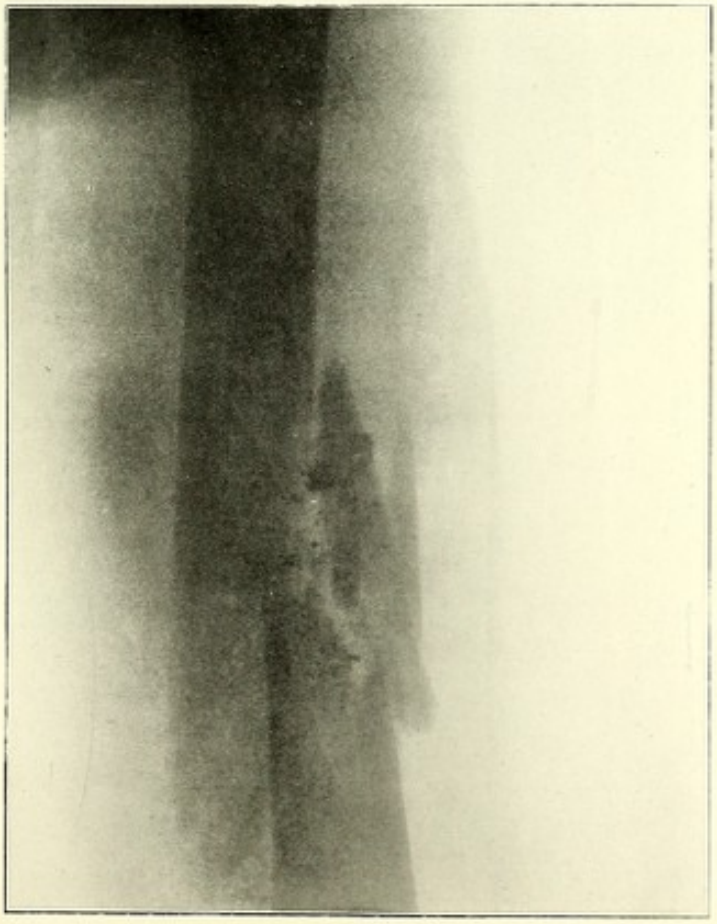


FIG. 34.
Severely Comminuted Fracture of Femur.—(By Captain PRESCOTT, R.A.M.C.)

FIG. 35.
Gunshot Fracture of Femur.—(By Mr. CATLING.)

FIG. 36.
Gunshot Fracture of Upper Third of Femur: Union quite firm.—(Skiagraphed at Netley.)

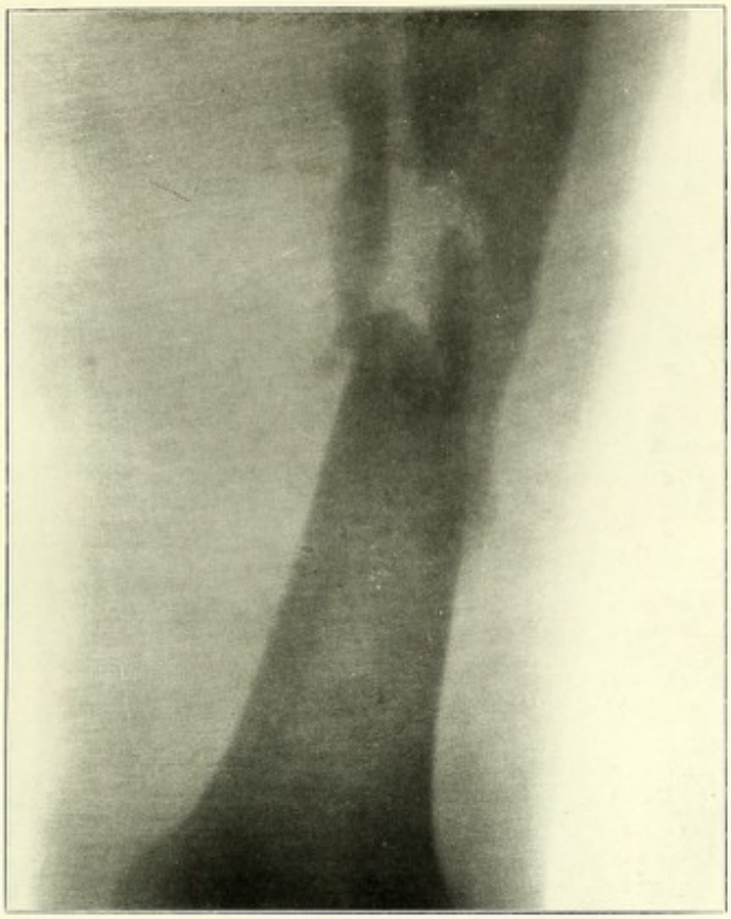


FIG. 37.
Gunshot Fracture of Femur.—(By Mr. CATLING.)

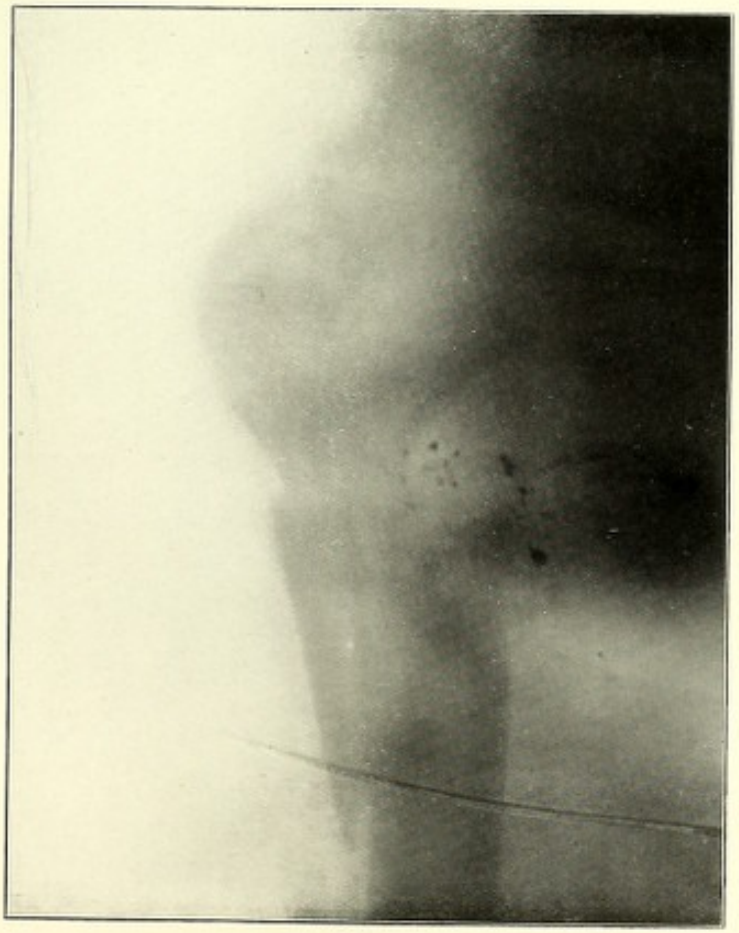


FIG. 38.
Gunshot Fracture of Upper End of Femur.

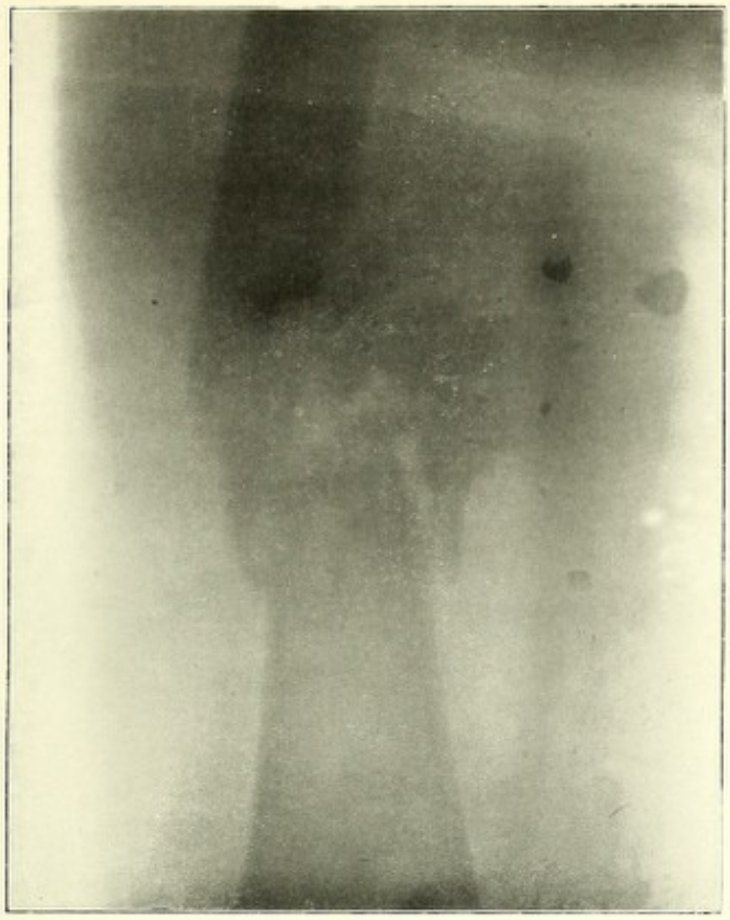


FIG. 39.
Severe Comminution : some pieces of metal lodged.—(Skiagraphed at Netley.)

FIG. 40.
Gunshot Fracture of Femur.—(By Mr. CATLING.)

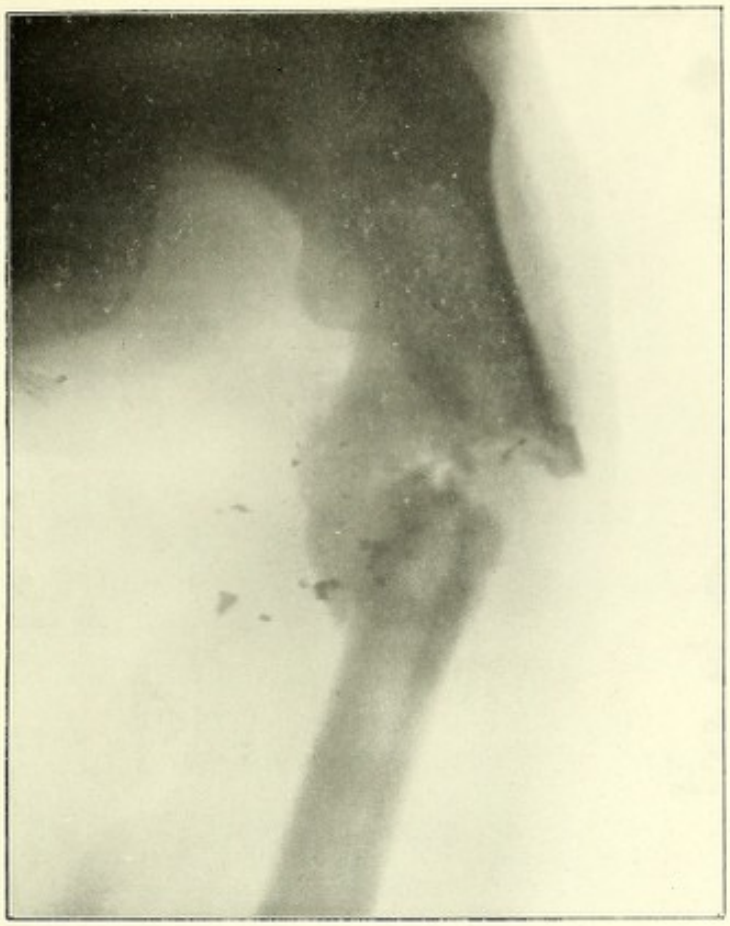


FIG. 41.
Union was strong in this Case.—(Skiagraphed at Netley.)

FIG. 42.
Slightly Comminuted Fracture of Femur. Fibrous union only ; Sciatic had been injured ; Leg paralysed ; Amputation.—(Skiagraphed at Netley.)

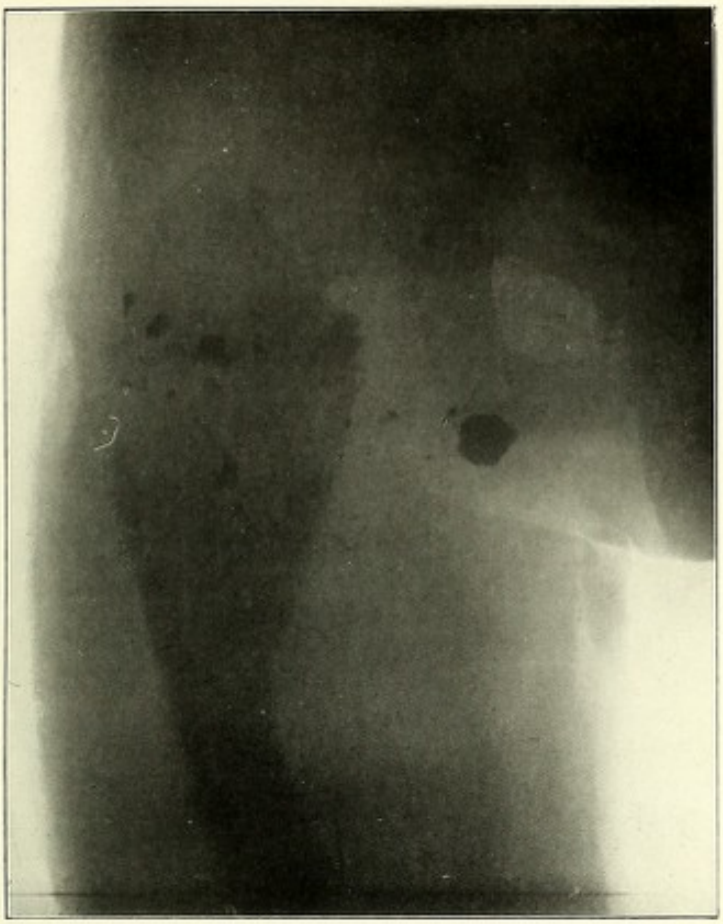


FIG. 43.

Severe Gunshot Fracture of Femur; many fragments of bullet lodged, none removed.—(Skiagraphed at Netley.)

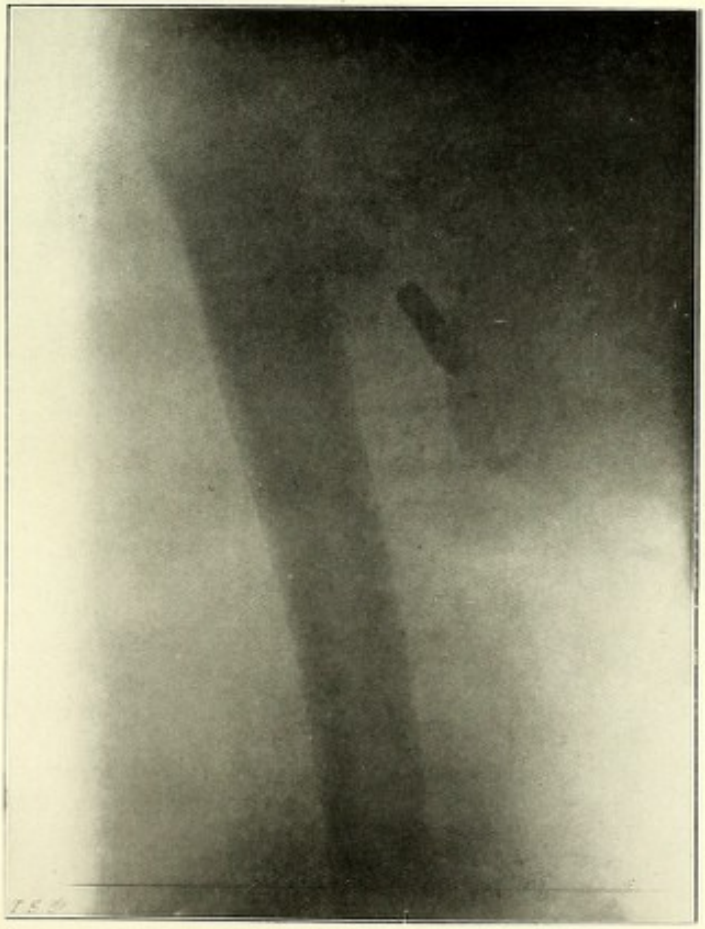


FIG. 44.

Bullet Lodged near Ischial Tuberosity; Removed.—(Skiagraphed at Netley.)

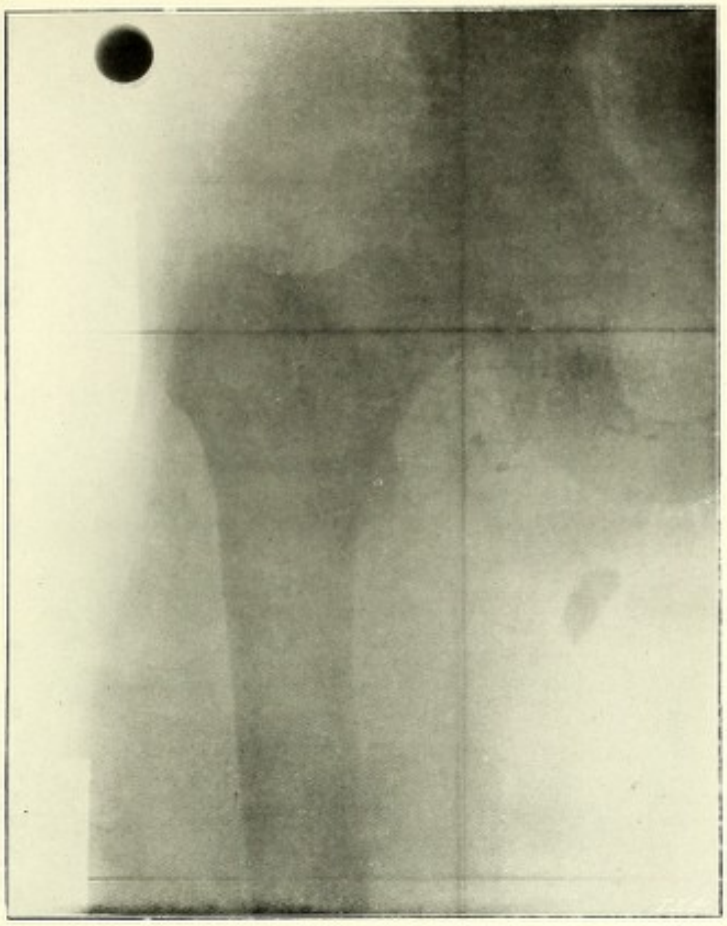


FIG. 45.

Fragments of Bullet Lodged; the large one was removed.—(Skiagraphed at Netley.)

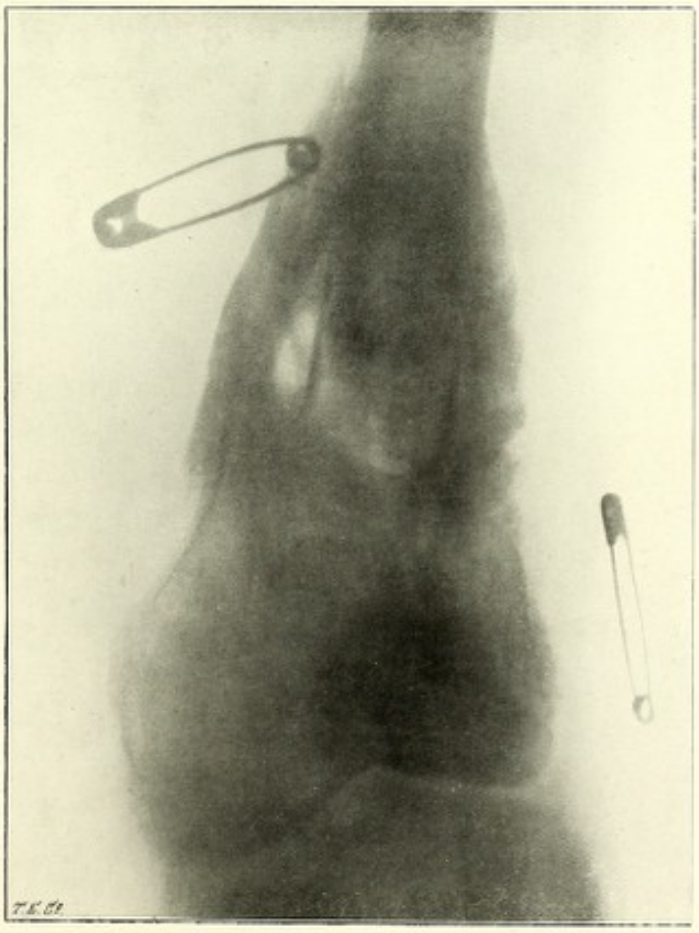


FIG. 46.

Severe Comminution of Lower Third of Femur; bone much expanded.—(Skiagraphed at Netley.)

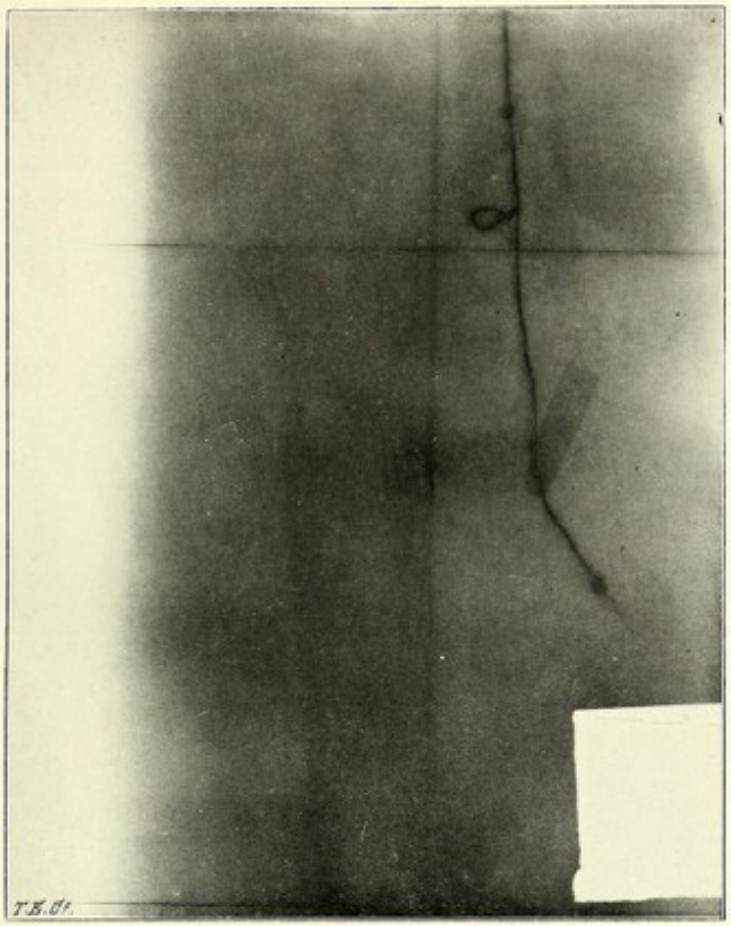


FIG. 47.

Bullet Lodged and Removed. The twisted wire was on the skin next the photographic plate.—(Skiagraphed at Netley.)

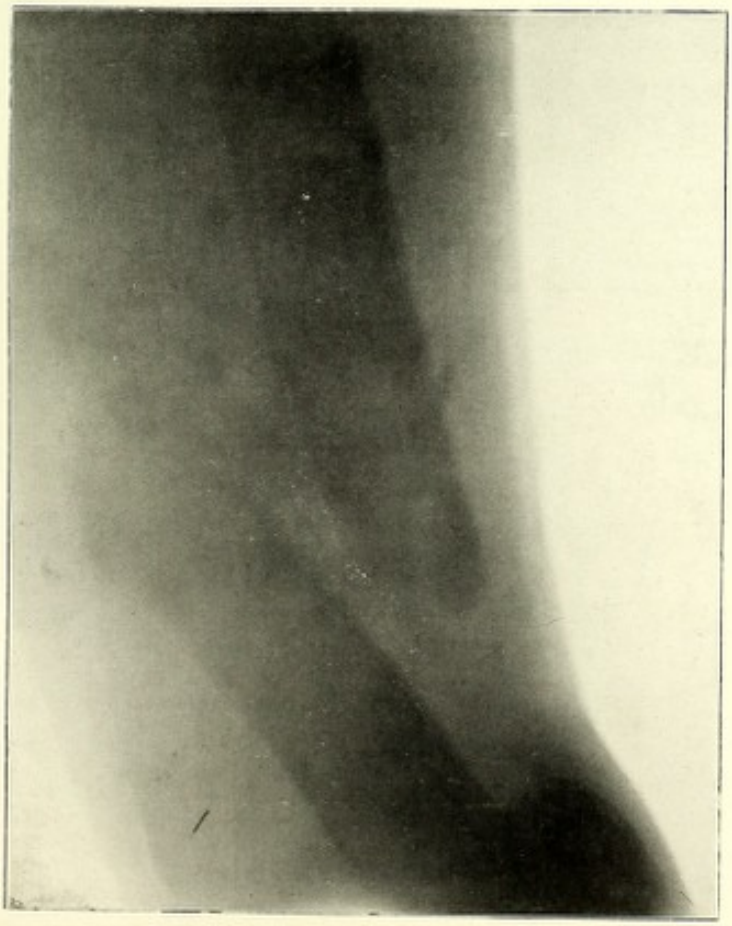


FIG. 48A.

Lateral View of Fig. 48B.—(Skiagraphed at Netley.)

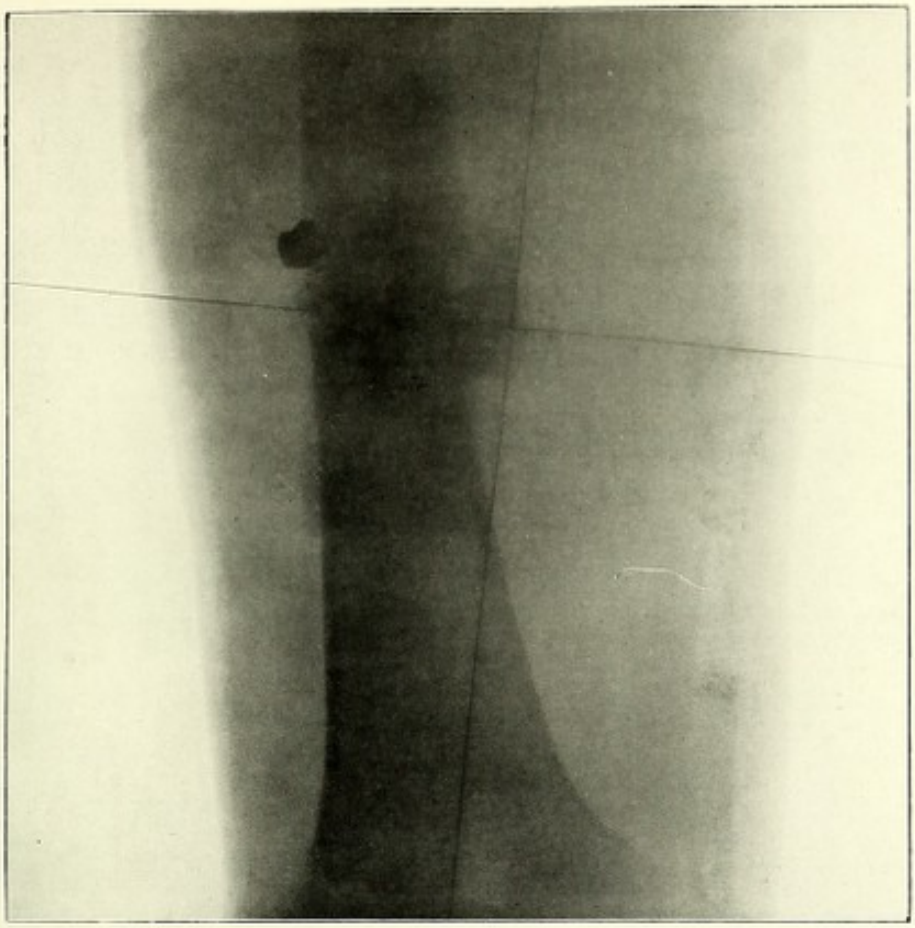


FIG. 48B.
Antero-Posterior View of Fig. 48A.—(Skiagraphed at Netley.)

FIG. 49.
Gunshot Fracture of Upper End of Femur.—(By Captain PRESCOTT, D.S.O.)

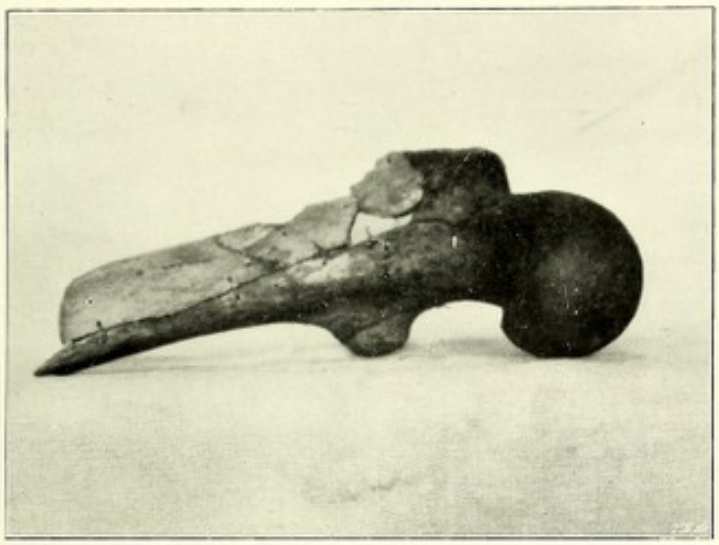


FIG. 50A.

Photograph of Specimen of Gunshot Fracture of Upper End Femur.

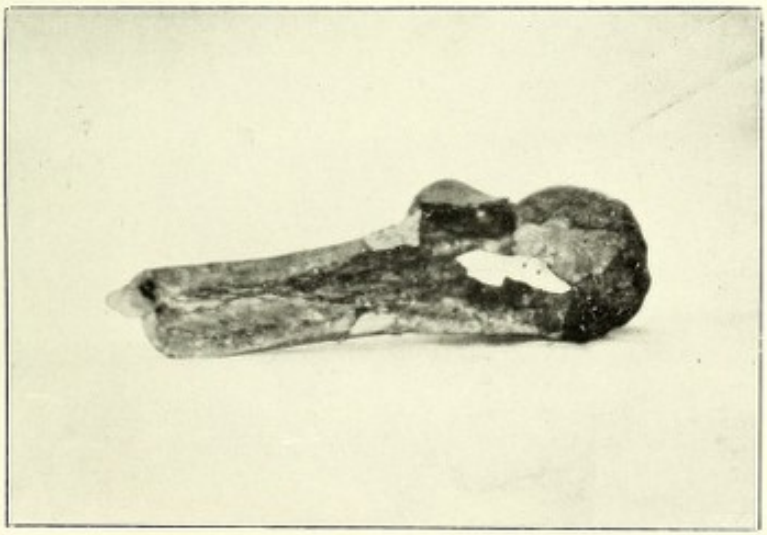


FIG. 50B.

Same Case as 50A.

FIG. 51A.
Fracture by Shrapnel Bullet: Lateral View.

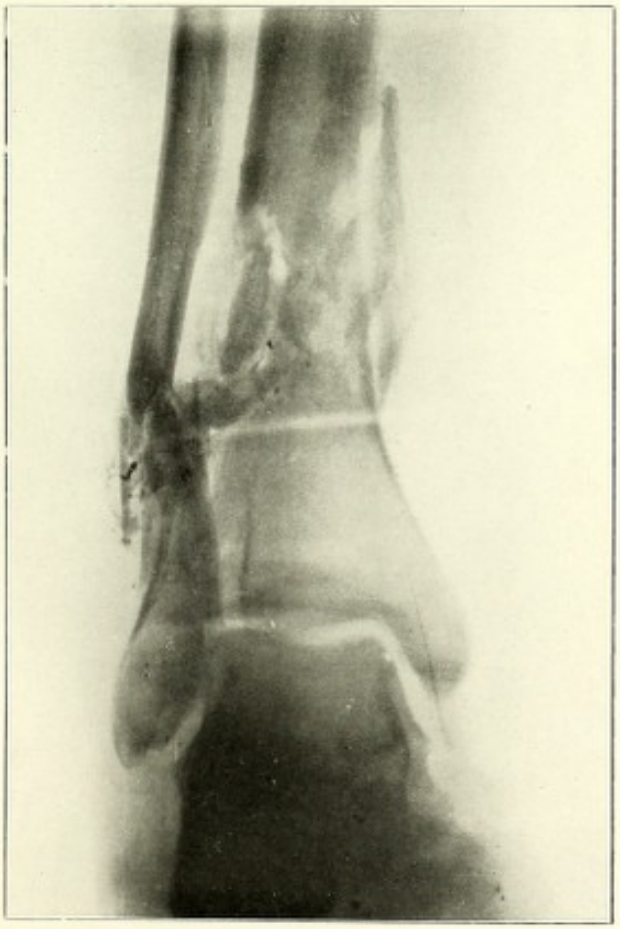


FIG. 51B.
Same Case as 51A: Antero-posterior View.—(By MR. SELLS.)

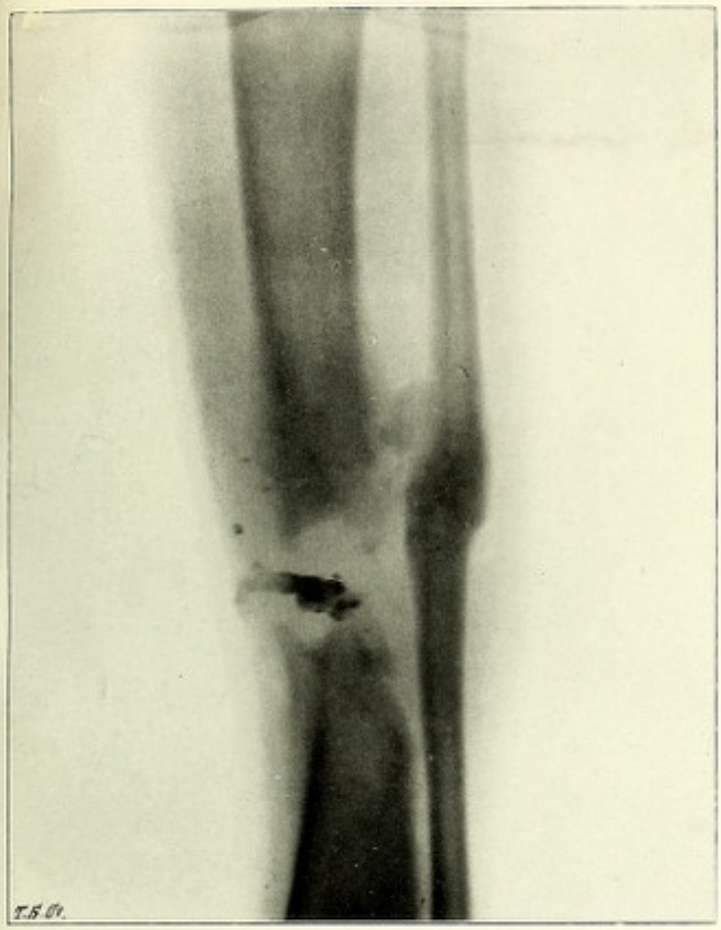


FIG. 52.

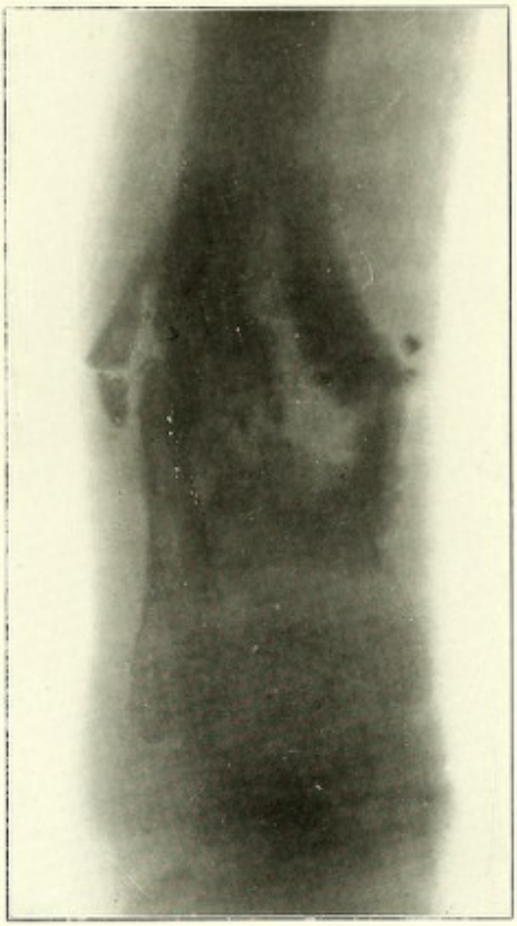


FIG. 53.

Gunshot Fracture of Leg.—(Skiagraphed at Netley.)

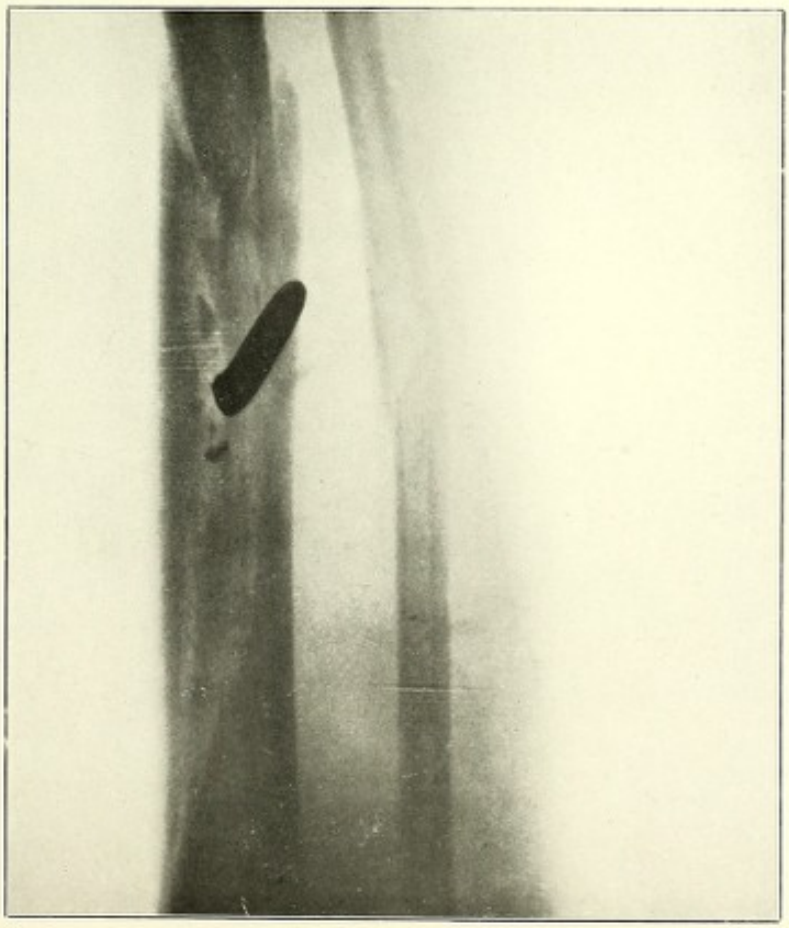


FIG. 54.
Fracture of Leg Bones.—(Skiagraphed at Netley.)

FIG. 55.
Wedge-shaped Fracture of Tibia.—(Skiagraphed at Netley.)

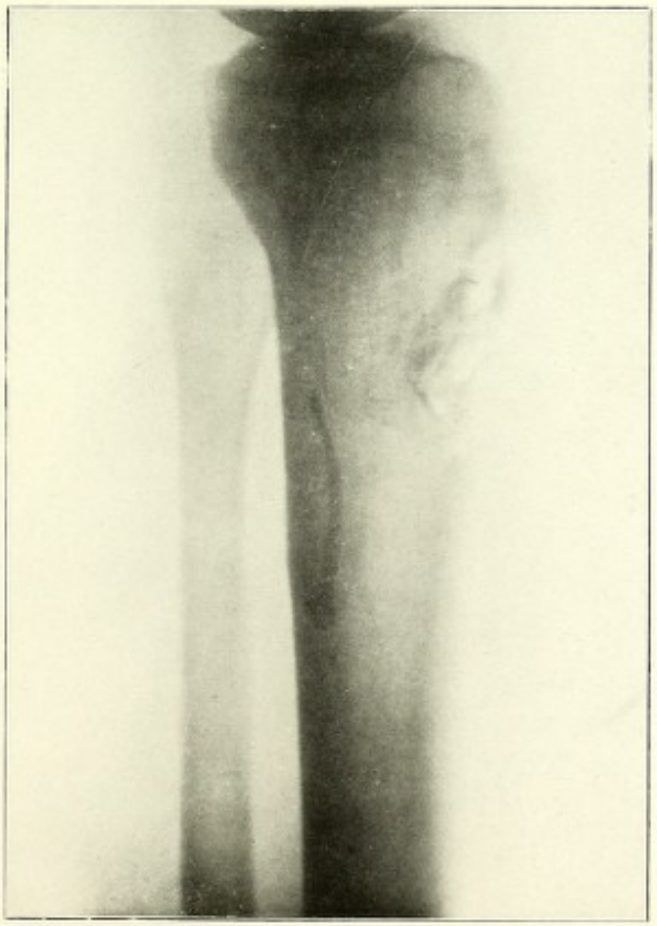


FIG. 56.
Incomplete Fracture of Tibia by Pom-Pom Shell.—(By Mr. SELLS.)

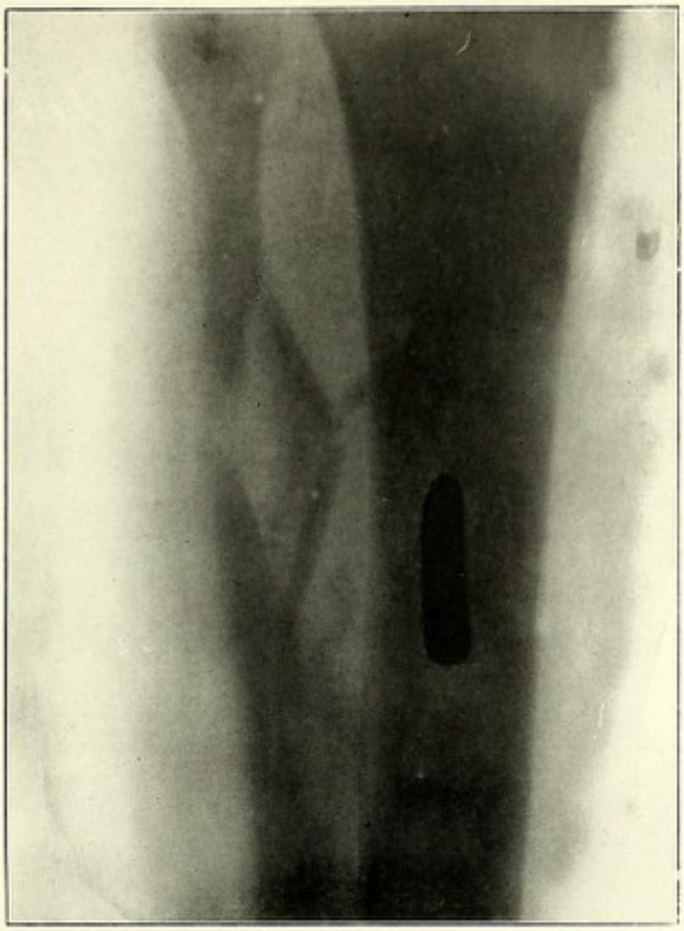


FIG. 57.
Gunshot Fracture of Fibula : bullet lodged.—(By Mr. CATLING.)

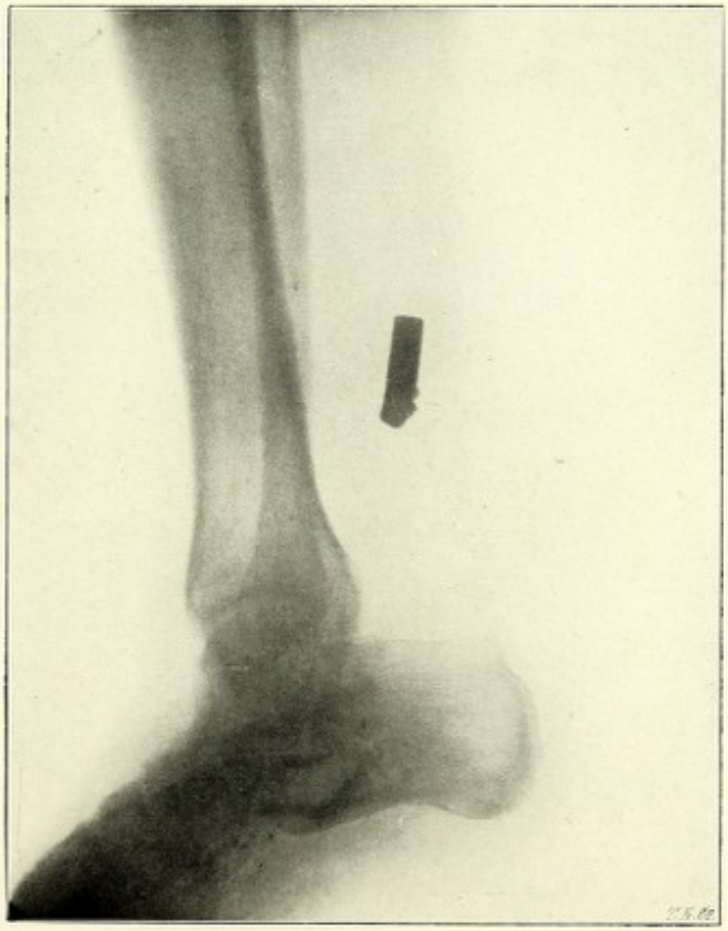


FIG. 58.
Ricochet Bullet lodged in Calf Muscles : Removed.—(Skiagraphed at Netley.)

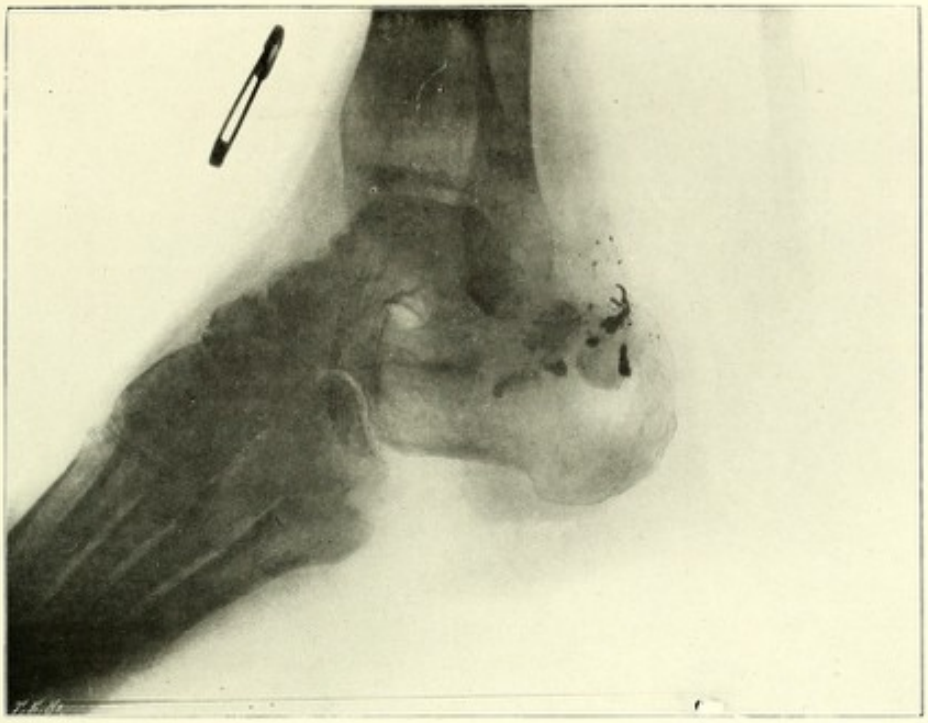


FIG. 59.

Fragments of, probably, Soft-nosed Bullet.—(Skiagraphed at Netley.)

FIG. 60.

Fragment of Mauser in Foot ; Removed.—(Skiagraphed at Netley.)

FIG. 61.

Mauser Deformed against 1st Metatarsal Bone, and lodged.—(Photographed at Netley.)

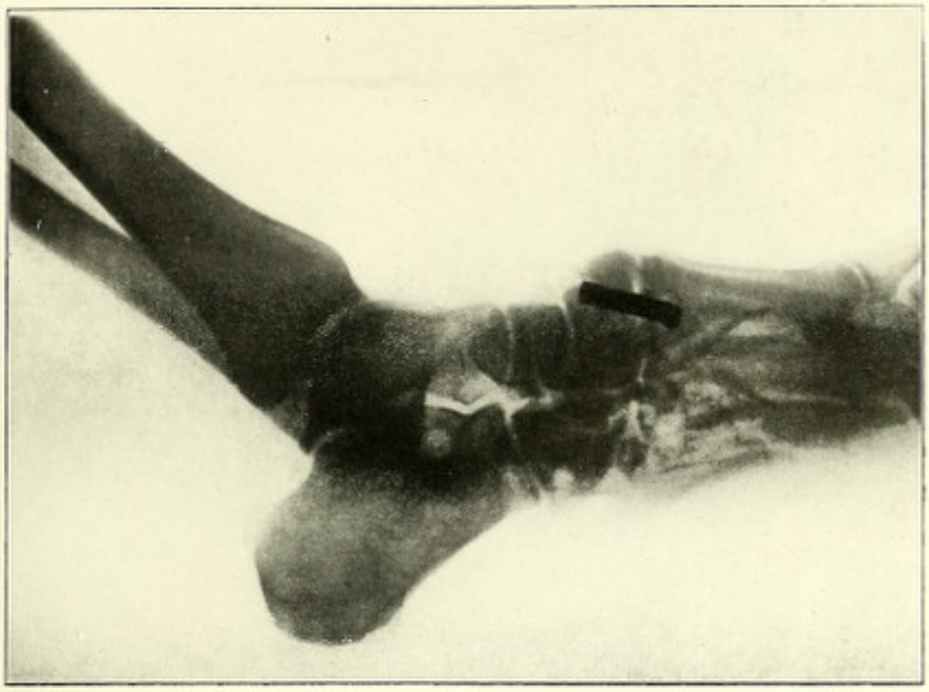


FIG. 62.

Fractures of Metatarsal Bones. Bullet flattened at point.—(By Mr. SELLS.)

FIG. 63.

Mauser lodged in Medullary Canal of Tibia: it entered above patella while knee was flexed to a right angle, and passed down canal. Tibia fractured and fissured at narrowest part. Bullet produced no symptoms, and was not removed.—(By Captain PRESCOTT, D.S.O.)

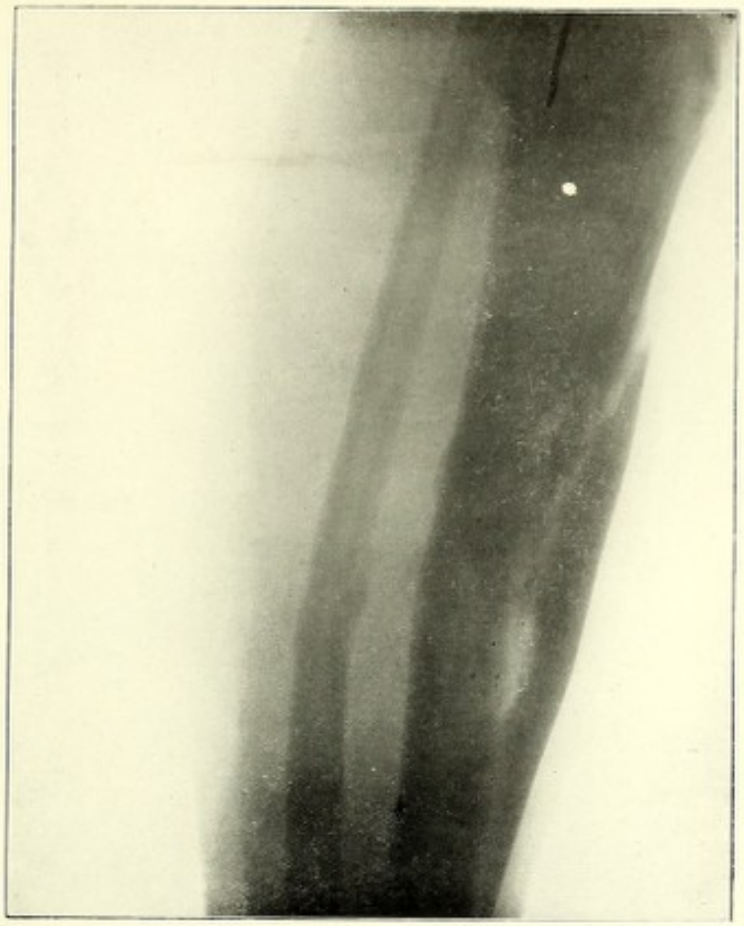


FIG. 64.
Gunshot Fracture of both Bones of Leg.—(Skiagraphed at Netley.)

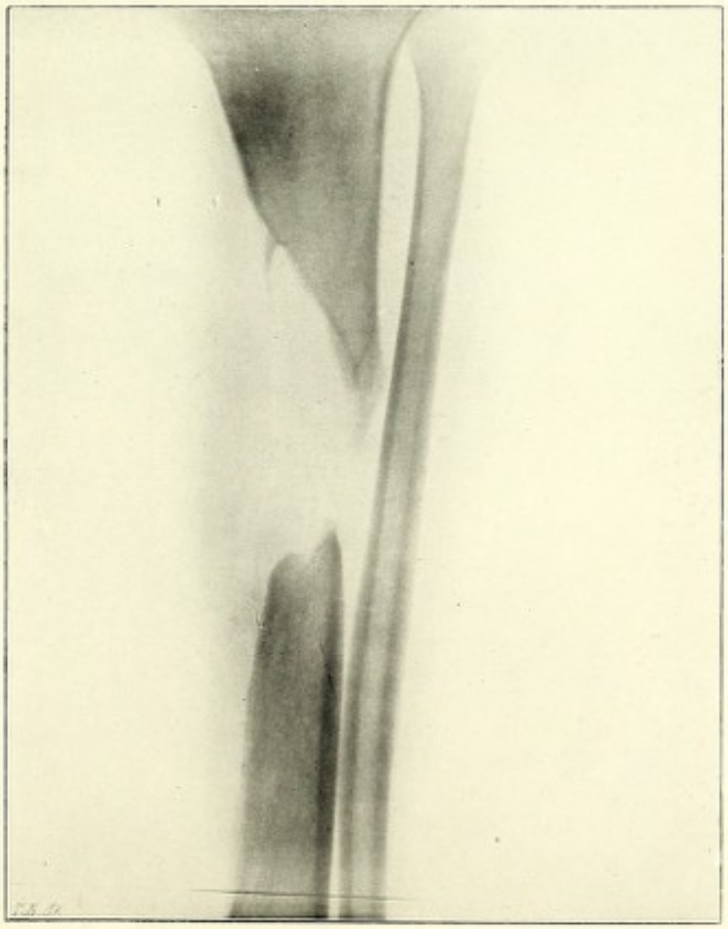


FIG. 65.
Much Loss of Bone at Site of Fracture.—(Skiagraphed at Netley.)

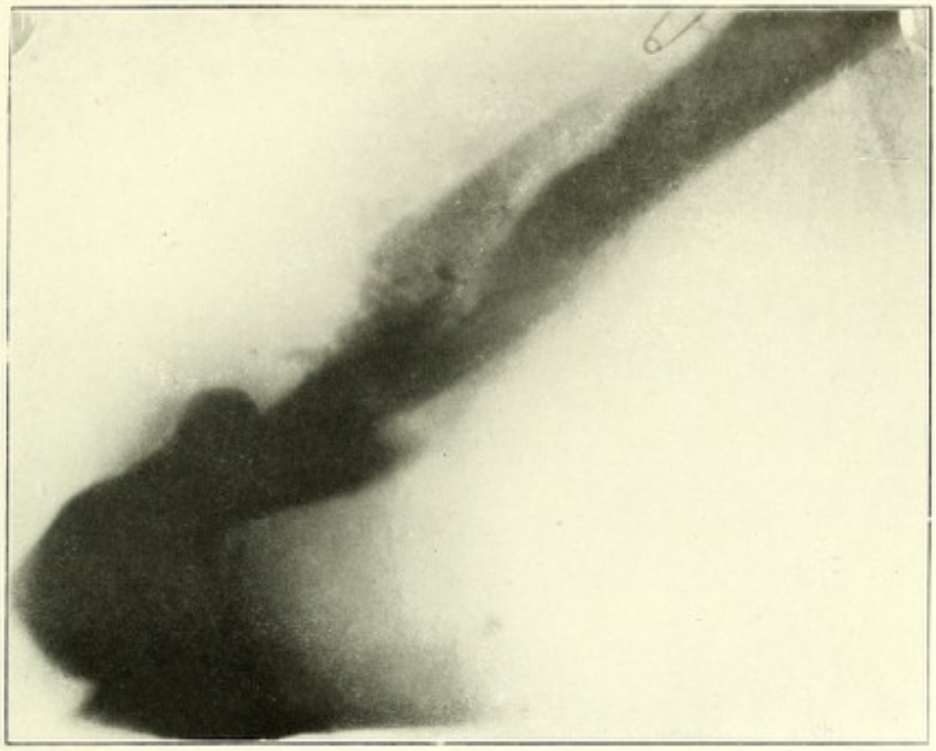


Fig. 66.

Comminution of the Humerus; range 250 yards.—(By Mr. Catling.)

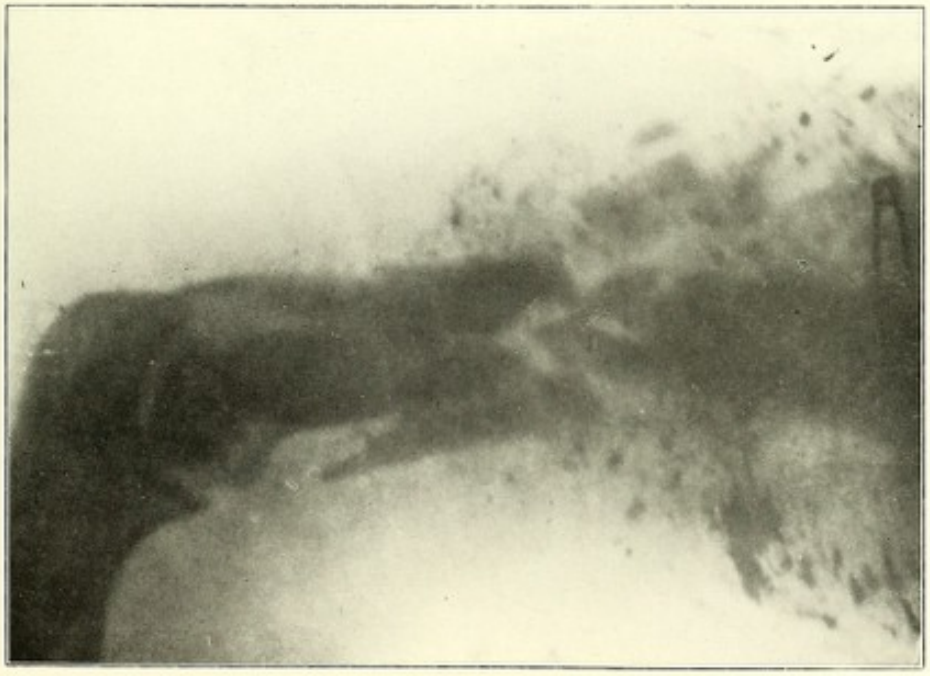


Fig. 67.

Comminution of Humerus.—(By Mr. Sells.)

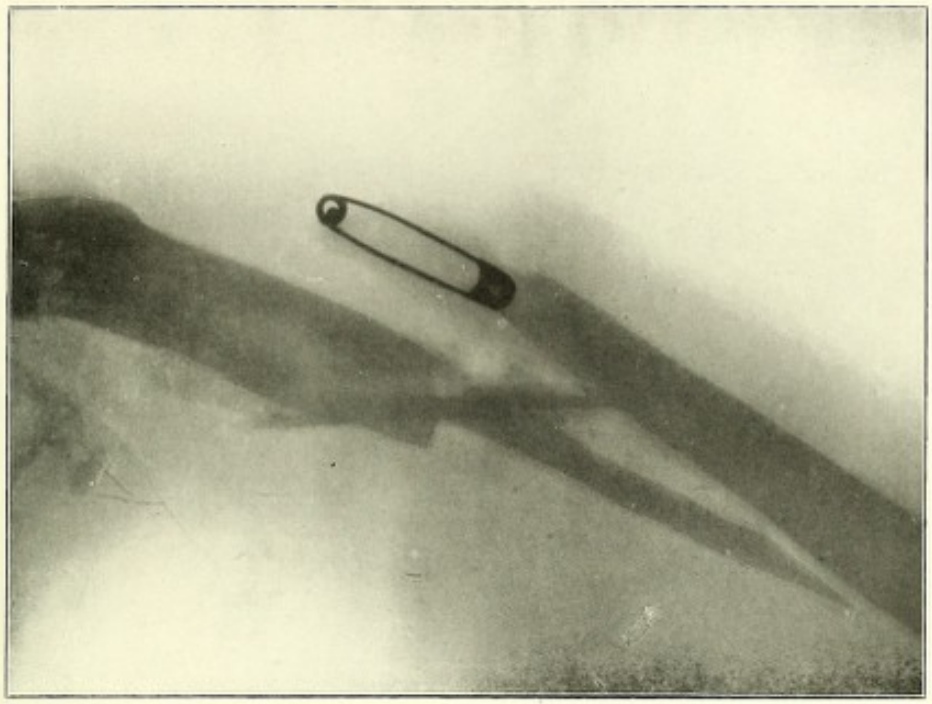


FIG. 68.

Comminution of Humerus.—(By Mr. SELLS.)

FIG. 69.

Comminution of Humerus.—(By Mr. CATLING.)

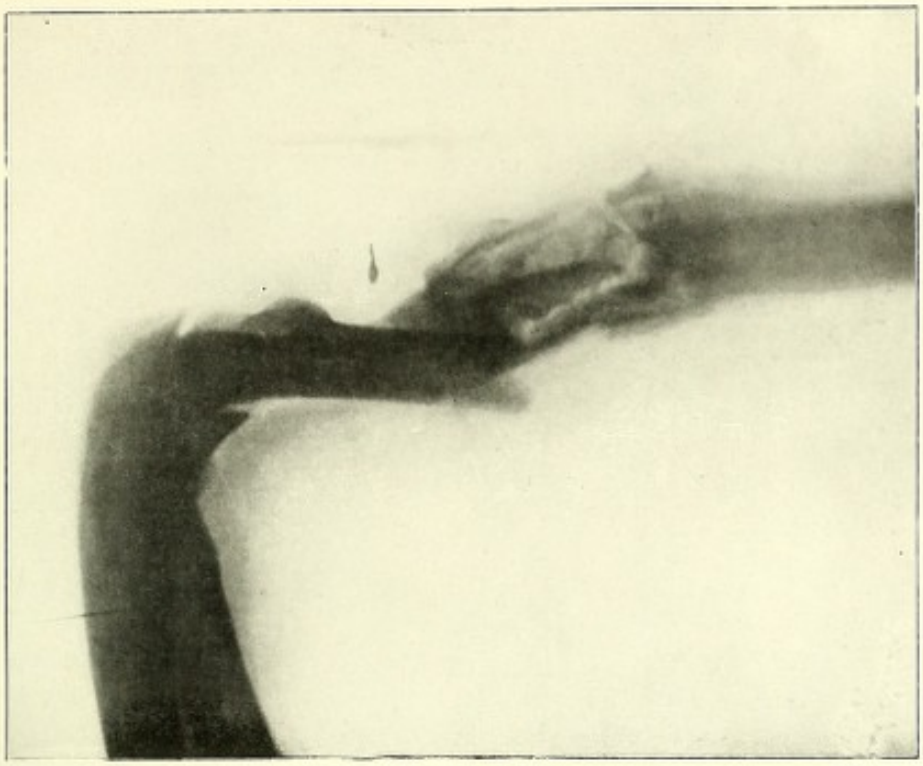


Fig. 70.

Gunshot Fracture, stated to have been produced by a Soft-nosed Mauser.—(By Mr. Sells.)

Fig. 71a.

Gunshot Fracture of Humerus, some months after receipt of injury ; the wires were on the skin, marking the ends of the sinus.—(Skiagraphed at Netley.)

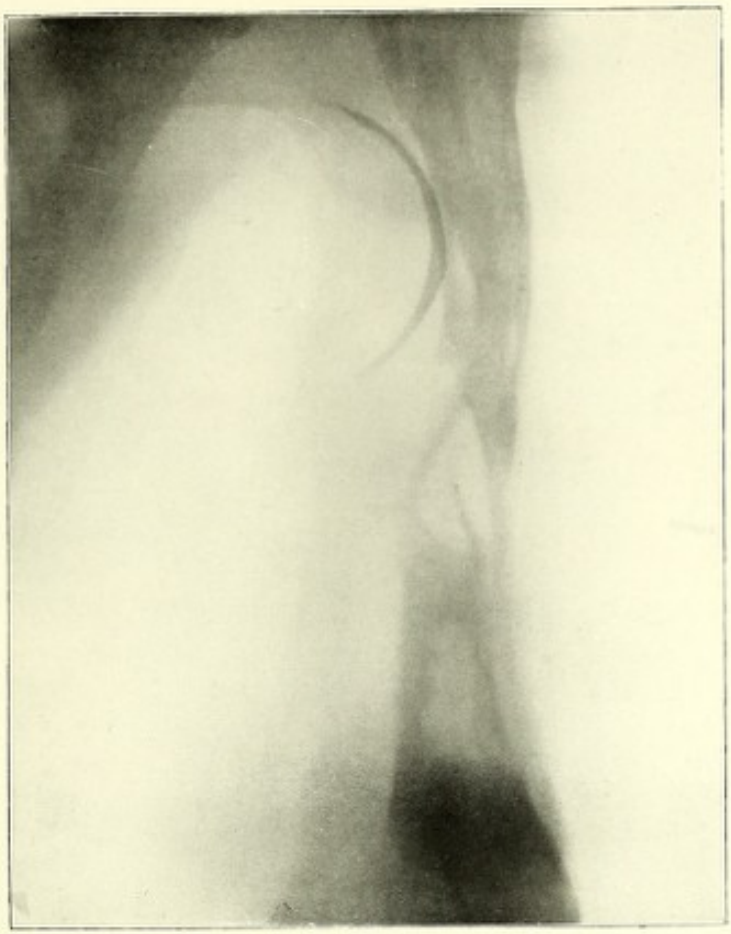


Fig. 71b.

Case 71a. Many months later: union seemed to be fairly strong.—(Skiagraphed at Netley.)

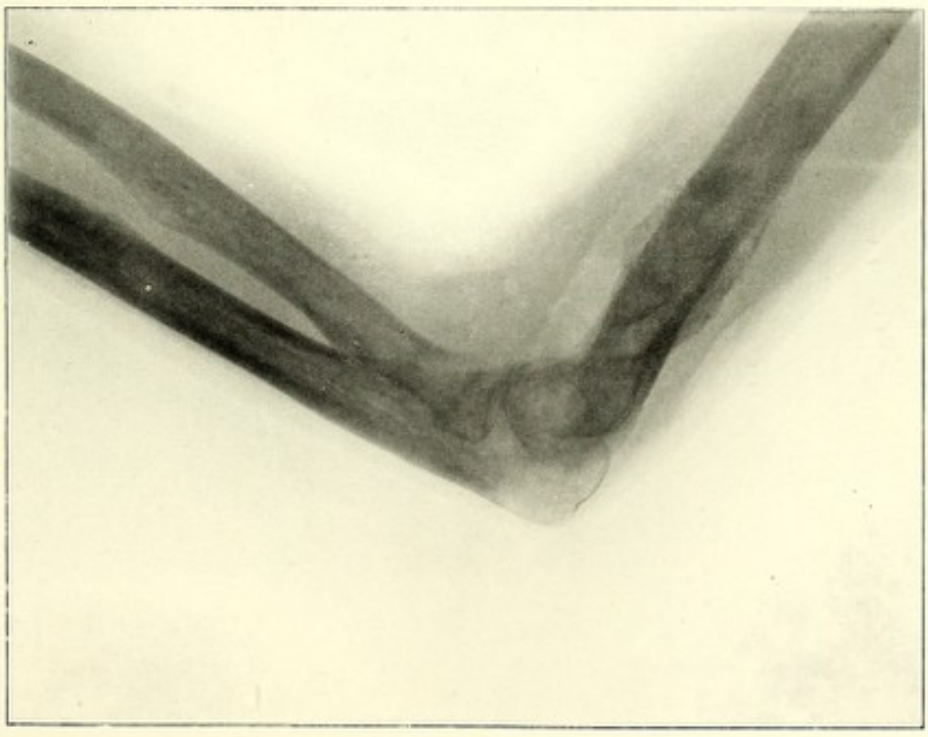


Fig. 72.

Gunshot Fracture of Humerus: callus very clearly seen.—(Skiagraphed at Netley.)

FIG. 73.

Gunshot Fractures of Radius in one ARM, of Ulna in the other, in the same case.
(By Captain STAMMERS, R.A.M.C.)

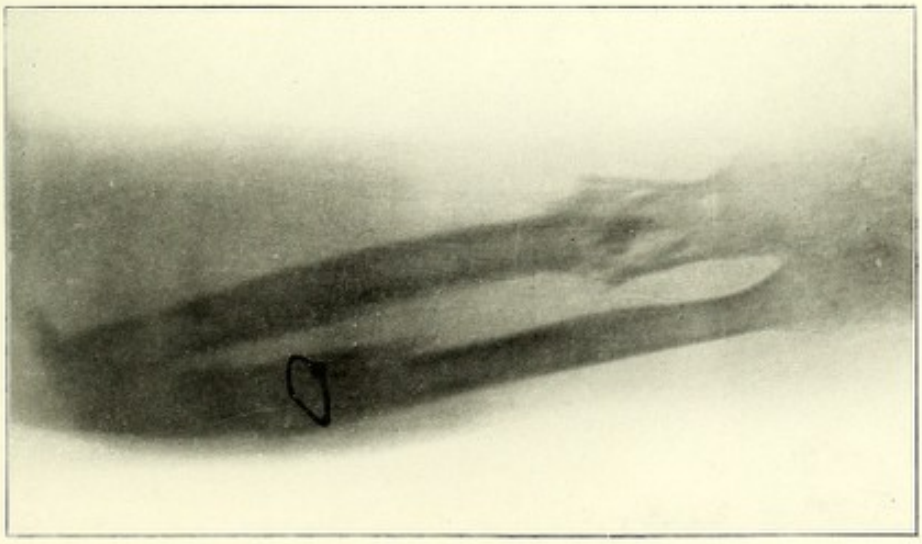


FIG. 74.

Ulna wired ; Case 83 in Notes.—(Lieut.-Colonel FREYER'S Case.)

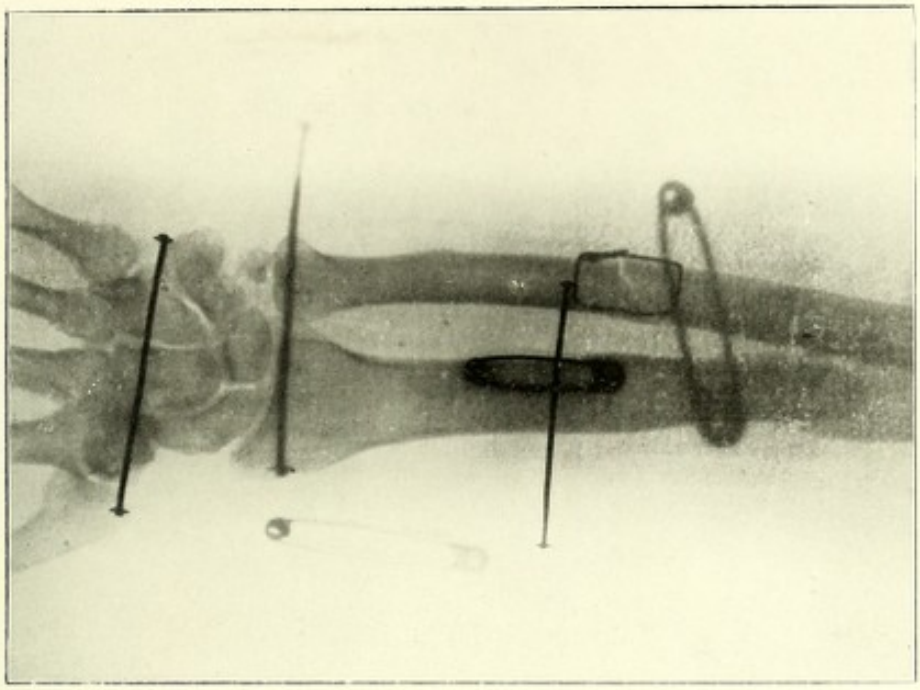


FIG. 75.

Ulna Wired ; Case 84 in Notes.

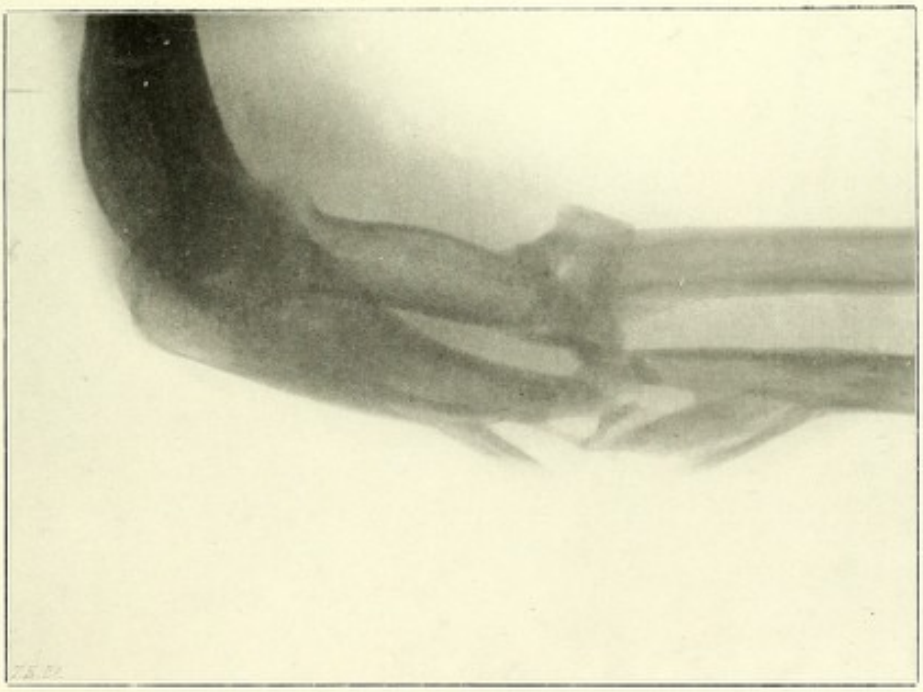


FIG. 76.

Gunshot Fracture of Both Bones of Forearm ; Entrance on Radial Side.—(Skiagraphed at Netley.)

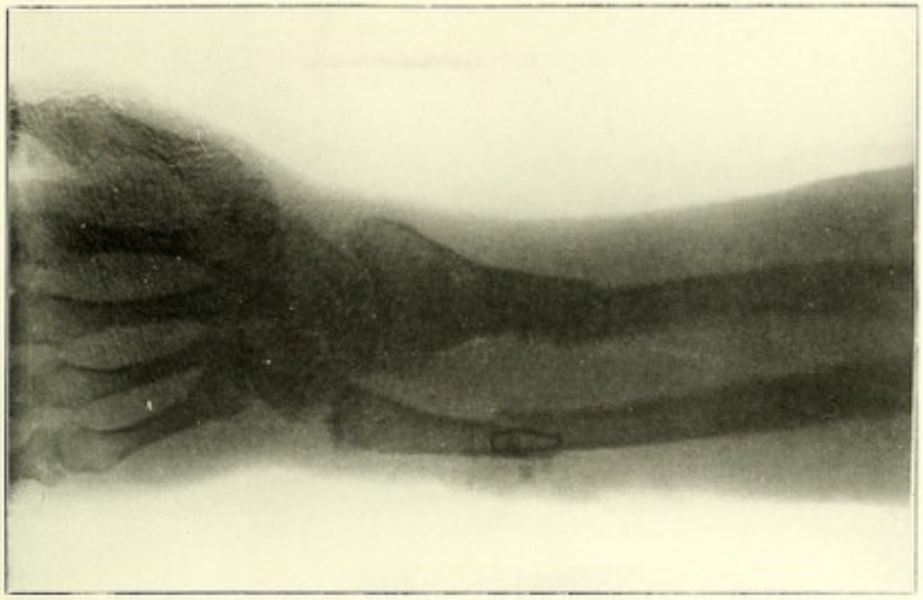


FIG. 77.

Gunshot Fracture of Both Bones of Forearm ; Ulna Wired.

FIG. 78.

Radius Fractured in two places ; many pieces of bullet lodged.

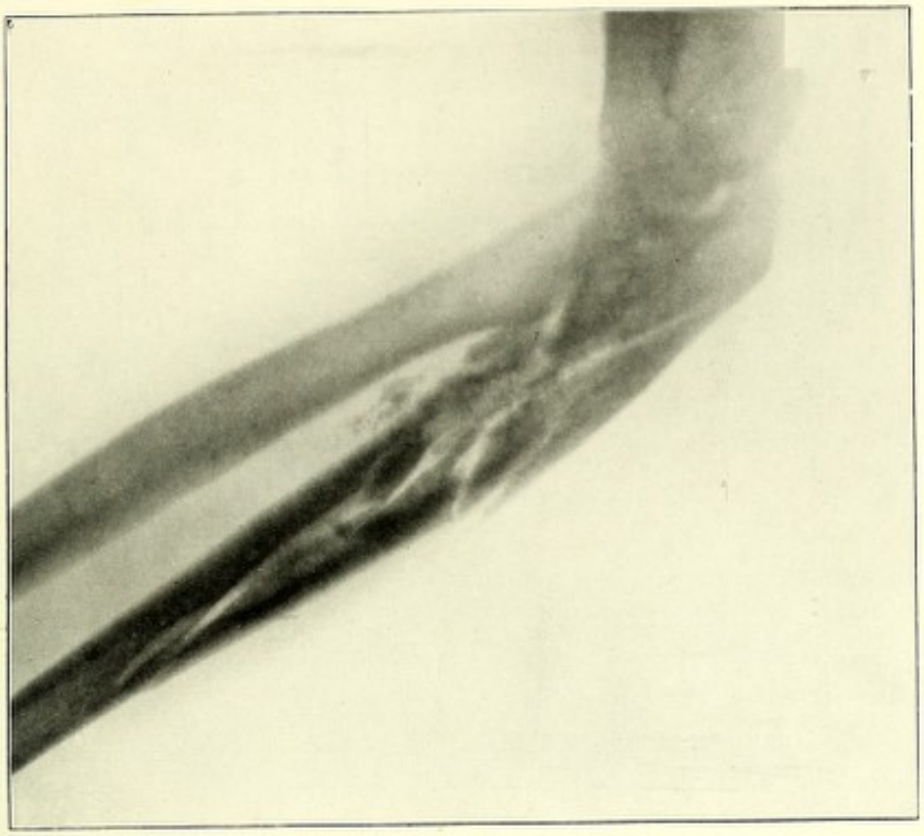


Fig. 79.

Very Severe Comminution of Ulna.

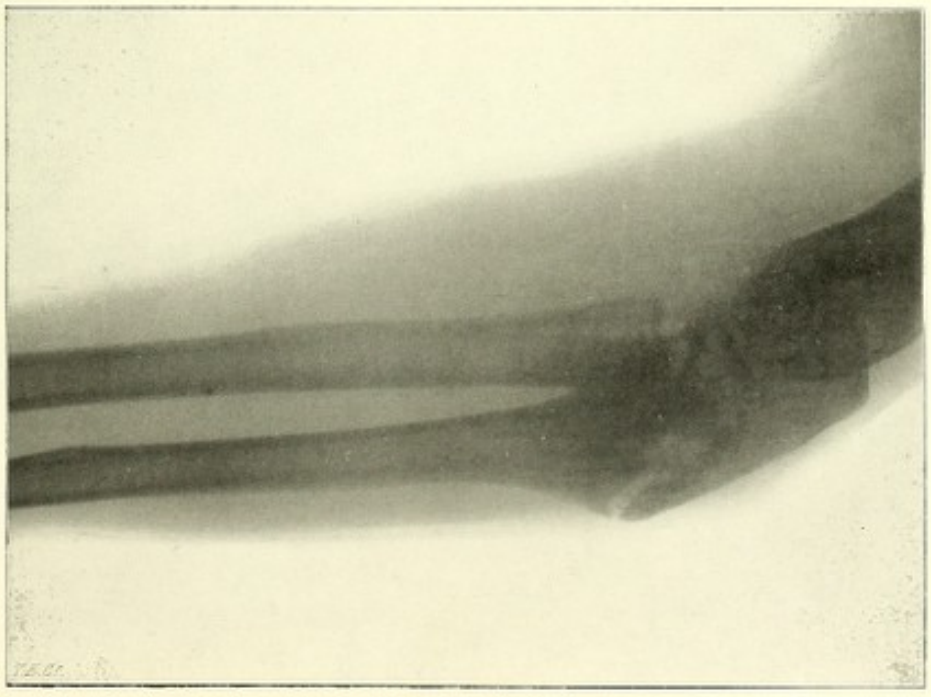


Fig. 80.

Gunshot Fracture of Ulna.—(Skiagraphed at Netley).

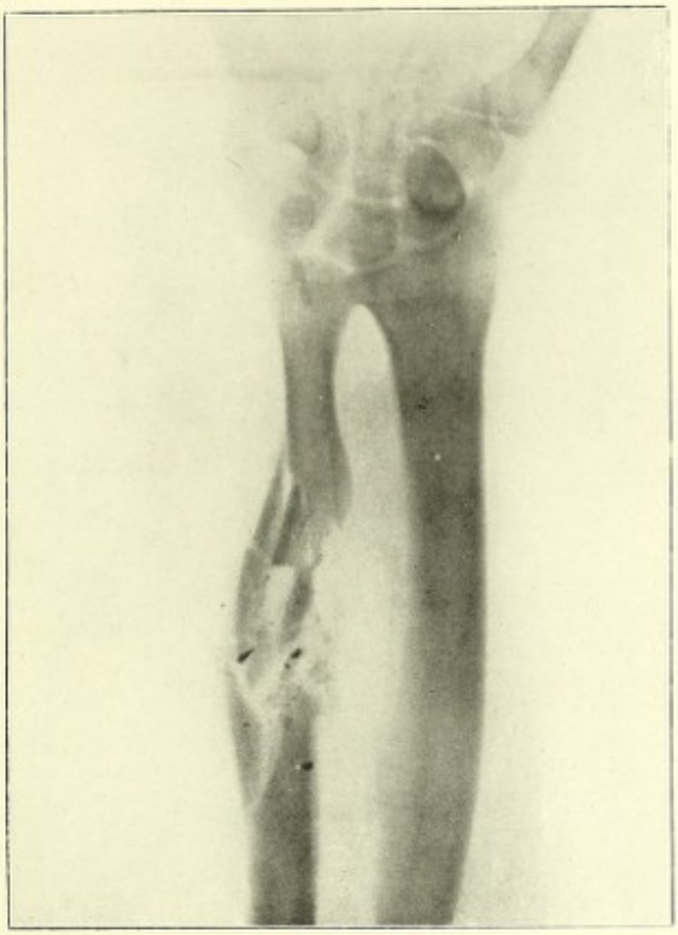


FIG. 81.

Severe Comminution of Ulna.—(By Mr. SELLS.)

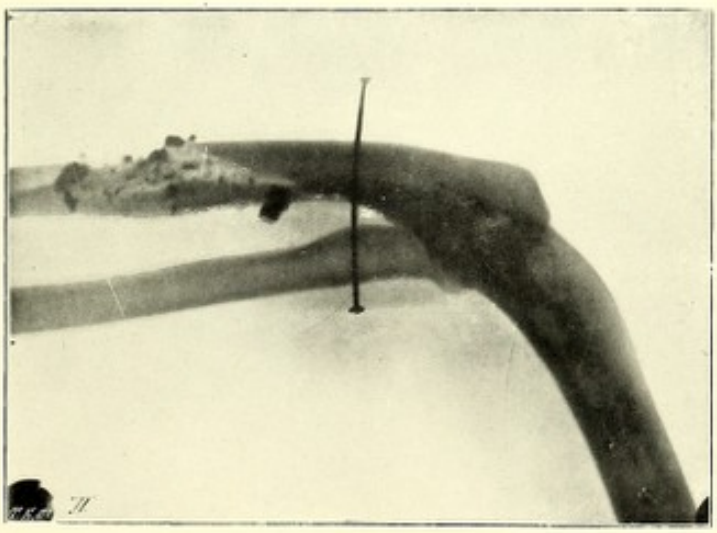


FIG. 82.

(Skiagraphed by Mr. SELLS.)

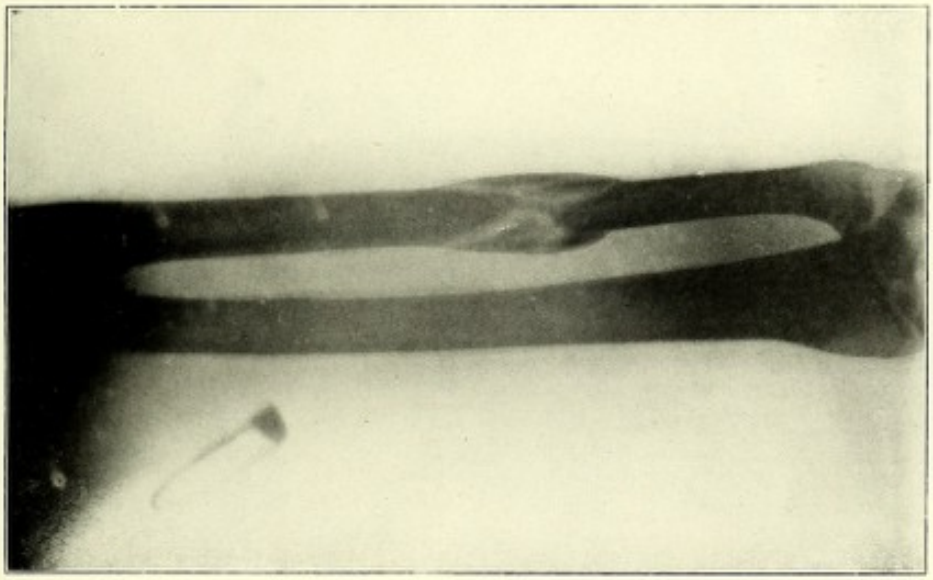


FIG. 83.
(Skiagraphed by Mr. SELLS.)

SECTION VIII.

By Bt. Lieut.-Colonel S. Hickson, R.A.M.C.

GUNSHOT WOUNDS OF JOINTS.

Gunshot wounds of joints now aseptic as a rule.

It is in connection with the joints that one of the distinctive features of wounds inflicted by the modern rifle-bullet becomes most apparent. In former days, when the projectile was large, even though its velocity was low, joint injuries, were, as a rule, of a very destructive nature, and a prolific cause of amputation or death. The introduction of the modern rifle of small calibre and high velocity, together with the advent of antiseptic surgery, has, however, completely altered the character and prognosis of joint wounds. Taken as a whole, the mortality from this class of injury during the late war has been undoubtedly low and the primary amputations infrequent.

Sepsis the most important factor.

The most important factor in all joint wounds, whatever the character of the lesion, is the presence or absence of suppuration, the gravity of an injury to a joint depending not so much upon the nature and extent of the wound as upon its septic or aseptic condition.

In collecting and classifying joint wounds, a number of cases have been noticed in which surgeons experienced great difficulty in determining whether the joint had been wounded or not; such cases have not been included in this Report.

Majority of wounds caused by Mauser.

The great majority of joint injuries recorded during the late war were inflicted by the modern small-bore rifle, either Mauser or Lee-Metford; but instances of wounds from every description of projectile have been noted, some examples of which will be given below, and the tables of mortality, amputations, &c., have been prepared from the total numbers of wounds irrespective of the varieties of projectiles.

Difficulties of diagnosis.

In many of the cases so slight are the effects of a Mauser or Lee-Metford bullet on a joint, that it is only after a careful consideration of the direction of the track of the bullet that a diagnosis can be made. The presence of fluid in an articulation is not pathognomonic of joint injury, as it not infrequently occurs in connection with injuries of the shafts not implicating the epiphyses, as a result of concussion, and has been noted by many surgeons and described by Mr. Makins as "Vibration Synovitis."

Classification.

Wounds of joints may be conveniently divided into two great classes: (1) in which the joint has been penetrated without injury to its bony constituents, and (2) those involving bone injury, these being by far the more frequent. The second class, again, includes the several varieties of fractures, *i.e.*, perforations, grooving, comminution, and occasionally fissures arising from wounds of the shaft in proximity to the epiphysis.

I.—*Simple Capsular Wounds without Implication of Bone*

When not implicating bone.

Rare in any situation, these are commonest in the knee joint, by reason of its size, the shape of the lower epiphysis of the femur, and the extent of the synovial pouches. If caused by a small-bore bullet they are usually small aseptic wounds, healing readily and causing no symptoms beyond those depending on the presence of fluid within the joint, the effusion being a mixture of blood and synovia. The treatment generally carried out in these cases was simple: the skin was sterilised, the punctured wounds sealed with antiseptic dressings and the limb placed at rest on a splint until the wounds were healed. Early massage, with the object of preventing adhesions, is a most important part of the treatment in cases of this description. Suppuration seems to be a rare event in simple punctured capsular wounds, and, should it occur, free incision and drainage of the joint is required.

The following cases illustrate the above remarks :—

Examples :— Simple aseptic capsular wound.

Case 1.—Private H., wound of right knee. Projectile Mauser. Estimated range about 1,000 yards. Joint wounded, but apparently no bony injury. Exit and entrance wounds both small. Was aseptic throughout. Treatment : antiseptic dressings. Result—Healed, with some stiffness of joint, which is diminishing.—(Civil Surgeon Corcoran.)

Septic. Simple capsular wound.

Case 2.—Private M., wounded 22nd October, 1900. Grazing wound outer side right knee, 2 inches long. Synovial fluid escaped. Pain and swelling of joint. Admitted 12 General Hospital 27th October, 1900. Pus found in joint with exploring syringe. Joint freely incised laterally, irrigation, drainage tubes. Daily irrigation till 6th November, 1900. On 1st December, 1900, wounds healed ; patella freely movable ; synovial membrane thickened ; knee can be flexed to a right angle. Transferred to Base 7th December, 1900.—(Major Lougheed, R.A.M.C.)

II.—*Joint Wounds Involving the Bony Constituents.*

When implicating bone, usually a clean perforation.

1. *Perforation.*—In this, the commonest form of joint injury, the bullet drills the cancellous tissue of the articular extremities, passing through the joint in its course. The type of perforation is generally pure, *i.e.*, without fissuring or comminution ; there is no solution in the continuity of the bone, and, broadly speaking, it may be described as the typical wound by the modern rifle. Wounds of this description, as a rule, heal readily without suppuration, and cause no permanent limitation of movement. It is, indeed, remarkable how quickly these wounds were recovered from ; they healed more readily than simple flesh wounds of moderate extent, and did not seem to be more serious than simple capsular punctures without implication of bone. In wounds of this class the apertures of entrance and of exit are small, equal in size, and correspond to the calibre of the bullet ; there is generally effusion, varying in extent, into the joint, consisting of a mixture of blood and synovial fluid, and the patient's temperature is generally raised. Should the wound remain aseptic, as is fortunately the rule, healing takes place under a scab in a few days, no treatment being required other than the usual antiseptic routine, with rest on splints followed by early massage. The local application of ice has been well spoken of in a few instances, but this form of treatment is not free from danger when used in connection with open wounds. The most favourable cases are those in which the impact is perpendicular to the surface, *i.e.*, the bullet traverses the bones and joint by the shortest route, long oblique tracks being more prone to suppurate, and there is, at least, some evidence to show that the higher the velocity of the bullet the cleaner is the perforation of the cancellous epiphyses. Treatment must, of course, be modified should sepsis supervene, free incisions and drainage being required, and should these measures be unsuccessful in arresting the septic process, excision or amputation may become necessary. Several instances of retention of bullets within the various articulations, such as the hip, the knee or the elbow joints, have been reported, examples of which will be given below.

Generally aseptic.

Character of the skin wound.

Instances of aseptic perforation.

The following cases illustrate the rapidity with which aseptic perforations of the knee joint may heal ; the close range may have contributed to the purity of the perforation in Case 3.

Knee joint; aseptic.

Case 3.—Corporal L., aged 30, wounded 26th May, 1900 ; estimated range, 35 yards ; projectile, probably Mauser. Entry inner side of middle of right patella ; exit on outer side of popliteal space. When admitted into 3 General Hospital, Kroonstadt, on 2nd June, 1900, only eight days after the date of injury, the wounds are described as being healed. He also suffered from a flesh wound below the iliac crest on left side ; this was suppurating, and took longer to recover from than did the wound involving the knee joint. He was discharged to Convalescent camp, date not given.—(Civil Surgeon A. Young.)

Shoulder joint; aseptic.

Case 4.—Captain M., wounded 1st April, 1902. Entry in front of shoulder joint, close to the anterior fold of axilla ; exit behind, 2 inches below spine of scapula ; track apparently passing through the joint. Treatment—

Usual dressings; arm bandaged to side for fortnight; then passive motion. Last note states, "Doing well, can raise arm to shoulder." Transferred to base.—(Lieutenant RICHARDSON, R.A.M.C.)

CASE 5.—Major G., wounded Colenso 15th December, 1899; projectile, Mauser; estimated range, 1,000 yards; posture when wounded, kneeling. Entry, normal size of Mauser, 3 inches above and 1 inch to left of right patella; bullet passed from above through joint and exit 1½ inches below and slightly to right of mid-line patella. Treated in Base Hospital, Maritzburg; noted that "wound healed without trouble"; passive motion end of first week. Invalided to England, and returned to campaign, walking without limp.—(Civil Surgeon IRVINE.) Knee joint; aseptic.

CASE 6.—Private S., wounded 24th January, 1900; projectile, Mauser; estimated range, 50 yards. Entry small, size of Mauser bullet, over greater tuberosity of right humerus, passed through head of humerus, and exit at top of posterior axillary fold, exit wound similar in size to entry. Admitted Modi River Hospital 31st January, 1900; ordinary antiseptic dressing with massage, and passive motion after 10 days; healed aseptically; discharged hospital 7th February, 1900.—(Civil Surgeon F. MARTIN.) Shoulder joint aseptic.

CASE 7.—Private S., aged 17, wounded 17th December, 1901; projectile, revolver bullet; range not stated. Entry over left patella; exit through calf a hand's breadth below joint; posture, kneeling. Admitted to General Hospital 21st December, 1901; temperature, 101° F.; pus welling from entry; no loose bone; joint swollen and fluctuating; chloroform, and lateral incisions into joint; pus and blood evacuated; drainage tubes; irrigation; splint; did well; wounds gradually closed; temperature fell. Invalided 6th March, 1902, when movements of joint improving, flexion = ¾ on discharge.—(Captain FAICHNIE, R.A.M.C.) Knee joint; septic.

It occasionally happens that a bullet on striking a joint does not possess sufficient remaining velocity to enable it to emerge, and it is retained, either lying loose in the articulation, or embedded in the bony constituents. A few examples are given here, as this condition may be regarded as one of incomplete perforation. Retention of bullets.

CASE 8.—Driver T., wounded Sanna's Post 31st March, 1900. Entry outer part middle right popliteal space; no exit. Admitted 2 General Hospital 26th April, 1900; joint painful, semi-flexed, some effusion; X-rays showed bullet lying obliquely in joint, apex forward. On 1st May, 1900, joint incised along outer border lig. patellæ; removal of bullet; incision closed; posterior splint; union by first intention. Invalided 23rd May; slight limitation of movement; improving.—(Major LOUGHEED, R.A.M.C.) Instances of lodged bullets. Knee joint.

CASE 9.—Private E., wounded 18th July, 1900 (Mauser); admitted Imperial Yeomanry Hospital, Deelfontein, 18th August, 1900. Entry in abdominal wall 1½ inches vertically above left pubic spine; no exit; entry healed; no tenderness, but pain on movement around left hip. X-rays showed bullet on level of neck of femur, 2¾ inches from skin of buttock. Oblique incision in buttock, parallel with fibres of gluteus max. Part of quadratus femoris divided; capsule of joint exposed and incised; nose of bullet seen protruding about ¼ inch from posterior compact layer of neck of femur, firmly embedded, and by a little gouging extracted; uninterrupted recovery; left for Base in three weeks. Movements of hip almost complete.—(Messrs. JOHNSTON and BALLANCE.) Hip joint.

CASE 10.—Private B., aged 27; wounded 25th February, 1902; entry through lig. patellæ; head of tibia grooved; no exit. Admitted 20 General Hospital; joint inflamed. On 31st March, 1902, inflammation subsided; bullet removed from joint at outer side patella. On 8th April, 1902, dressings removed; union complete. 12th April, 1902, movement of knee quickly improving. Invalided 30th April, 1902.—(Major WHAITE, R.A.M.C). Knee joint.

Retention of soft-nosed bullets.

The two following cases, Nos. 11 and 12, are of special interest as showing the small amount of damage sometimes inflicted on a joint by even a soft-nosed bullet; the estimated range is not given, but it was probably extreme and the bullets "spent":—

Radio-ulnar joint.

CASE 11.—Private F. G., wounded Klipdrift 16th February, 1900. On admission to 2 General Hospital, wound healed. Entry, an oval scar over anterior surface of external condyle left humerus; no exit; impaired movement and pain in joint; X-rays showed bullet. On 2nd April, 1900, incision behind between olecranon and head of radius. Soft-nosed Mauser extracted, lying between head of radius and lesser sigmoid cavity of ulna; healed first intention; movement somewhat limited. Invalided 25th April.—(Major LOUGHEED, R.A.M.C.)

Hip joint.

CASE 12.—Lieutenant D., wounded at Wepener; admitted into Base Hospital, Maritzburg. Entry 4 inches below and in line with great trochanter; no exit. Bullet removed from outer aspect of capsule of hip joint; recovery.—(Civil Surgeon JOHNSTON.)

Grooved wounds of joints.

2. *Grooved wounds* of the articular surfaces differ from perforations in that the bullet instead of striking the joint more or less vertically and crossing the joint by the shortest route, impinges at an oblique angle and forms a long groove or tunnel in the articular surface. Such injuries cause a larger wound in the capsule than do perforations, are more liable to septic infection, and suppuration may exist in the deeper portions of the track after the external wounds have healed. The two following cases are examples of aseptic and septic grooved wounds of the bones of the knee joint:—

Examples:—
Knee; aseptic.

CASE 13.—Private H., wounded Paardeberg 26th February, 1900. The groove implicated the articular surfaces of femur, tibia, and patella. Projectile, Mauser; estimated range between 400 and 500 yards. Entry above patella, scoring its under surface, and grooving articular ends of femur and tibia. (Site of exit not described.) Both entry and exit small. Admitted 1 General Hospital 21st March. Wounds healed, but joint full of fluid, probably blood. Treatment: Bed, with absolute rest to joint; bandaging and back splint; swelling disappeared; movements of joint almost quite free; invalided.—(Civil Surgeon DUNLOP.)

Knee; septic—Incision—Amputation—Death.

CASE 14.—Private B., wounded Paardeberg 18th February, 1900. Entry, inner side left tibia, 3 inches below tubercle; exit 2 inches above joint on outer side. Projectile, Mauser; range unknown. Admitted 1 General Hospital 25th February, 1902. Marked "Bed," but on 27th February got up and walked to latrine. When trying to sit down his knee suddenly became extremely painful; suppurative arthritis supervened. On 2nd March, 1900, incisions on either side of joint; evacuation 4 ozs. pus; washed out with boric lotion. On 10th March, 1902, septicæmia; amputation at mid. third thigh. On 14th March, 1902, profuse secondary hæmorrhage; ligature of bleeding vessels in stump; intravenous infusion; died. Examination of amputated limb showed suppuration of about 2 inches of track between entry and tibia; a small abscess had formed in this position, and evidently burst into joint on movement.—(Major BURTON, R.A.M.C.)

Comminuted joint fractures usually suppurated.

3. *Comminuted Fractures and Fissures Implicating Joints.*—Comminuted fractures in connection with joints occurred in every degree, from the slighter forms associated with impure perforations, to complete shattering of the articulation. They were often caused by the impact of large projectiles such as shell, shrapnel, and rifle bullets of large bore, but may also result from the modern small-bore rifle bullet at short ranges. When caused by the latter they arise from comminutions of the diaphysis close to its termination, the resulting fissures extending into the neighbouring joint, when the comminution of the articular ends, especially at short ranges, may be very great. These wounds commonly suppurated, and in extreme cases the joint was represented by a bag of pus containing numerous small fragments of bone. I have by me as I write the fragments of the head of the humerus of a patient of mine who was wounded by a Mauser bullet (said to be expanding) at 30 yards range

(*see* Fig. 92). The bullet struck the bone about 1 inch below the head, pulverising it at that point, causing a long fissure upwards, which completely divided the head into two parts, one of which remained whole, the other was shattered into innumerable fragments. It was very septic and was treated by excision of the head and the 1½ inches of the shaft. He made a good recovery with a useful arm. In addition to the above wound he also sustained a very severely comminuted gunshot fracture of the femur at the same time. Septicæmia supervened, and his thigh was amputated at the middle third. Fig. 88 is a photograph of a similar injury to the head of the tibia by a Mauser. Numerous examples of comminuted fractures implicating joints have been reported, and the treatment varied with the severity of the injury and the joint implicated.

Treatment.

In aseptic cases, and in the less severely septic injuries, good results were often obtained from simple methods, *i.e.*, the application of antiseptic dressings with rest to the joint by means of suitable splints, plaster of Paris, &c. Intra articular suppuration, not accompanied by severe comminution, was generally treated by free incision into the joint, irrigation and drainage, and in a few cases by removal of fragments. Severe, highly comminuted, septic wounds required further measures, and, in proportion to the severity of the local destruction and general symptoms, either the removal of loose fragments of the articular surfaces, excision, or amputation was adopted. The following cases are quoted as examples of comminutions of different joints.

Instances of comminutions; septic and aseptic. Shoulder joint; aseptic.

Case 15.—Private B., wounded right shoulder; neck of humerus slightly comminuted; projectile, probably Martini-Henry; estimated range about 200 yards. Exit, size of florin; aseptic; usual antiseptic dressings, arm bandaged to side, pad in axilla; sling; recovery; some stiffness in joint, but gradually disappearing; admitted 18th September, 1899; discharged 20th February, 1900.—(Major Macdonald, R.A.M.C.)

Knee joint; aseptic.

Case 16.—Private W., wounded 22nd November, 1900; comminution of lower femoral epiphysis, implicating knee joint (? fissuring). Exit wound small, ⅛ inch; Mauser; range about 1,100 yards; aseptic; usual antiseptic dressings and Listons' long splint; union with about 1½ inches shortening on 27th December, 1900. Invalided 5th February, 1901.—(Civil Surgeon Stott.)

Ankle and tarsus; septic.

Case 17.—Private E., wounded 18th February, 1900; admitted 1 General Hospital 28th February. Perforation of ankle with some comminution of tarsal bones. Projectile, Mauser; estimated range 300 yards; wounds diameter of Mauser bullet; slightly septic; usual antiseptic dressings and sand bags; wounds healed, good result; invalided 31st March, 1900.—(Civil Surgeon Gairdner.)

Knee joint; comminution—Amputation—Died.

Case 18.—Private S., wounded accidentally, Lee-Metford; range about 1 foot. Entry, inner side thigh 2 inches above knee joint; both condyles split into joint; admitted to 3 General Hospital; free primary hæmorrhage; removal of fragments of condyles; packed with gauze; McIntyre's splint. A week after admission joint was explored; osteomyelitis of femur present; medulla removed; subsequently amputation upper third, bone healthy at this point; died one hour later.—(Notes not signed.)

Shell wound, right knee joint—Amputation—Recovery.

Case 19.—Sergeant F., wounded Venter's Spruit 7th February, 1900; admitted Mooi River Hospital 11th February, 1900; large septic wound on inside right knee, exposing inner condyles and head of tibia; exposed bone eroded on surface, also large septic flesh wound on inner surface left thigh; 23rd February, 1900, amputation right thigh in lower third. Result—Primary union; invalided 29th March, 1900.—(Major Freyer, R.A.M.C.)

Knee joint; shell; septic—Arthrectomy—Recovered.

Case 20.—Private T., wounded Pieter's Hill 27th February, 1900; admitted 4 general hospital 1st March, 1900; large septic wound communicating with knee joint; comminuted patella; suppuration of joint; antiseptic irrigation; no improvement. On 14th March, 1900, joint explored by transverse incision; pus evacuated; fragmented patella and all diseased

synovial membrane removed, as well as some dead bone; scissors, knife and spoon freely used; irrigation and drainage; wound closed. Result: Wounds healed; stiff knee; invalided 15th May, 1900.—(Major FREYER.)

Elbow joint; septic—Excision—Amputation—Recovered.

CASE 21.—Driver H., wounded Colenso, shell, on 15th December, 1900; admitted 3 General Hospital; comminution of upper end ulna, olecranon torn off and dragged up by triceps; large cavity in posterior surface elbow joint; inflamed and septic joint; exposure of internal condyle humerus. Treatment: On 27th December, 1900, removal of olecranon and trimming off upper end ulna; on 5th January, 1901, complete excision of joint with removal of 2½ inches humerus much necrosed, and 1½ inches ulna and radius. On 9th January, 1901, amputation upper third arm. Last note is 19th January, 1901, when stump is described as "looking very well."—(Civil Surgeon KER.)

Shoulder joint; septic—Excision—Recovered.

CASE 22.—Shoeing-smith S., wounded 15th December, 1901; admitted 7 General Hospital 29th December. Entry behind, 1½ inches below spine of scapula, about 1 inch internal to joint; joint traversed, and head of humerus shattered; exit immediately in front head of humerus. Projectile and range not stated. Wounds very foul; joint full of pus; removal of fragments. On 25th February, 1901, as general condition was unsatisfactory, complete resection of head of humerus; free drainage. Result—Recovery, with very fair movement of arm; transferred to Base 20th May, 1902.—(Lieut.-Colonel MACNAMARA, R.A.M.C.)

Wounds of the Hip-Joint.

Rarity of wounds of hip joint.

Although the femur is one of the most frequently injured bones, wounds of its superior articulation seem to have been particularly rare in the Boer War. This was probably due to so much of the fighting having been done in the prone position behind "cover," when, perhaps, the hip-joint is the least exposed part of the body. Reports of only 7 cases of injury to the hip-joint have been collected, 2 of which were fatal. Of the 7 cases, in 3 the bullet was retained within the articulation, but this very high percentage of retention must be regarded as accidental, and not due to any anatomical peculiarities of the joint. Two cases were simple punctures of the capsule, and did not involve bone. In the 2 fatal cases the head of the femur was extensively comminuted, and complicated by comminuted fractures of the iliac crest and ischium respectively, and both were highly septic. Two excisions were performed, and one died. In connection with the retention of bullets within joints, two cases of wounds of this joint have been already quoted (Cases Nos. 9 and 12, above), and as the remaining cases are only 5 in number they may be cited here:—

Examples:—Hip; aseptic—Bullet extracted—Recovered.

CASE 23.—Private J. S., wounded 11th June, 1900; Mauser; estimated range 1,500 yards; admitted 3 General Hospital 13th June. Posture when struck, standing. Entry front of left thigh, 1 inch below Poupart's ligament, 2¼ inches below and inside ant. sup. spine, ¾ inch outside femoral artery. Great pain on slightest movement of hip. X-rays showed bullet in close association with head femur, 2 inches from posterior surface. On 16th June, 1900, bullet removed through fibres of gluteus max.; found in close relation to head of bone; bullet intact; nose rather flat, presumably from contact with head of bone. Primary union; hip movement good; walks without pain.—(Civil Surgeon A. YOUNG.)

Hip; septic—Excision—Died.

CASE 24.—Private B., aged 24, wounded Elands River 3rd August, 1900; projectile, shrapnel. Besieged with Colonel Hore's force; lay in shelter trench for 14 days; then journey on ox wagon for five days. Admitted 17 Field Hospital 22nd August, 1900. Entry small, behind and internal to great trochanter; track through left hip joint; exit large, 3 inches by 2 inches, over left iliac crest, which was fractured. Left leg in position of dorsal dislocation of femur. Very septic; fever; bedsores. 25th August, 1900, removal of fragments; dislocation reduced; free incision into hip joint; Liston's splint; delirium. On 8th September, 1900, excision of head of femur;

extensive necrosis of head; delirium. Death 14th September, 1900.—(Civil Surgeon A. BURTON.)

Hip; septic—Fragments removed—Recovered.

CASE 25.—Lieutenant O., wounded Rhenoster Kop; Mauser; range not stated; admitted Imperial Yeomanry Hospital. Entry in front, above Poupart's ligament; exit behind, near lower border of buttock. Fracture neck of femur; slight shortening, but marked eversion of foot; septic. Removal of fragments; Liston's long splint; irrigation, and more necrosed bone removed. Three months in hospital, then transferred to Base. Some union of femur had taken place.—(Messrs. DOUGLAS and WILLIAMSON.)

Hip; aseptic—Grooving of bone—Recovery.

CASE 26.—Private C., wounded Paardeberg; Mauser; estimated range 800 yards. Right hip; bone grooved; capsule of joint penetrated. Both wounds small. Admitted 1 General Hospital 28th February, 1900. Treatment—Absolute rest to joint; "no disturbance by probing or otherwise." Both wounds aseptic. Recovered quickly; invalided 21st March, 1900.—(Civil Surgeon DUNLOP.)

Comminution head of femur and ischium—Septicæmia—Death.

CASE 27.—Private B., admitted 11 General Hospital 26th August, 1900. Left ischium and head of femur greatly comminuted. Mauser; estimated range 50 yards; bullet broken and retained; wounds aseptic on admission. Incision ischio-rectal fossa; removal bullet in six pieces, also pieces of shattered bone; became highly septic and fœtid. Died of septicæmia 10th November, 1900. *Post mortem.*—Head of femur shattered; spontaneous dislocation.—(Civil Surgeon HUNTER.)

The numbers of reported cases of wounds of the hip joint are so small that, statistically, no conclusion based on them is of any value; such as they are the figures read :—

TABLE 26.—Gunshot Wounds of Hip Joint.

Total cases.	Septic.	Aseptic.	Died.	Death-rate.
7	3	4	2	28·5
—	Excision. 2		1	50·0

Wounds of the Knee Joint.

Frequency of knee-joint wounds.

The knee joint is, for obvious reasons, the most frequently wounded joint in the body, and in no other region are the comparatively trivial injuries to bone inflicted on joints by the modern rifle more apparent. In collecting and classifying wounds of this joint, care has been taken to include only genuine cases in which the joint had been entered, and all those in which the penetration of the joint seemed doubtful have been disregarded. In all 95 cases have been reported, of which only 4 died, being a mortality of 4·2 per cent. This extremely low rate of mortality is clearly due to the large proportion of simple perforations of the cancellous articular extremities and of the patella, which healed aseptically in a surprisingly short time, or in which a slight degree of suppuration of the entrance and exit wounds did not extend into the joint. Of the 95 cases, 6 are described as simple capsular wounds not involving bone; in 81 cases one or more of the bones entering into the articulation were injured, a description of the injury being given in detail. In the remaining 8 cases the notes are so vague that nothing can be learned from them beyond the fact that the joint was wounded; for instance, one case in which amputation was carried out is simply referred to as "shot through the knee joint." The different bony constituents of the articulation were injured in the following order of frequency:—Femur alone, 33; tibia alone,

14 ; femur and patella, 12 ; femur and tibia, 9 ; patella alone, 8 ; tibia and patella, 3 ; femur, patella, fibula, and tibia, 1. In 10 cases the bullet had lodged in or near the joint, and was extracted. The comparatively slight injury inflicted on this joint by the small-calibre rifle bullet is clearly shown by an analysis of the treatment; thus, in 55 of the series of 95 wounds no operative measures were carried out, the treatment consisting of careful antiseptic dressing, with rest. Fifty of the above cases were perforations, and, with a few exceptions, aseptic, the remaining 6 being simple capsular wounds.

From the above it will be seen that in 40 cases operative treatment of some description was required. The different measures adopted were, in order of frequency :—Amputation, 11 ; extraction of retained bullets, 10 ; removal of bony fragments not necessitating further measures, 10 ; incisions for intra-articular suppuration, 7 ; partial resection (patella and condyles), 1 ; and ligation of femoral artery, 1. The condition of wounds of this joint, whether septic or otherwise, was generally though not universally noted ; thus 33 are stated to have been septic, 58 aseptic, and in 4 no mention has been made of the conditions. Disregarding the doubtful cases, we find that septic infection was present in 36·2 per cent.

Mortality.—Four cases ended fatally, being a mortality of 4·2 per cent., the immediate cause of death in all cases being shock, the result of amputations of the thigh in cases of septicæmia.

Amputations.—In 11 cases amputation was carried out ; or, in other words, 11·5 per cent. of total cases required amputation. Of the 11 cases amputated 4 died, or an amputation mortality of 36·3. The site of the operation was :—

	Cases.	Died.	Death-rate.
At the hip joint	1	0	0·0 per cent.
Upper third of thigh	2	1	50·0 ,,
Middle ,, ,, ...	5	2	40·0 ,,
Lower ,, ,, ...	2	1	50·0 ,,
Region not stated	1	0	0·0 ,,
	11	4	36·3 ,,

TABLE 27.—Wounds of the Knee Joint from all Projectiles.

Total number.	Septic.	Incised.	Removal of fragments.	Extraction of bullets.	Partial or complete excision.	Ligation femoral artery.	Amputations.	Died.	Death-rate for amputations.
95	about 36 per cent.	7	8	10	3	1 (recovered)	11	4	per cent. 36·3

Death-rate for all cases = 4·2 per cent.

Examples :—

The following notes of cases are quoted as serving to illustrate the different varieties of injuries with the treatment :—

Rapid recovery from (seemingly) a simple capsular wound.

CASE 28.—Private R., aged 28, wounded Colenso 15th December, 1899. Projectile and range not stated. Admitted 3 General Hospital, Rondebosch, 24th December, 1900. Entry on outer and upper aspect left knee joint. Exit on inner side of knee below level of patella. Both wounds quite healed on admission. Some synovitis, which disappeared under treatment. Invalided to England 17th January, 1901.—(Captain WADE-BROWN, R.A.M.C.)

Suppuration of entry and exit, not extending to joint. Simple capsular wound.

CASE 29.—Private C., wounded Magersfontein, 11th December, 1899. Projectile, Mauser ; range, 1,500 yards. Entry small, oval, 4 inches above right patella, middle line. Exit just below and internal to patella. Admitted 2 General Hospital 23rd December, 1899. Both wounds septic. Temperature, 100·° F. ; joint full of fluid. Antiseptic dressings and firm bandaging ; wounds healed, fluid absorbed. Result—Movements nearly perfect. Invalided.—(Major LOUGHEED, R.A.M.C.)

Both knee joints ; aseptic.

CASE 30.—Major S., aged 40 ; admitted to 4 General Hospital 22nd August, 1900. Projectile and range not stated. Left knee, entry outer

side, below level of patella, beneath ligamentum patellæ; no bony injury; both wounds small. Bullet then entered inner side right patella, drilled it, and exit size of shilling on outer side. All wounds aseptic; right knee some hæmorrhage; aseptic dressings; splints; temperature, 100° F. for three days. On 29th August, 1900, left knee healed and splint removed. 10th September, 1900, plaster case to right leg; entry healed; exit open. Result—Invalided 24th September, 1900. This officer now commands his regiment in India.—(Lieutenant PARRY, R.A.M.C.)

Aseptic; antero-posterior perforation.

CASE 31.—Private B., admitted 7 General Hospital six days after receipt of wound. Entry, centre of patella, passed directly backward through joint and exit middle of popliteal space. On admission practically well; wounds healed. Some slight tingling of foot; mobility of joint almost normal.—(Lieut.-Colonel MACNAMARA, R.A.M.C.)

Aseptic; lateral perforation.

CASE 32.—Lieutenant B., wounded in train 21st July, 1901. Posture, kneeling; range 40 yards. Admitted Hospital, Beaufort West, same day. Bullet grazed left instep, passed upwards and perforated both femoral condyles of right knee. Entry on inner and exit on outer side. Some synovitis and hæmorrhage from knee. Early passive motion of joint. By 10th August, 1901, all fluid absorbed and fair movement in joint. Sent to Wynberg 19th August, 1901.—(Captain EVANS, R.A.M.C.)

Transverse fracture of patella; aseptic.

CASE 33.—Patient wounded Belmont, 23rd November, 1899. Sent to Cape Field Hospital, Orange River. Entry very small, at back of internal tuberosity tibia. Exit centre of patella, which was transversely fractured. Joint distended, 1½ inches interval between fragments; splint. Antiseptic dressings for a fortnight, wounds healed rapidly, then approximation of fragments by strapping and plaster of Paris case. On 13th January, 1900, wounds quite healed, one finger's breadth separation. Joint normal, no pain, still wears back splint.—(Civil Surgeon RICHARDSON.)

Oblique grooved fracture of patella; aseptic.

CASE 34.—Private R., admitted to Hospital 13th August, 1900, suffering from wound of patella, a grooved fracture, running upwards and outwards. Exit wound size of a threepenny piece; range estimated 80 yards; projectile unknown; knee joint distended, with blood; usual dressings and figure of 8 bandage, back splint. When wounds healed, plaster of Paris applied. When plaster case put on, separation little more than ⅛ inch; fluid absorbed. Transferred to Base, 9th October, 1900.—(Civil Surgeon PETTIE.)

Grooving of under-surface patella.

CASE 35.—Private B., wounded 25th February, 1900. Projectile, shrapnel bullet. Admitted 4 Stationary Hospital next day. Entry inner margin ligamentum patellæ; direction upwards into joint; great pain; fever. 27th February, 1900, exploration, incision, drainage, no relief. On 4th March, 1900, joint freely laid open, piece of shrapnel removed from synovial pouch; under-surface of patella grooved; scraped, and joint washed out; temperature fell; great relief from pain; steady improvement. Transferred to Base, 14th March, 1900.—(Lieut.-Colonel KIRKPATRICK, R.A.M.C.)

Perforation; aseptic—Injury to external popliteal nerve.

CASE 36.—Lance-Corporal R., wounded Magersfontein on 11th December, 1899. (?) Mauser; range unknown. Admitted 2 General Hospital, 16th December. Entry centre left patella; exit behind and slightly below head of fibula; wounds small, circular, quite clean, healed in a week; some effusion into joint; complete motor paralysis of muscles supplied by external popliteal nerve, and paresis of front and outer side of leg and foot; tender spot above and behind head of fibula. On 6th January, 1900, nerve cut down upon; nerve found enlarged above wound, and narrowed to a waist below but not divided; adherent to track of bullet; freed and wound closed; wounds healed first intention, but no return of nerve power. Invalided 3rd February, 1900.—(Major LOUGHEED, R.A.M.C.)

Examples of the retention of a bullet within the articulation have been given above (*see* cases Nos. 8 and 10).

Septic, comminuted—Removal of fragments—Recovery.

CASE 37.—Jacobus Van der W., prisoner of war, aged 21, wounded 12th May, 1901. Admitted 10 General Hospital 13th May, 1901; lay for 24 hours on veldt. Entry inner side right knee in line with centre patella; bullet passed through joint, comminuting femur. Exit outer side thigh, junction middle and lower third. Thigh greatly swollen, joint distended with fluid, lateral deformity and much shortening. On 14th May, wounds enlarged, joint opened from outer side, blood, pus and synovia escaped; irrigation and drainage tubes; long fissure of femur into joint, with detachment of large fragment from shaft; extension; sand bags. On 21st May, 1901, abscess incised near exit. On 14th June, 1901, large abscess incised 6 inches above knee, and several pieces dead bone removed. Convalescence very prolonged; several abscesses opened and seqestra removed. Eventual recovery without much shortening. Discharged 17th October, 1901, after 157 days' stay in hospital.—(Captain FAICHNIE, R.A.M.C.)

Comminuted, septic—Removal of fragments—Recovery.

CASE 38.—Private D., wounded Modder River 28th November, 1899; admitted 2 General Hospital 2nd December, 1899. Entry 2 inches below inner side right knee; exit in front of fibula, 3 inches below joint. Head of fibula fractured and fissured. Exit large, irregular; spiculæ protruding; knee joint full of fluid. On 4th December, 1899, entry enlarged; removal of fragments; irrigation; posterior splint. On 14th January, 1900, bone scraped. On 16th January, 1900, high temperature, pain, and distension of joint; joint opened by two lateral incisions; irrigation and drainage. On 25th January pus evacuated from behind joint, and from muscles of thigh; irrigation. Eventual healing of wounds; mobility of joint limited to 45 degrees. Invalided 25th April, 1900, after a stay of five months in hospital.—(Major LOUGHEED, R.A.M.C.)

Fissure of shaft of tibia into knee joint—Amputation—Recovery.

CASE 39.—Private N., accidentally wounded by discharge of Lee-Metford at very close range. When admitted into 7 General Hospital wound very foul; knee joint full of pus. Amputation at middle third thigh; tibia found vertically split into knee joint. Very good stump. Transferred to Base.—(Lieut.-Colonel MACNAMARA, R.A.M.C.)

Septic, comminution—Shrapnel—Amputation—Death.

CASE 40.—Private T., aged 25, wounded Elands River on 3rd August, 1900. Besieged with Colonel Hore's force; lay in shelter trench for 14 days, then five days' journey in ox wagon; admitted 17 Field Hospital 22nd August, 1900. Entry small, just above inner margin right patella; no exit; projectile shrapnel; septicæmia. Explored 23rd August, 1900; complete fracture above condyles, communicating with knee joint; sinus from wound to abscess in calf. Free incisions and drainage; too weak to amputate; splint; irrigation and dressing every second day. Pus burrowed up thigh; pus in knee joint evacuated. On 10th September, 1900, amputation at mid thigh; died same night.—(Civil Surgeon A. BURTON.)

Septic, comminuted; wound of femoral artery and vein—Amputation—Death.

CASE 41.—Prisoner of war, B., aged 29, wounded 19th November, 1901; projectile, Lee-Metford; range not known; admitted 15 Stationary Hospital 24th November, 1901. Entry back of right knee, ½ inch external to head of tibia; exit internal surface of joint, large and ragged. Collapsed; temperature, 101° F.; limb swollen from groin to foot; bullet had removed and shattered internal half of internal condyle and opened joint. On 26th November, 1901, amputation at lower third femur; died same day. Bullet had completely divided femoral artery and vein.—(Major HEUSTON, R.A.M.C.)

Perforation; wound of femoral artery—Ligature—Recovery.

CASE 42.—Sergeant M., wounded Magersfontein 11th December, 1899; admitted 2 General Hospital 18th December, 1899; (?) Mauser. Entry middle of patella; exit middle popliteal space. Limb on back splint on admission; splint removed; great hæmorrhage; ligation of femoral in Hunter's canal; aspiration of knee joint; posterior splint. Recovery; very good movement of joint; no trace of tumour in popliteal space.—(Major LOUGHEED, R.A.M.C.)

Partial resection in old standing wound.

CASE 43.—Prisoner of war, P., wounded 22nd July, 1901; admitted 4 Stationary Hospital 17th October, 1901. Old bullet-wound of knee joint; lower end of femur comminuted, and exit through patella; offensive discharge;

temperature hectic; wasting. Resection of patella and articular end of femur; free drainage. Result—Recovery, with firm anchylosis.—(Lieut.-Colonel KIRKPATRICK, R.A.M.C.)

Gangrene after ligature—Disarticulation at hip joint—Recovered.

CASE 44.—Lance-Corporal R., wounded 24th February, 1900; admitted 4 General Hospital, Mooi River, 20 days later. Entrance (normal Mauser) on outer side of knee joint; exit on inner side of buttock, close to ischial tuberosity. Both wounds were healed, and there was no trouble from perforation of knee joint. (For injury to vessels demanding operation *see* Case 93, "Gunshot Wounds of Blood Vessels.") Gangrene followed, and extended up in front to Poupart's ligament. Amputation at hip joint was performed at midnight, 56 hours after the operation on the vessel, when temperature began to rise. An anterior racket was made to exclude gangrene; no tourniquet; very little blood lost. Healed by first intention, except for narrow strip in front round large vessels, which was tainted in spite of having been scraped and flushed out. Invalided.—(Major S. F. FREYER, R.A.M.C., and Civil Surgeon STANLEY COPLEY.)

Wounds of the Ankle Joint.

Wounds of ankle joint usually septic.

Forty cases of wounds of the ankle joint from all projectiles have been collected—a somewhat meagre number; they include, however, instances of every sort of joint injury, except the simple capsular variety, which, from anatomical reasons, it would seem impossible to produce. There were no deaths. The proportion of septic cases was high: thus 28 are stated to have been septic, 10 aseptic, and in 2 the condition has not been noted, giving a septicity of 70 per cent. in cases where a record has been made. No doubt this high ratio of septic infection is due to local causes, *i.e.*, the dirty condition of boot, sock, and skin.

Pure perforations.

In 13 cases the type of injury was pure perforation of the bones forming the articulation, and sometimes one or more of the tarsal bones not entering into the articulation were the subjects of perforation in addition. These cases all did well, requiring nothing beyond the usual simple treatment mentioned previously; 9 of the perforation cases are described as aseptic, 2 as septic, and in 2 no record was made. It is to be noted that, although all cases of the perforative type were quickly recovered from, particularly those in which the wounds remained aseptic, still in the majority some limitation of movement remained when invalided to England. In only 2 cases were incisions made without further measures being subsequently required, and in 1 case a bullet lodged in the substance of the astragalus was removed. The removal of bony fragments of either the tibia, fibula, or tarsal bones, not necessitating further operative treatment, was carried out in 12 cases; all of these, with one exception, were septic, and recovery was generally followed by considerable limitation of movement in the joint, and in some cases by absolute fixation.

Amputations.—Amputation was performed in 11 cases, or in 27·5 per cent., and was required, as a rule, for septic conditions associated with comminuted fractures. Shell wounds were responsible for 5 amputations, and in 3 of these, in which Syme's amputation had been performed on the field, re-amputation at a higher level was subsequently required, again instancing the unsatisfactory results of primary amputation at the front.

TABLE 28.

Total cases.	Septic.	Incised.	Bullet extracted.	Fragments removed.	Amputations.	Deaths.
40	per cent. 70·0	2	1	12	11	0

Excision.

There is no record of any cases of systematic excision of the ankle joint, but Civil Surgeon C. S. Irvine, in his report on gunshot wounds, mentions one as having come to his knowledge, and the following particulars are

extracted from his report :—Projectile, Mauser ; range, 1,000 yards. Entry, small, just beneath external malleolus ; exit, small, through internal malleolus, which was pierced and fissured, but not detached. There was a gutter fracture of superior articular surface of astragalus, without comminution. Long continued and slight suppuration followed, with caries. Excision of the ankle joint was performed, " with excellent results."

Examples :— Examples of various wounds of the ankle joint :—

Aseptic perforation. Case 45.—Private S., aged 32, wounded Paardeberg 21st February, 1900 ; projectile, Mauser ; estimated range, 30 yards ; admitted 3 General Hospital about four weeks after injury. Entry, over tendo achillis, 4½ inches above heel ; exit, inner margin of foot, 3½ inches from posterior part of heel, 2¼ inches below internal malleolus. Both wounds quite healed on admission, joint recovering movements. Massage ; walks very well.—(Civil Surgeon A. Young.)

Aseptic ; antero-posterior perforation. Case 46.—Captain C., wounded Elandslaagte 21st October, 1899 ; projectile, Mauser ; range unknown ; admitted Base Hospital, Maritzburg. Entry, normal Mauser, in middle line of anterior fold of ankle, passed downwards and backwards, and exit in middle line of curve of heel. Dressings, with early passive movement. He returned to duty within eight weeks of injury.—(Civil Surgeon C. S. Irvine.)

Aseptic ; lateral perforation. Case 47.—Private M. (date of injury not given) ; admitted 1 General Hospital 14th April, 1900. Perforation of left external and internal malleoli and astragalus. Entry and exit wounds size of Mauser ; range, about 700 yards ; wounds aseptic and quite healed. Invalided 25th April, 1900.—(Civil Surgeon Brown.)

Aseptic, antero-posterior perforation. Case 48.—Private B., admitted to hospital 3rd December, 1899 ; tarsus and ankle drilled from end to end. Entry, small ; exit, a slit ; projectile, a Mauser ; estimated range, 800 yards. Great swelling of joint ; hot fomentations ; all cleared up and remained aseptic. Result—Very good ; invalided 2nd January, 1900.—(Civil Surgeon Pooley.)

Septic; incisions. Case 49.—Corporal B., wounded 9th March, 1902 ; admitted 10 General Hospital 31st March. Entry and exit both on outer side, above and below malleolus respectively ; ankle joint damaged ; septic ; joint puffy ; cellulitis of leg. On 3rd April, 1902, incisions into joint on either side ; scraped ; irrigation ; drainage tubes ; gradually healed. Result—Still very small sinus, joint fixed. Invalided 7th June, 1902, after three months' treatment.—(Captain Faichnie, R.A.M.C.)

Comminution ; septic—Removal of fragments. Case 50.—Private W., wounded Modder River 28th November, 1899 ; sent to 2 General Hospital ; projectile not known ; range, short. Entry and exit wounds both large and irregular just below and slightly in front of either malleolus. Very septic ; ankle joint shattered. On 6th December, 1899, both wounds enlarged ; many fragments removed from tibia and astragalus ; drainage. On 19th December, 1899, removal of 12 more pieces of tibia and tarsal bones ; drainage ; eventual healing of wounds. Plaster of Paris case. Invalided 2nd March, 1900.—(Major Lougheed, R.A.M.C.)

Primary amputation—Sloughing—Re-amputation. Case 51.—Captain D., wounded Vaalkrantz ; shell pitched on foot ; disorganization of ankle ; amputation (Syme's) on field ; transferred to 4 Stationary Hospital, thence 25 miles on stretcher to 1 Stationary Hospital, thence to 4 General. On admission to latter, 11th February, 1900, stump very septic, flaps sloughing, leg infiltrated ; same day re-amputation at middle of leg, lateral flaps. Result—Healed by first intention. Invalided.—(Major Hackett, R.A.M.C.) (*Vide* Case 32, " Injuries of Long Bones.")

Septic ; comminuted—Amputation. Case 52.—Private W., wounded 11th December, 1899 ; projectile, shell ; admitted 2 General Hospital 19th December. Three pieces of shell ; first piece entry inner side ankle, smashing internal malleolus and astragalus, tip of external malleolus lay in abscess cavity at outer side ankle ; second piece

passed through back of calf, large irregular wounds; third piece entry 1½ inches below tubercle of tibia, and was embedded; septic; amputation at seat of election above highest wound, lateral flaps. When sawing tibia large piece of shell found embedded in cancellous tissue, removed and bone sawn at slightly higher level; healed almost wholly per primam. Invalided 20th February, 1900.—(Major Lougheed, R.A.M.C.)

Bullet retained in astragalus—Removed.

Case 53.—Private B.; projectile, Mauser; range, 800 yards; perforation of tibia and astragalus. Chronic œdema of ankle one month after injury. X-rayed; bullet localised in centre of astragalus, removed with considerable difficulty. Still small sinus remains from site of bullet extraction (upper and outer side of foot); no œdema; invalided.—(Civil Surgeon Kirkman.)

Wounds of the Tarsus.

As it has been found impossible to divide wounds of the tarsus into those affecting the bones alone, and those in which the intertarsal articulations were injured, they have all been placed under the latter group, although many perforations must have occurred in which no joint was involved. Although wounds of this region were fairly common, only 27 cases have been noted. On account of the cancellous nature of the tarsal bones the majority of wounds were perforations, and, unlike perforations in more cleanly regions, septic infection occurred in the greater number. Thus of the 27 cases only 10 are described as aseptic; and this number is probably too great, as in many records of the cases were not made until a somewhat late period, when a small amount of suppuration would have subsided. There seems to be a special inclination of wounds of this region to heal superficially, but, owing to the formation of pus in the deeper parts of the track, to break down later on. A troublesome after-effect also is the formation of abscesses in the sole, with a tendency to burrow.

Generally septic perforations.

With regard to treatment, in 15 cases nothing more was required beyond the usual antiseptic dressings or fomentations. In 6, fragments of the various tarsal bones were removed, sometimes followed by incisions for the evacuation of pus. In 2 recovery followed incisions for pus without further operative treatment. In 2 cases retained bullets were removed, and in 2 cases amputation was found necessary. There was no death.

Treatment.

Table 29.—Wounds of the Tarsus from all Projectiles.

Total number.	Septic.	Incised.	Bullet extracted.	Fragments removed.	Amputations.	Deaths.
27	about 63·0 per cent.	2	2	6	2	0

Examples of tarsal wounds:—

Examples:—

Aseptic perforation.

Case 54.—Private W., wounded 15th December, 1899; admitted 3 General Hospital 24th December, 1899. Projectile, Mauser, found in heel of boot; estimated range, 600 yards; entry on dorsum in front ankle joint; exit on sole, passed downwards and backwards through os calcis, clean perforation. Healed under scabs on admission; aseptic; invalided 17th January, 1900, unable to bear weight on foot.—(Major Poole, R.A.M.C.)

Aseptic perforation.

Case 55.—Private B., admitted 31st July, 1900, two hours after receipt of injury. Intertarsal joint traversed; exit, 2 inches long. Supposed Lee-Metford; range, 20 yards; parts cleaned; dry dressings; healed by first intention.—(Civil Surgeon A. Young.)

Septic perforation.

Case 56.—Driver A., aged 22, wounded 1st March, 1902. Projectile, revolver, accidentally self-inflicted; admitted 16 General Hospital same day.

Entry on dorsum ; exit in sole 1 inch in front of inter-malleolar line ; septic ; bath of hyd. perchlor. 1/5,000 during daytime for 10 days, at night cyanide gauze ; wounds healed ; arch of foot somewhat flattened. To Base 15th April, 1902.—(Captain WALTON, R.A.M.C.)

Bullet retained in os calcis.

CASE 57.—Private S., perforation of os calcis ; Mauser ; range unknown ; aseptic ; admitted 7th July, 1900. Bullet removed by 3-inch curved incision behind external malleolus, embedded in os calcis ; healed first intention.—(Civil Surgeon WARING.)

Wounds healed, suppuration of track.

CASE 58.—Captain P., admitted 10 General Hospital 24th July, 1901. Entry below internal malleolus ; exit, under surface of heel. Wounds healed, but rise in temperature at night ; pain and swelling of foot. Incisions 16th August, 1901, below either malleolus ; abscess found outer side ; thorough drainage ; irrigation ; daily dressings. 10th September, 1901, wounds quite healed. Result—Not able to bear much pressure on foot, and movement of ankle impaired. To Base 22nd September, 1901.—(Captain FAICHNIE, R.A.M.C.)

Septic ; comminuted ; prolonged treatment.

CASE 59.—Private M., aged 44 ; admitted 7 Stationary Hospital 9th April, 1902. Entry, through os calcis ; exit, outer side fifth metatarsal ; septic, foot bath, removal fragments of fifth metatarsal. On 29th April, 1902, cuboid, and os calcis scraped, free bleeding ; fever. On 8th June, 1902, abscess over heel incised. On 18th July, 1902, abscess incised ; eventual recovery. Discharged hospital 11th August, 1902.—(Civil Surgeon MACGREGOR.)

Comminuted ; septic—Removal of fragments.

CASE 60.—Private J., aged 20, wounded 20th September, 1901. Projectile (?), expanding. Admitted 20 General Hospital, 24th September. Entry, outer side right foot ; exit, inner side ; extensive destruction of distal row tarsal bones ; septic ; carbolic bath. On 2nd October, 1901, removal of parts of internal, middle, and external cunieforms, scaphoid and cuboid ; gauze plugs, splint ; sinus remained for two months, abscess incised. Result—Healed. Invalided 19th November, 1901.—(Captain THOM, R.A.M.C.)

Commination ; septic—Amputation.

CASE 61.—Sergeant D., aged 38, wounded 30th January ; admitted 10 General Hospital 3rd May. Entry in front of internal malleolus ; exit at base fifth toe, marks of several incisions on foot ; foot much swollen, bluish colour ; both wounds oozing pus. On 5th May, incisions ; os calcis astragalus and cunieforms much diseased. Next day amputation about 3 inches above ankle ; some sloughing of anterior flap. On 22nd May removal of 1½ inches fibula. Result—Good stump. Invalided.—(Civil Surgeon KEY.)

Wounds of the Shoulder Joint.

Comparatively rare.

Septicity.

From the small number of reported cases, wounds of this joint seem to be relatively rare. Only 27 cases have been noted, of which 9 were perforations and 18 comminutions or fissures of various degrees of severity. With regard to the ratio of septicity, no conclusion of any value can be drawn from the above small number of cases, and the fact that suppuration was present in over 60 per cent. is given for what it is worth. Of the 9 perforations all were aseptic, and of the 18 comminutions 16 were septic, one was aseptic, and the remaining one, in which a primary amputation proved fatal, has been classed as doubtful.

Perforations.

1. *Perforations.*—As in other joints, the issue of pure perforations was most favourable. Eight of these cases recovered without any operative measures being necessary, the treatment consisting of antiseptic dressings, with rest ; they remained aseptic throughout. Incision for the extraction of a retained bullet in the dorsal region was required in one case of perforation ; in this case also sepsis did not occur.

Comminutions.

2. *Comminuted Fractures.*—These resulted either from serious fractures of the upper end of the diaphysis of the humerus with fissures extending into the joint, or from the impact of the larger-bore bullets, such as the Martini-Henry, from expanding bullets, or from fragments of shell. The very

destructive nature of some of the injuries of this type will be seen from extracts of cases given below, and from the fact that in 16 of the 18 cases of this description of wounds operative interference was called for. Thus, in 3 cases recovery followed the removal of fragments; in 8, excision of the shattered head of the humerus was successfully carried out; in 4, amputation at the shoulder joint was required, one of which died, and in 1 Berger's interscapulo-thoracic amputation was successfully performed. The 2 remaining cases which recovered without any operative measures were the two examples of aseptic comminutions. It will be seen from the above analysis that either partial or complete excision of, or amputation at, the shoulder joint was carried out in 16 septic comminutions out of a total of 18 such wounds, or in nearly one-half of the total number of reported cases of every variety.

TABLE 30.—Wounds of the Shoulder Joint from all Projectiles.

Total number.	Septic.	Bullet extracted.	Fragments removed.	Excisions.	Amputations.	Died.	Death-rate for both operations.
27	per cent. 60	1	3	8	5	1 (amputation)	7·7 (nearly)

Note.—When the bullet was extracted in the course of an operation, such as amputation or removal of fragments, it is included in this table under the major operation.

The following cases are cited as examples of different injuries of the shoulder joint:— Examples:—

CASE 62.—Private F., aged 29, wounded at Driefontein 10th March, 1900. Projectile, Mauser; range unknown. Admitted 3 General Hospital 30th March. Entry 1 inch below and in front of anterior margin of acromion. Exit 4 inches behind entry at posterior edge of acromion. Wounds healed on admission, and patient quite recovered save for some slight local pain on movement of shoulder.—(Civil Surgeon A. YOUNG.) Aseptic perforations.

CASE 63.—Lieutenant C., wounded 13th May, 1901. Projectile and range not stated. Admitted 16 General Hospital. Entry behind, near outer border of scapula, at level of its spine. Exit in front, at point of shoulder; track through joint; antiseptic dressings; passive movements and massage; adhesions broken down under chloroform; gradual improvement in movement. To Base, 4th July, 1901.—(Major ALLPORT, R.A.M.C.) Aseptic perforation.

CASE 64.—Private S., wounded 24th January, 1900. Projectile, Mauser; estimated range, 50 yards. Admitted Mooi River Hospital 31st January. Entry over greater tuberosity right humerus, passed through joint (and scapula). Exit at top of posterior axillary fold; aseptic, both wounds very small; antiseptic dressing; early massage and passive movements. Discharged hospital 7th February, 1900.—(Civil Surgeon F. MARTIN.) Aseptic perforation.

CASE 65.—Private C., aged 22, wounded at Winburg 26th February, 1902. Projectile and range not stated. Admitted 9 General Hospital. Entry at upper end right humerus; no exit; septic; temperature, 102° F.; dressed; great pain. X-rays showed bullet embedded partly in humerus and partly in glenoid. On 17th March, 1902, incision over entry; bullet could not be extracted without removal of fragments; this done, and bullet removed. Temperature, 101° F., for two weeks; gradually improved; discharge less; several small pieces of bone extruded. Entry healed 10th week; passive motion. By 12th week could raise arm to right angle with shoulder. Improved quickly by use of Indian clubs.—(Major WATSON, R.A.M.C.) Septic comminution—Retained bullet—Removal of fragments—Recovery.

CASE 66.—Private D., admitted 2 General Hospital 20th February, 1900. Projectile, Mauser; estimated range, 500 yards. Comminution of upper end left humerus with upper fragment split into joint; aseptic; internal Aseptic; comminuted.

rectangular splint and shoulder cap; bed for 14 days. Recovery. Discharged 16th April, 1900.—(Civil Surgeon C. A. Brown.)

Septic; comminution.

Case 67.—Private F., admitted 2 General Hospital 28th December, 1899. Comminution of upper end shaft left humerus; fissured into joint; no exit; bullet extracted; Martini-Henry; range unknown; septic; removal of a small fragment; daily dressing; splints; great pain in joint and effusion. Invalided 17th January, 1900.—(Captain Withers, R.A.M.C.)

Comminution; septic—Excision.

Case 68.—Lance-Corporal S., aged 27, transferred to 17 Field Hospital 28th June, 1900. Entry middle of right arm; inner aspect; passed upwards towards joint; range and projectile not stated; very septic; comminution of upper end humerus and fissures into joint; whole upper fragment removed and 10 smaller ones; bullet extracted; was in contact with glenoid; drainage; no splint; arm bandaged to side; daily dressing and irrigation; wounds healed, except for small sinus leading to glenoid. Complete paralysis of extensors of fingers (musculo-spiral). Elbow stiff; limited flexion, extension, pronation, and supination.—(Civil Surgeon Burton.)

Comminution; septic—Excision.

Case 69.—Private A., wounded Spion Kop 24th January, 1900. Projectile, shell. Admitted 4 General Hospital, 30th January, 1900. Septic Shell wound 1½ inches long, ragged, over bicipital groove, 2 inches from joint; upper part of shaft shattered for 3 inches. This was removed, and by extension upwards of wound, head of bone also excised. Two long fragments extending downwards, but not into elbow joint, left *in situ*, as they had firm muscular and periosteal attachments. Long head of biceps found destroyed. Large piece of lead (shrapnel) and fuze screw removed from *débris* of upper end humerus, and heavy concave piece of iron, 1 inch square, from back of deltoid. Recovered. Invalided 29th March, 1900, wound almost closed; able to write. Now (1904) contributing with this arm towards livelihood. (*See* Figs. 89 and 89A.).—(Major Freyer, R.A.M.C.)

Comminution; septic—Excision.

Case 70.—Private S., wounded Rocksberg 24th March, 1901; admitted same day 16 General Hospital. Entry, small, below left coracoid. Exit, large, ragged, size of five-shilling piece, below acromion; comminuted fracture head of humerus; some oozing. Removal of head of humerus, some fragments of shaft, and pieces of clothing; some suppuration; wounds healed; movement of shoulder improving.—(Lieutenant Smith, R.A.M.C.)

Septic; comminution—Amputation.

Case 71.—Private S., admitted Mooi River Hospital 5th March, 1900. (?) Projectile; about 500 yards range. Comminution of epiphysis of left humerus, and upper end shaft, with shoulder joint and acromion. Exit, size of half-crown piece; septic; exploratory anterior vertical incision converted into racket amputation at joint owing to extent of bone damaged; healed mostly first intention; good stump. Transferred Base. Invalided 5th April, 1900.—(Major Freyer, R.A.M.C.)

Comminution—Berger's amputation.

Case 72.—Private K., wounded 24th January, 1900; admitted 4 Stationary Hospital, Spearman's Camp, 25th January. Entry, ragged, 1½ inches below and behind acromion; no exit; shoulder joint shattered; head of bone comminuted; joint full of bone *débris* and blood; remains of head impacted in surgical neck. Projectile and range not stated. Excision of head; drainage; suppuration; scapula probably fractured; Berger's interscapulo-thoracic amputation (Sir F. Treves); suppuration; drainage; irrigation; recovered. Transferred Mooi River 9th February, 1900. (*Vide* Fig. 90 for bone injury in this case, reproduced by permission of Editor of "British Medical Journal.")—(Civil Surgeon Nuthall.)

Comminution—Shell—Amputation—Died.

Case 73.—Private G., wounded Rhenoster River; admitted Imperial Yeomanry Field Hospital 7th June; extensive shell wound right shoulder, 3 inches by 4 inches; humerus shattered 1 inch below surgical neck and fissured into joint; fracture outer end clavicle and acromion. On 8th June amputation of shoulder joint; axillary artery previously ligatured. On

10th August considerable oozing. Moved in ambulance 2½ miles, as camp in danger. Died *en route*.—(Civil Surgeon F. GREEN.)

Shell; comminuted; septic —Amputation.

CASE 74.—Private G., admitted hospital, Mooi River, 2nd February, 1900; comminution upper end right humerus and epiphysis; injury, shoulder joint; shell; range unknown; septic; vertical exploratory incision in front through wound, converted into amputation at joint by anterior racket incision as bone too extensively comminuted for excision, and whole arm œdematous; healed mostly first intention. Invalided to Durban 26th April, 1900; good stump.—(Major FREYER, R.A.M.C.)

Wounds of the Elbow Joint.

Comparative frequency.

More cases of wounds of this joint have been noted than of any other, except the knee, the number being 49. On account of its formation, simple capsular wounds without injury to bone do not occur, but a considerable number of pure perforations of the various bones have been observed. As far as can be judged from the description and history of the injuries, 13 of the 49 were of the nature of pure perforations, and the remainder either comminutions of more or less severity or fissures extending into the articulation. In 9 cases the site of injury was not particularised, the wounds being referred to in such phrases as "fractures of bones of elbow joint," "shot through the elbow," and the like, but in the remaining number (40) the seat of injury has been specified. Injuries to the various bones occurred in the following order of frequency: Humerus alone, 18; ulna and humerus, 9; ulna alone, 4; humerus and radius, 4; radius and ulna, 3; radius alone, 1; humerus, radius, and ulna, 1.

Septicity.

Septicity.—In 12 cases the conditions as to septic infection has been classed as doubtful, as the wounds were either healed when the first observation was recorded, or the state of the wound was not described. Of the remaining 37, 25 were septic, and 12 aseptic; or, omitting the doubtful cases, a septicity percentage of 67·5.

Perforations.

Perforations.—13 cases are considered to have been perforations, *i.e.*, they were either diagnosed as such at the time of injury or have been placed in this category from the description and course of the wounds; 9 of them were certainly aseptic, and 4 have been classified as doubtful on account of the wounds having been healed at the time the first note was made, though this fact alone is a presumption in favour of asepticity. The treatment did not vary from that of the same class of injuries in other joints. Examples will be found below.

Comminutions.

Comminutions and Fissuring.—36 cases of the total 49 were comminutions or fissures of the various bones composing the articulation, and, as is usual in such wounds, the greater number were septic. Only 3 are described as being aseptic, 8 are doubtful, and the rest (25) were septic; neglecting the doubtful ones, septicity in these injuries reached the very high figure of 89·2 per cent.

Treatment.

Treatment.—In the aseptic and in the less serious septic cases the treatment was directed to keeping the wound as free from infection as possible and placing the limb on suitable splints. The total number of comminuted fractures which recovered without recourse to operative measures was only 8. The remainder were subjected to operative interference of some sort: thus, in 17, fragments of the various bones were removed, of which number 15 were septic, 1 aseptic, and 1 doubtful. Incision for the evacuation of pus, without further measures being required, was performed, and was followed by recovery in 1 case. Excision of the elbow joint has been reported in 7 cases, but in 2 of these amputation was subsequently carried out on account of necrosis and suppuration. Amputation of the arm was required in 7 cases, in 2 of which an unsuccessful excision had previously been performed, and one died.

TABLE 31.—Wounds of Elbow Joint from all Projectiles.

Total number.	Septic.	Incision alone.	Fragments removed.	Excision.	Amputation.	Died.	Death-rate for both operations.
49	per cent. 67·5	1	17	5	7	1 (amputation)	per cent. 8·3

Mortality.—One death occurred in the series of 49 cases, a little over 2 per cent. The case is cited below; it was one of amputation of an arm in which gangrene had occurred, and from the notes of the case the application of a plaster of Paris casing would appear to have induced, or, at any rate, contributed, to the occurrence of the gangrene.

Examples :— Examples of various wounds of the elbow joint :—

Aseptic perforation. CASE 75.—Private P.; projectile, Mauser; range—"long." Entry left humerus, in middle line of epiphysis just above condyles; bullet passed through joint; exit of small size on posterior aspect forearm 4 inches below olecranon; aseptic. Entrance almost healed when first seen; exit not quite so far advanced; heat, swelling, and pain in joint, some fever, range of joint movement very limited. Treatment: Rest on jointed rectangular splint, dry dressings, early passive movement; wounds healed, swelling, &c., of joint passed off, leaving slight limitation of extension. Admitted 3rd December, 1899. Invalided 2nd January, 1900.—(Major MACDONALD, R.A.M.C.)

Aseptic perforation. CASE 76.—Lieutenant A., aged 27, wounded Zand River, 4th May, 1902; admitted Radzaal Hospital 8th May, 1902. Entry over radius 1 inch below head, passed through joint; and exit, inner aspect humerus 1½ inches above lower end; no displacement; swelling of elbow and to within an inch of wrist; aseptic; angular splint, much effusion round joint. On 22nd May, 1902, splint removed, wounds healed; slight stiffness of joint, pronation and supination normal. Invalided 7th June, 1902.—(Major HINDE.)

Aseptic perforation. CASE 77.—Captain L., aged 30, wounded Monte Christo, 24th February, 1900; admitted Base Hospital, Pietermaritzburg, 14th March, 1900. Entry, normal Mauser 2 inches below left external condyle; passed through joint; exit larger than entry, 4 inches above internal condyle; estimated range 1,200 yards; wounds healed on admission; passive movement early; extension improved to within 1 inch of normal; discharged to duty 2nd April, 1900. Patient writes 19th September, 1900: "My arm is practically as good as the other, and does not trouble me at all."—(Civil Surgeon IRVINE.)

Retained bullet near joint; comminuted. CASE 78.—Driver K., wounded Flakfontein; admitted 8 General Hospital. Fracture right ulna, penetration of elbow joint, fracture internal condyle; bullet retained lying above internal condyle; removal of bullet and of fragments of ulna; joint washed out; rectangular splint; passive motion in 10 days; recovery, with good movement. Invalided.—(Captain BEGBIE, R.A.M.C.)

See also Case No 11, page 200.

Aseptic comminution. CASE 79.—Private J., aged 31, wounded Paardeberg, 18th February, 1900. Projectile and range not stated. Admitted 6 General Hospital 5th March, 1900. Entry posterior surface of arm, exit ulnar side forearm; T-shaped fracture of humerus into joint; chip taken out of ulna 1 inch from coronoid process; wearing plaster of Paris apparatus. This removed, joint swollen and painful; plaster re-applied; pain, plaster removed, joint much swollen and tender; explored by incision and use of a trochar, blood-stained serum found, no pus; exit scraped, several fragments removed; dressed daily. 24th March, 1900, wounds healed, treated as simple fracture; did well. Invalided Cape Town, 28th March, 1900.—(Civil Surgeon BRINKER.)

Septic comminution—Fragments removed.

CASE 80.—Patient wounded at Nooitgedacht, 13th December, 1900. For three days in hands of Boers, then admitted 2 General Hospital. Entry back of arm 2 inches above elbow; exit same level in front; very septic; whole arm greatly swollen and œdematous. 18th December, 1900, wound explored, joint full of pus, removal of loose fragments, large counter openings and drainage tubes; free irrigation; internal rectangular splint. Later, boric arm bath for eight hours daily and further removal of fragments. Result—"Two months after admission complete union, with bony ankylosis of joint." Invalided.—(Civil Surgeon EVANS.)

Septic comminution—Incision and removal of fragments.

CASE 81.—Private W., wounded 18th February, 1900; admitted 2 General Hospital, 5th March, 1900. Antero-posterior wound through upper and outer part left forearm; very septic; arm swollen; temperature high; pus in elbow joint; wound in front enlarged; radial head quite loose, removed; joint incised on either side of triceps tendon, washed out, and drained; suppuration soon ceased. Result—All wounds healed; elbow joint stiff. Invalided 12th May, 1900.—(Major LOUGHEED, R.A.M.C.)

Comminuted; septic—Excision.

CASE 82.—Private M., wounded Colenso, 21st February, 1900; admitted 4 General Hospital 7th March, 1900. Entry over left external condoyle; exit inner aspect below level of olecranon; comminution of both condyles and olecranon; septic; temperature, 104° F. On 26th April, 1900, long posterior incision; ends of humerus and ulna sawn off above comminution; small portion of synovial membrane excised, much thickened; arm became swollen and painful; fomentations; fluctuation, stitches gave way; incisions opened again, thickened, and gelatinous membrane cut away and splinters of bone removed; scraped, wound plugged, sutured, iodoform emulsion; temperature fell to normal, wound became healthy. Invalided 16th June, 1900.—(Civil Surgeon F. MARTIN.)

Septic; comminution—Excision.

CASE 83.—Trooper B., aged 22, wounded Klipdrift, 7th March, 1902. Projectile, Martini-Henry; range unknown; admitted 11 General Hospital; posture when wounded, riding. Entry, inner side opposite bend of elbow; exit, outer side same level; both humeral condyles comminuted, also olecranon and coronoid process; very septic; splint; drainage. On 1st April, 1902, complete excision of joint; joint full of pus and small pieces of bone; drainage; rectangular splint. Sinuses remained leading to necrosed humerus, so on 27th May, 1902, resection of about 2 inches end of humerus. Subsequent recovery, with satisfactory movement of arm. Invalided—(Bt. Lieut.-Colonel HICKSON.)

Case No. 21 (page 202) illustrates an unsuccessful excision of the elbow joint, followed by amputation.

Septic comminution of joint—Partial excision—Recovered.

CASE 84.—Private T., admitted 4 General Hospital, Mooi River, 14th March, 1900. Entrance on outer side elbow joint; exit on inner side behind supra-condyloid ridge. Loose bone felt in septic joint; joint laid open 14 days later by Langenbeck's incision. Ulna pushed out through wound and whole olecranon removed; synovial membrane and part of articular surface of humerus cut away; ends of wound sutured; cavity plugged with gauze; put up on splint. Granulated rapidly; passive movements being carried out when invalided to England 20 days later.—(Civil Surgeon J. POPE.)

Septic comminution of joint—Partial excision—Recovered.

CASE 85.—Corporal W., admitted 4 General Hospital, Mooi River, 4th April, 1902, for septic gunshot wound of elbow joint. The ends of humerus and ulna were comminuted; partial excision of joint performed; all loose fragments of bone removed; ends of bone trimmed, and triceps insertion transplanted. Successful; invalided to England.—(Major S. F. FREYER, R.A.M.C.)

Septic comminution—Amputation.

CASE 86.—Trooper S., admitted 16th December, 1900. Projectile and range not stated. Entry, outer side below elbow; exit, inner side, large; muscles and tendons torn and protruding; septic; carbolic fomentations. X-rays showed comminution of ulna and humerus into elbow joint. On

23rd December, 1900, limb swollen and œdematous to shoulder; amputation above elbow; septic fever; flaps suppurated; drainage and irrigation. Result—Temperature normal; better; no further note.—(Major Gray, R.A.M.C.)

Comminution—(?) Gangrene—Amputation—Recovery.

Case 87.—Lance-Corporal F., aged 23; wounded 12th February, 1900. Sent from field to De Aar *viâ* Rensburg. Comminution of elbow joint and upper arm; Mauser. Patient states "artery and vein were injured;" was wearing improvised tourniquet applied by comrade on admission. Next day, amputation in upper third arm (? for gangrene). Some suppuration of flaps. Recovered, with good stump.—(Civil Surgeon Young.)

Explosive type—Gangrene—Amputation—Died.

Case 88.—Private W., aged 21, wounded accidently 7th March, 1901. Projectile, Lee-Metford; range, about 1 foot; admitted 3 General Hospital. Entry, middle forearm, irregular, blackened, with protruding muscles. Exit, point of elbow, small; hæmorrhage. Ulnar artery wounded; ligatured. Application of plaster of Paris over antiseptic dressings. On 11th March, 1901, pain, fingers swollen, purple; plaster removed, forearm gangrenous; amputation at middle arm. Died same night of pulmonary ebolism.—(Hospital Records.)

The Wrist Joint and Carpus.

Only ten examples of wounds of the wrist joint have been collected. When produced by the hard-cased small-rifle bullet, injuries of this joint appear to be almost invariably pure perforations, healing quickly under a scab when aseptic, and causing little or no permanent limitation of movement. In two of the recorded cases fragments of the carpal bones were removed, the injuries having been caused by revolver or Martini-Henry bullets. No case necessitating amputation has been noted, and there is only one recorded instance of excision of the wrist joint. The case in question, one of my own, in which the bullet, considered to be a ricochet, completely shattered the left wrist joint, disorganising the carpus, and fissuring the lower end of the radius. The wound was very septic. At first the injury seemed to call for amputation, but complete excision was carried out as an alternative. Convalescence was prolonged, the arm-bath being constantly used for weeks, but he eventually recovered. At the time of invaliding, the movements of the fingers were fair, but those of the wrist very limited.

Examples:—

Examples of wounds of the wrist joint:—

Aseptic perforation.

Case 89.—Driver T., aged 25; wounded Riefontein 7th March, 1900; admitted to 1 General Hospital. Entry, dorsal surface left hand between second and third metacarpals, 2½ inches below wrist joint; passed through wrist, and exit on palmar surface forearm close to end of radius; much swelling, numbness second and third fingers; wounds healed; swelling subsided. Only very slight stiffness of joint. Invalided in April, 1900.—(Hospital Records.)

Perforation.

Case 90.—Private D., aged 30, wounded Paardeberg 18th February, 1900; projectile, Mauser; estimated range, 400 yards, lying prone when wounded; admitted 3 General Hospital seven weeks after injury. Entry ¾ inch above ulnar styloid, midway between ulnar and radial borders of extensor surface, passed through wrist joint, and exit in palm of hand at hypothenar eminence; wounds quite healed on admission; movements of fingers and wrist very good; invalided.—(Civil Surgeon A. Young.)

Septic; comminuted—Removal of fragments.

Case 91.—Private H., admitted 11 General Hospital 9th May, 1900. Projectile, Martini-Henry; range about 100 yards. Septic wound of wrist joint, and first carpo-metacarpal joint, comminution of metacarpal bones of thumb and index fingers; exit, size of shilling; boracic fomentations and drainage; iodoform gauze dressings. On 5th June, 1900, removal of pieces necrosed metacarpal and of trapezium; wounds healed; loss of power in hand. Invalided 10th August, 1900.—(Civil Surgeon Rowell.)

TABLE 32.—Wounds of Wrist Joint from all Projectiles.

Total Number.	Removal of Fragments.	Excision.	Amputation.	Deaths.
10	2	1	0	0

Tables 33 and 34 give certain details regarding all the gunshot injuries of joints noted, and Table 35 the results of all amputations performed for gunshots of both extremities.

N.B.—As it is impossible to differentiate operations on joints for the removal of fragments from true excisions—partial or complete—all operations of these two kinds have been classified as excisions in Table 34; but the numbers of cases in which more or less systematic operations were performed will be found in other tables under the headings of the various joints referred to.

TABLE 33.—Showing Results of all Cases noted.

Joint Injured.	Total.	Recovered.	Died.	Results per cent.	
				Recovered.	Died.
Hip	7	5	2	71·4	28·5
Knee	95	91	4	95·7	4·2
Ankle	40	40	—	100·0	—
Tarsal joint	27	27	—	100·0	—
Shoulder	27	26	1	96·2	3·7
Elbow	49	48	1	98·0	2·0
Wrist and carpus ..	10	10	—	100·0	—
Total	255	247	8	96·8	3·1

TABLE 34.—Showing Results of Amputations and Excisions—Partial or Complete—in all Cases noted.

Cases.	Joint Injured and Operation Performed.		Totals of Operations.	Recovered.	Died.	Results per cent.	
						Recovered.	Died.
7	Hip ..	amputation *	—	—	—	—	—
		excision ..	2	1	1	50·0	50·0
95	Knee ..	amputation ..	11†	7†	4	63·6	36·3
		excision ..	11	11	—	100·0	—
40	Ankle ..	amputation ..	11	11	—	100·0	—
		excision ..	12	12	—	100·0	—
27	Tarsal joints	amputation ..	2	2	—	100·0	—
		excision ..	6	6	—	100·0	—
27	Shoulder	amputation ..	5‡	4‡	1	80·0	20·0
		excision ..	11	11	—	100·0	—
49	Elbow ..	amputation ..	7	6	1	85·7	14·2
		excision ..	22	22	—	100·0	—
10	Wrist and carpus.	amputation ..	—	—	—	—	—
		excision ..	3	3	—	100·0	—
255	Totals ..	amputations	36	30	6	83·3	16·6
		excisions ..	67	66	1	98·4	1·5
	Total, all operations ..		103	96	7	93·2	6·7

* None for injury of the hip. † One at hip joint. ‡ One Berger's inter-scapulo-thoracic.

TABLE 35.—Showing Results of all Amputations noted.

Cases.	Site of Amputation.	Number of Amputations.	Percentage of Amputations.	Recovered.	Died.	Results per cent.	
						Recovered.	Died.
7	Hip joint	13*	†	5	8	38·4	61·5
170	Femur	33	19·4	17	16	51·5	48·4
95	Knee joint	11‡	11·5	7‡	4	63·6	36·3
137	Bones of the leg ..	33	23·2	25	8	75·7	24·2
40	Ankle joint	11	27·5	11	—	100·0	—
27	Tarsus	2	7·4	2	—	100·0	—
27	Shoulder	12§	10·9‖	9	3	75·0	25·0
83	Humerus	6	7·2	6	11	100·0	—
49	Elbow joint	7	14·2	6	1	85·7	14·2
60	Bones of the forearm	6	10·0	6	—	100·0	—
10	Wrist and carpus ..	—	—	—	0	—	—
705	All amputations ..	134	19·0	94	40	70·1	29·8

* Another amputation through the hip joint which recovered is noted at p. 239, under "Injuries of Vessels," Case 98. There were, therefore, 14 amputations at this joint noted, with 8 deaths, or a mortality of 57·1 per cent.

† No injury of the hip-joint itself required amputation.

‡ One at hip, and recovered.

§ Five, including one Berger's operation, were for injury of shoulder joint, and seven for fracture of the humerus lower down.

‖ Calculated on the total number of injuries (110, shoulder joint and humerus), 12 of which necessitated this operation.

Tetanus.

Tetanus was a rare complication of wounds in this war. The three cases given, which succumbed, are the only ones noted, and it will be observed that these did not follow Mauser wounds, but the more lacerated injuries due to shell fragments and Martini-Henry bullets. The antitoxin treatment which was tried in Case 1 seemed to have favourably influenced the disease for a time, but the case was probably too far advanced for cure to be obtained.

They were all, it will be noted, wounds of the lower extremity, and of considerable extent.

Tetanus antitoxin injected into cerebrum—Died.

CASE 1.—Private W., wounded 24th January, 1900; received from Stationary Hospital, Modder Spruit, into 4 General Hospital eight days later, when he was found in tetanic spasms, with a history of tetanus for the previous 36 hours.

Extensive septic wound on right thigh from shell; taken to operating room at once; whilst thigh was being dressed he was trephined over both frontal lobes, and 5 c.c. tetanus antitoxin injected in front of motor areas on each side. Spasms ceased for 15 hours but then recommenced. After four large doses of pot. brom. they ceased again for ten hours; died three days later.—(Mr. SIDNEY HULKE and Major S. F. FREYER, R.A.M.C.)

Wound opened and irrigated, and chloroform administered—Died.

CASE 2.—Private T., admitted 14 General Hospital 2nd January, 1901, with Martini-Henry bullet wound of both thighs. Temperature 102° F. One of the wounds opened up and irrigated, when temperature fell. Indications of tetanus were present, but this was not noticed till later. Complained of inability to use his jaw for eating; afterwards general spasms set in; chloroform used to allay spasms; died 11 days from admission.—(Records 14 General Hospital.)

Shell fragments removed—Died.

CASE 3.—Private I., admitted 2 General Hospital for shell wound of thigh—compound com. fracture of femur at junction of lower and middle thirds. Operation 5th December, 1899, by Civil Surgeon Suffield; three shell fragments removed; tetanus supervened; died three days later.—(Records 2 General Hospital.)

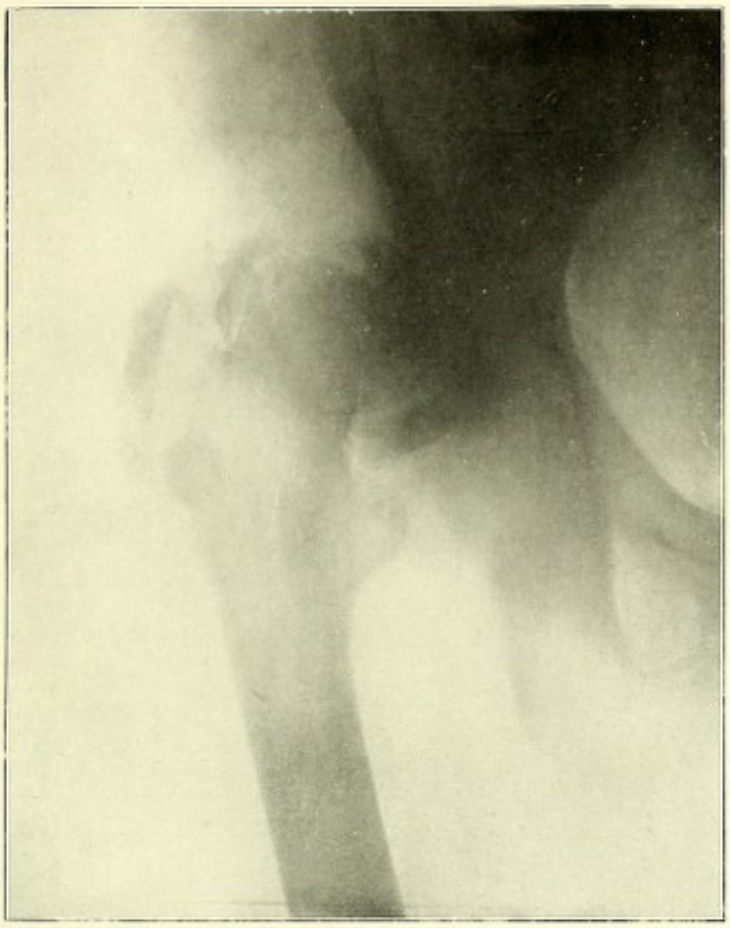


FIG. 84.
Unexploded Pom-Pom struck over Great Trochanter, Fracturing it and Dislocating Head of Femur on to Dorsum Illii.—(Skiagraphed at Netley.)

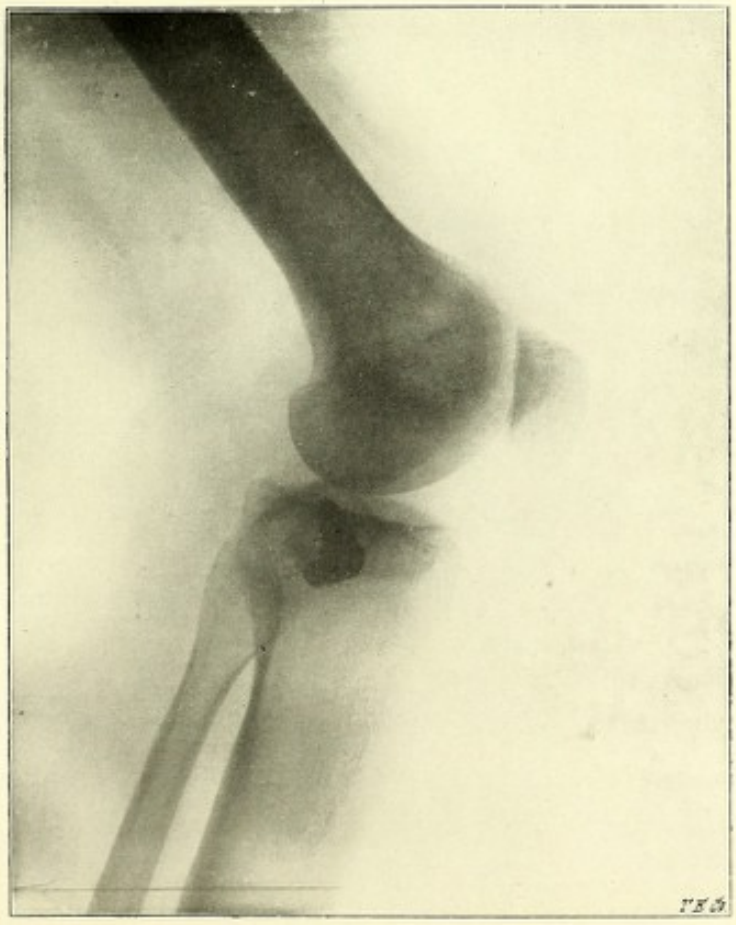


FIG. 85.
Gunshot Wound of Knee; Bullet lodged, but caused trouble; not removed.—(Skiagraphed at Netley.)

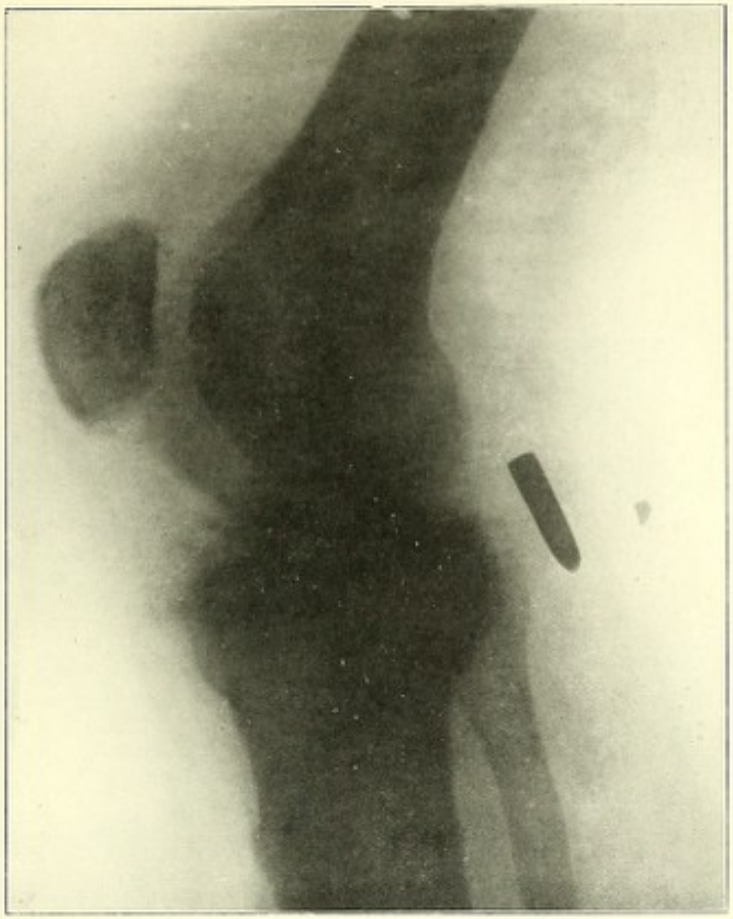


FIG. 86.
Gunshot Wound of Knee; Bullet lodged.—(By Mr. CATLING).

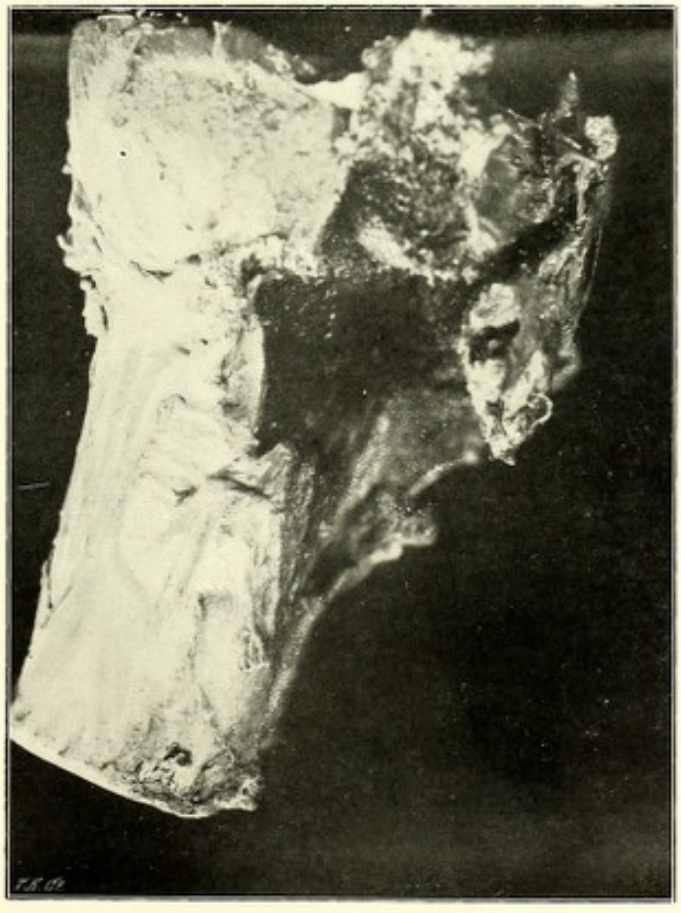


FIG. 87.
Extensive Damage to Head of Left Tibia. Bullet first passed through head of right tibia, making small track, suppurating on admission; amputation through lower third of femur.—(Photographed at R.A.M. College, where specimen now is.)

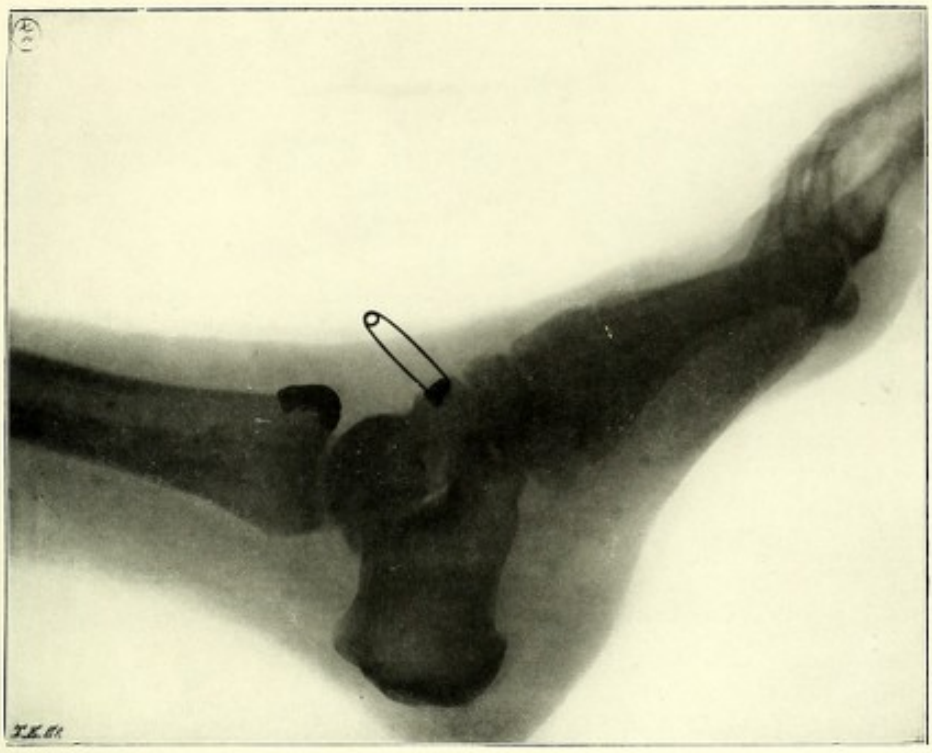


Fig. 88.

Bullet deformed and lodged against lower end of Tibia. No record of the case.

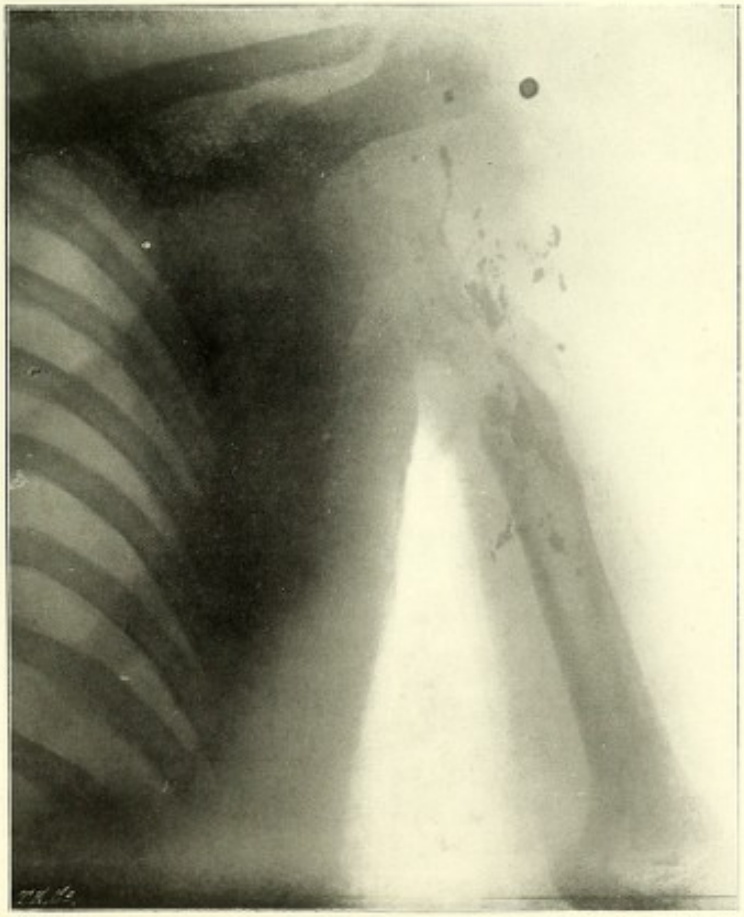


Fig. 89.

Head of Humerus and 3 inches of Shaft excised. Useful arm; see Fig. 89A for appearances three years later. Case 69 in Notes.—(Skiagraphed at Netley.)

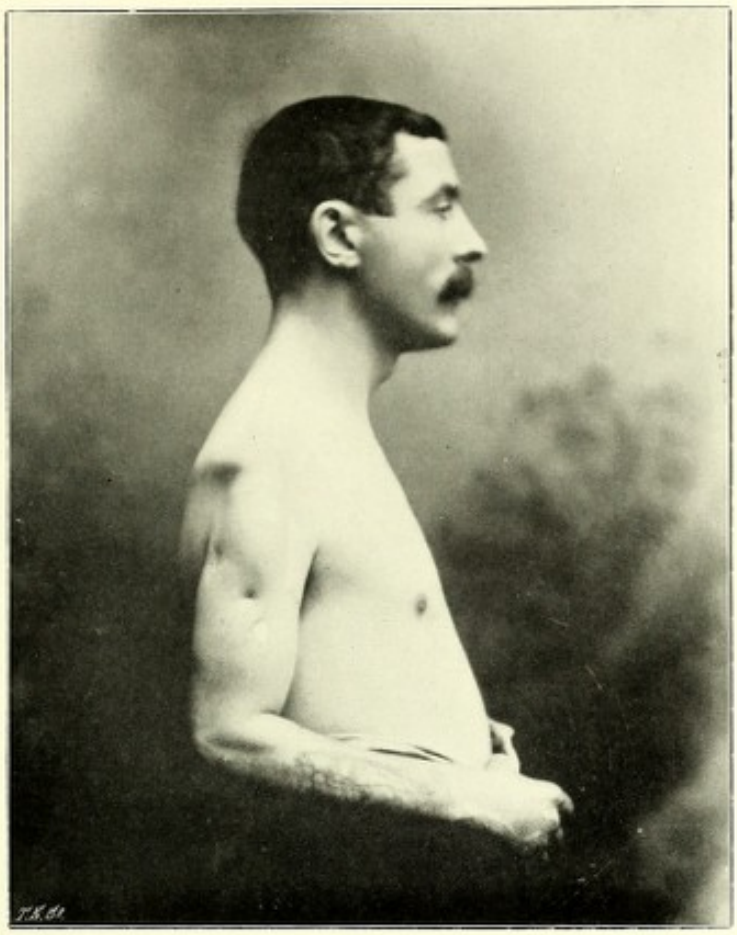


FIG. 89A.

Case 89 three years later.—(Photograph sent by Patient.)

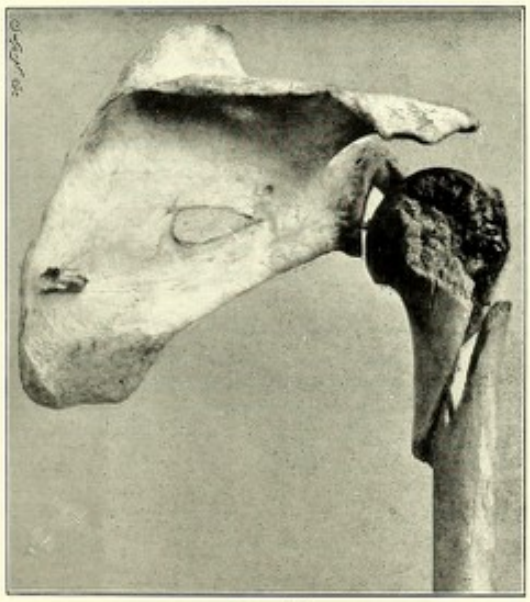


FIG. 90.

Condition of Fracture in Sir F. Treves' case of Berger's intersapulo-thoracic amputation.—(Reproduced by permission of Editor of "British Medical Journal.")

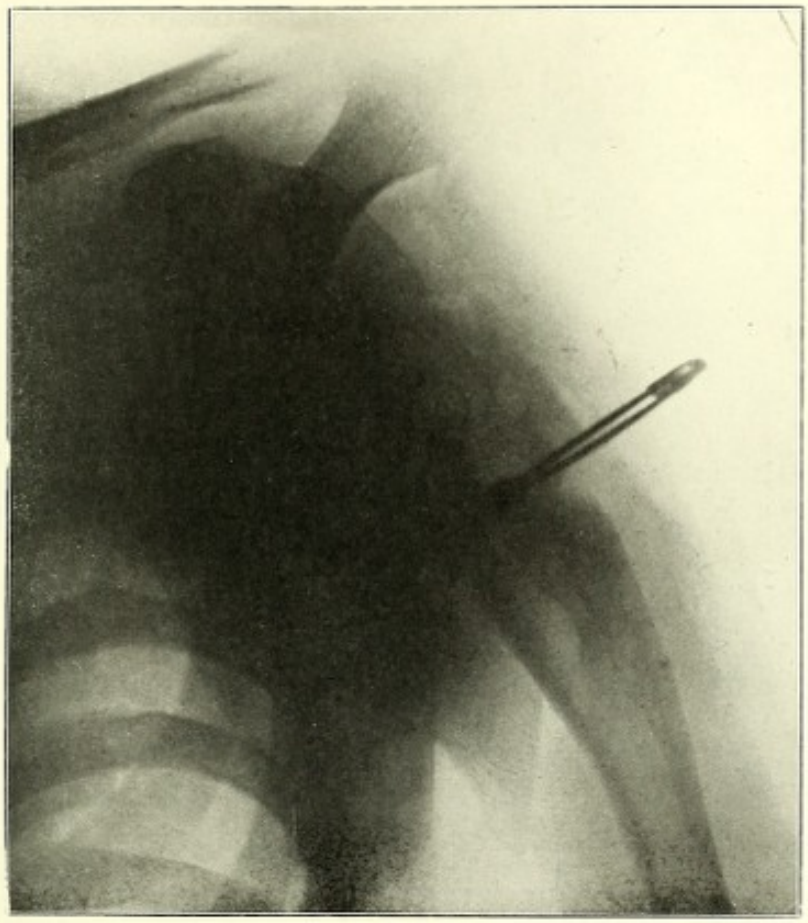


FIG. 91.

Greater part of Head of Humerus excised.—(Skiagraphed at Netley.)

FIG. 92.

Fragments of Head of Humerus excised. Colonel Hickson's case.—(Photographed at R.A.M. College, where specimen now is.)

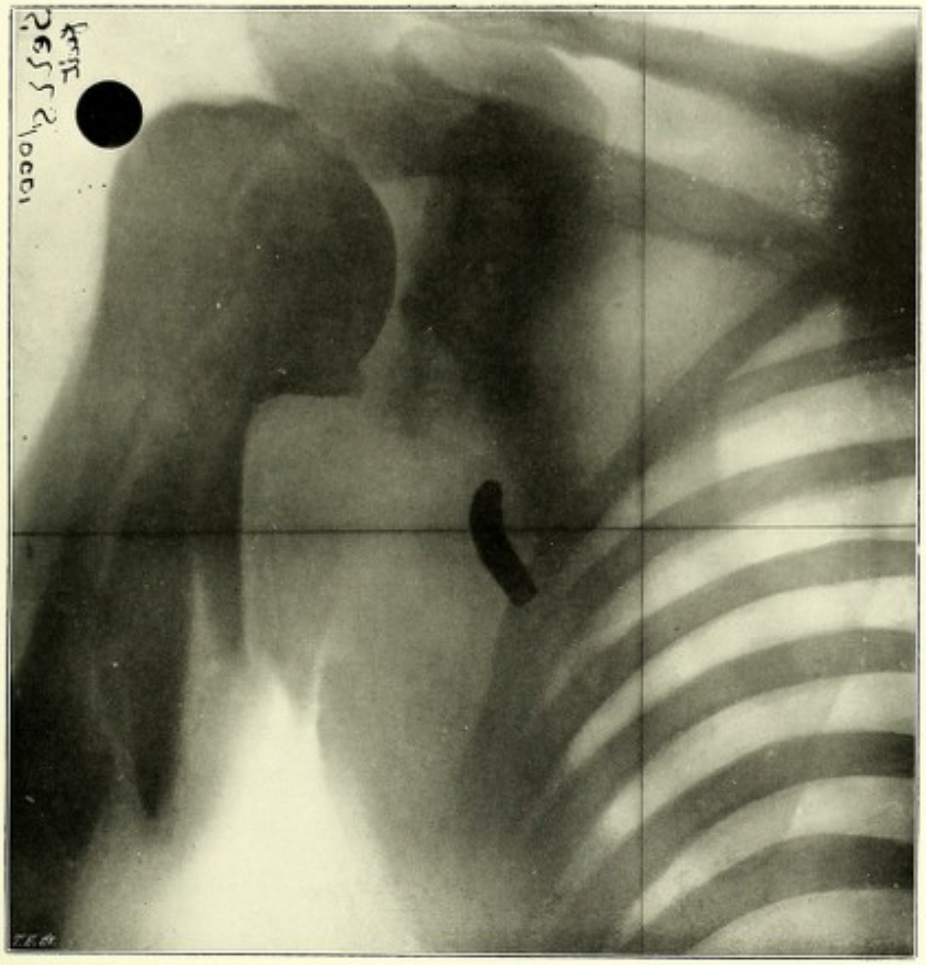


FIG. 93.

Gunshot Wound of upper end of Humerus and of Shoulder Joint. Bullet deformed against the bone and lodged in chest wall.—(By Mr. SELLS.)

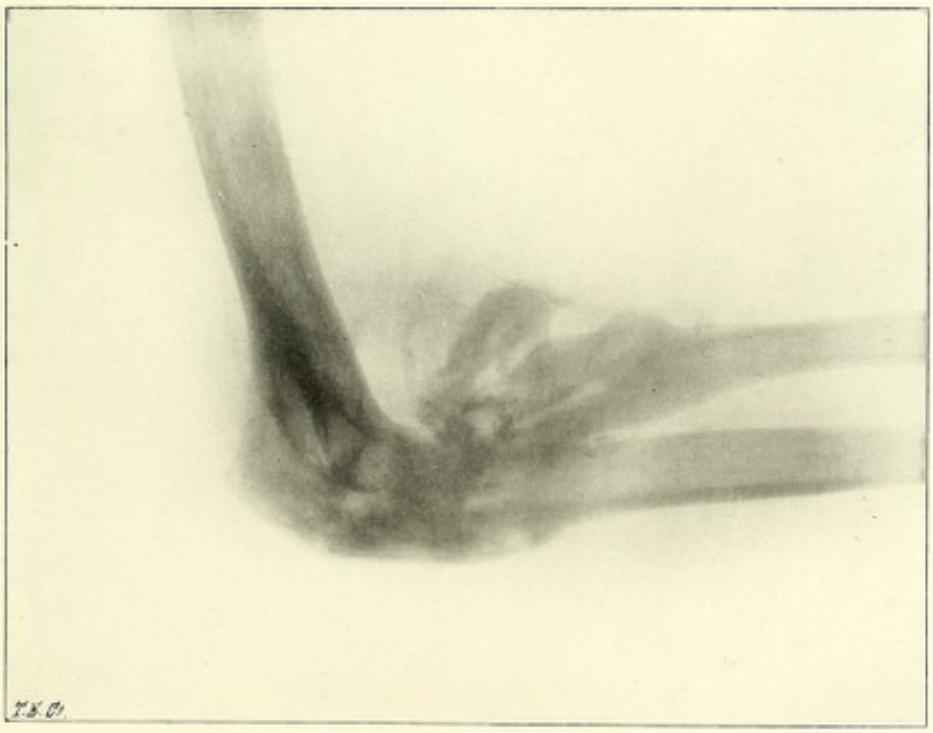


FIG. 94.

Gunshot Wound of Elbow ; ankylosis at over a right angle ; joint excised at a late period ; useful arm.—(Skiagraphed at Netley.)

SECTION IX.

By Lieut.-Colonel Sylvester, R.A.M.C.

GUNSHOT INJURIES OF BLOOD VESSELS.

Classification.

THE following classification of these injuries may be adopted :—

A.—*Of Arteries :—*

1. Contusion.
2. Partial division (including perforation).
3. Complete division.

B.—*Of Veins :—*

Partial or complete division and perforation.

Arteries.

A.—*Injuries to Arteries.*

Contusion.

1. *Contusion.*—This varies greatly in degree, and may result in (*a*) complete recovery ; (*b*) the vessel may give way later, causing external hæmorrhage, or the formation of a traumatic aneurysm ; or (*c*) the vessel may become obliterated at the site of injury.

Partial or complete division.

2 and 3. Partial or complete divisions are, of course, the more common injuries met with. Perforations have been less frequent, but a few are noted.

Perforation of vessels.

No doubt a certain number of deaths on the field were due to perforations of the large arteries in the chest and abdomen, where lesions of this kind are more likely to occur in consequence of the size of the vessels ; but naturally these cases did not come under observation.

B.—*Injuries to Veins.*

No cases have been recorded of injuries to veins alone, but arterio-venous aneurysms have been very common, and instances will be given later on.

The effects of injuries to blood vessels may be described under the following heads :—

1. Obliteration.
2. Primary and recurrent hæmorrhage.
3. Secondary hæmorrhage.
4. Traumatic aneurysms. (Diffuse and circumscribed.)
5. Arterio-venous aneurysms.

1. *Obliteration.*

This appears to have occurred in Cases 2 to 5. It may be due either to the formation of a clot in the artery at the site of injury, or, as has been suggested in the report of the Imperial Yeomanry Hospitals, to the rupture and retraction of the internal and middle coats of the vessel. There is no record of the dissection of any case of an obliterated artery, and it appears to be a rare result of gunshot injury.

2. *Primary and Recurrent Hæmorrhage.*

Very little evidence is available as to the frequency of this form of hæmorrhage on the field ; no doubt, in a considerable number of rapidly fatal cases the deaths are due to injury of the large vessels in the chest and abdomen ; but as regards external hæmorrhage, it appears that it is rarely fatal, even when vessels of considerable size, but deeply placed, are injured.

That this is to be accounted for chiefly by the narrow track made by the modern small-bore bullet as it passes through the tissues, which is practically closed shortly after the receipt of the wound from want of coincidence in the apertures through the various structures shutting off the deeper portion of the track from the external wound, is fairly certain; but when superficially-placed large arteries are wounded death from external hæmorrhage may quickly occur.

A case in which a patient lived nearly 24 hours after a wound of the popliteal artery and vein—during the first seven of which he received no treatment at all—is given below in No. 6.

3. *Secondary Hæmorrhage.*

Notes of 20 cases have been obtained showing the treatment adopted. All were septic wounds.

In 8 cases ligature of both ends of the vessel at the injured spot was performed, as is shown in Table 36 :—

TABLE 36.—Showing Results of Ligature of the Vessel in the Wound.

Artery Wounded.	Number.	Recovered.	Died.	Remarks.
Radial	1	1	—	
Brachial	1	—	1	
Posterior tibial	2	2	—	
Anterior tibial	2	2	—	
Superficial femoral	2	1	1*	* After amputation for gangrene.
Totals	8	6	2	Death-rate = 25 per cent.

In 11 cases proximal ligature was applied, as shown in Table 37.

TABLE 37.—Showing Results of Proximal Ligature.

Vessel Ligatured.	Vessel Wounded.	Number.	Recovered.	Died.	Remarks.
Subclavian	Axillary	1	—	1	
Axillary	Brachial ..	1	1	—	
Common femoral ..	Vessels in thigh	3	1	2*	* No recurrence of hæmorrhage. Cases 9–12.
Superficial femoral..	„ „	1	—	1	
Common carotid ..	Internal carotid	2	2	—	
Popliteal	Posterior tibial..	2	2	—	
Brachial	Vessels of fore-arm.	1	1	—	
	Totals ..	11	7	4	Death-rate = 36·3 per cent.

In one case amputation was performed after search had been made unsuccessfully for the bleeding vessel (the posterior tibial), death occurring shortly after (No. 14). For the cases in the above table, *see* Nos. 8, 9, 12 to 20 and 27.

These results of proximal ligature in the cases noted, as regards the arrest of hæmorrhage, at any rate, are hardly so unfavourable as might have been expected; but the death-rate was 11·3 per cent. higher than it was for ligature of both ends of the vessel at the point of injury.

4. *Traumatic Aneurysms.*

Diffuse and circumscribed aneurysms.

Notes of 63 cases of traumatic aneurysms due to gunshot injuries were recorded during the war, 45 of the diffuse kind, and 18 more or less circumscribed. Of these, 61 were treated by ligature either at the site of injury or on the proximal side, as is shown in Tables 38 and 39; and in 2, amputations

were performed. One of the latter was a primary operation, performed, apparently, because the bleeding vessels could not be tied, and the other nine days after the receipt of the wound, when gangrene was already well advanced (Nos. 67–69).

Symptoms.—A traumatic aneurysm is generally obvious; the following points may, however, be noted as having been mentioned in the various reports of cases:—

1. If the vessel is completely divided, as a rule the pulse below is absent.
2. If it is only partly divided, the pulse below is usually present, though weaker than on the other side.
3. The more circumscribed the aneurysm, the more are the classical symptoms of aneurysm present; pulsation and bruit in a typical diffused case are often completely absent.
4. The tendency of the blood in the diffused form to spread in the direction of least resistance and along the bullet track.

The condition referred to above in No. 4 is well shown in Cases 54 and 115, which came under the writer's observation. In No. 54 the popliteal artery had been completely divided, just beyond the adductor magnus, by a Mauser bullet which entered the anterior surface of the thigh 3 inches above the patella, passed backwards and slightly inwards, cutting a groove in the femur, and came out on the inner side of the upper part of the popliteal space. The blood in this case made its way between the vastus internus and the bone, where it formed a large pulsating tumour, instead of spreading in the popliteal space.

In No. 115 the bullet, also a Mauser, passed from the centre of the buttock behind to the apex of Scarpa's triangle in front, through the upper part of the thigh, cutting the sciatic artery, the blood from which made its way along the bullet track and formed a pulsating tumour in Scarpa's triangle.

Treatment.—The following methods of treatment have been adopted:—

1. Ligature of both ends of the vessel at the injured point.
2. Proximal ligature.
3. Proximal ligature combined with separate incisions for removing effused blood.
4. Amputation.

The following tables show the results of treatment by ligature in each form of aneurysm:—

Diffuse Traumatic Aneurysms.

TABLE 38.—Showing Results of Ligature at Site of Injury.

Artery Wounded.	Number of Cases.	Recovered.	Died.	Vein also tied.	No. of Case in Notes, and Remarks.
Axillary	5	5	—	—	28, 30, 47, 49, 51.
Superficial femoral..	10	10	—	7	29, 31, 32, 36, 38, 40, 48, 70, 71, 72.
Popliteal	2	2	—	1	39, 54.
Posterior tibial ..	4	4	—	—	38, 50, 52, 53.
Brachial	3	3	—	2*	* Basilic vein. 41, 45, 68.
Both tibials.. ..	1	1	—	—	Anterior only tied; hæmorrhage recurred, amputation. 42.
Ulnar	1	1	—	—	44
Profunda femoris ..	1	1	—	—	46.
Totals ..	27	27	—	10	

TABLE 39.—Showing Results of Proximal Ligature.

Artery Wounded.	Artery Ligatured.	Number of Cases.	Recovered.	Died.	No. of Case in Notes, and Remarks.
Superficial femoral..	Superficial femoral	6	6	—	34,* 55, 56, 61, 66, 37. One followed by gangrene recovered after amputation.
Posterior tibial ..	,, ,,	1	1	—	35.*
Popliteal	,, ,,	2	2	—	43, 57.
Brachial	Axillary	2	2	—	58, 63.
Posterior tibial ..	Posterior tibial ..	1	1	—	59.
Subscapular ..	Subclavian ..	1	1	—	60.
Popliteal	Popliteal	1	1	—	62.
Axillary	Subclavian ..	2	2	—	64, 65.
	Total ..	16	16	—	

* The clots were removed from the aneurysm by a separate incision in these cases.

Circumscribed Traumatic Aneurysms.

TABLE 40.—Showing Results of Ligature at Site of Injury.

Artery Wounded.	Number of Cases.	Recovered.	Died.	No. of Case in Notes, and Remarks.
Popliteal	1	1	—	73.
Radial	1	1	—	74. Sac dissected out.
Superficialis volæ	1	1	—	75.
Ulnar	1	1	—	88.
Total	4	4	—	

TABLE 41.—Showing Results of Proximal Ligature.

Artery Wounded.	Artery Ligatured.	Number of Cases.	Recovered.	Died.	No. of Case in Notes, and Remarks.
Internal plantar ..	Posterior tibial ..	1	1	—	76.
Axillary	Subclavian ..	1	1	—	77.
Superficial femoral..	Superficial femoral	1	1	—	78.
Deep femoral ..	Common femoral ..	1	—	1	79. Died from septicæmia a month after operation. Aneurysm cured.
Popliteal	Superficial femoral	2	2	—	80, 85.
Brachial	Brachial	1	1	—	81.
Axillary	Axillary	3	3	—	82, 83, 87.
Popliteal	Popliteal	1	1	—	84.
External iliac ..	Common iliac ..	1	1	—	86.
Common femoral ..	External iliac ..	1	1	—	89.
Ulnar at bend of elbow.	Brachial	1	1	—	90.
	Total ..	14	13	1	

3. *Proximal ligature with separate incision in the aneurysm to evacuate clots.*—Two cases only are described. In one, the superficial femoral was tied for aneurysm in Hunter's canal, and in the other, the superficial femoral for popliteal aneurysm. Both successful. (*See* Cases 34 and 35.)

4. *Amputation.*—In two instances of diffuse aneurysm, as already mentioned at p. 221, the condition of the parts necessitated amputation. (Cases 67 and 69.)

Contrasting these methods of treatment, there does not seem to be much difference between the results of methods 1 and 2, both being very good; but there is nothing to show any necessity for abandoning the recognised methods of proximal ligature for distinctly circumscribed aneurysms and ligature of both ends of the vessel at the seat of injury in diffused cases. Nevertheless, if for any reason it is found necessary to treat a diffused aneurysm by proximal ligature, it would appear that there is a better chance of a successful result being obtained than was formerly supposed, and that immediate amputation is not always required.

5. *Arterio-Venous Aneurysms.*

These affections, as a result of wounds of blood-vessels by the modern bullet, have been very numerous, and anyone who had surgical experience in a general hospital during the war must have seen instances implicating most of the principal arteries and veins in the body. Aneurysmal varices were by far the most common, and, as a rule, were not interfered with when recognised as such, nor were the cases specially recorded.

Notes of 33 cases have been collected, 28 of which were submitted to operation, 27 by ligature, and 1 by primary amputation. In most of them it is not definitely stated whether they were aneurysmal varices or varicose aneurysms, but when describing the treatment adopted in each case, the condition probably present—whether aneurysm or varix—is suggested, the diagnosis being based on the symptoms recorded.

A general disturbance of the circulatory system has been observed in many patients with arterio-venous aneurysms, characterised by quick and often irregular heart's action; otherwise the cases seen during the war presented the ordinary signs of these conditions.

Treatment.—The following operative methods were adopted:—

1. Ligature of both artery and vein above and below the communication.
2. Proximal ligature of the artery alone.
3. Ligature of the artery alone above and below.
4. Ligature of the artery above and the vein above and below.
5. Ligature of the artery above and both vein and artery below.
6. Amputation.

1. *Ligature of both artery and vein above and below.*—This was done four times, twice for probable aneurysmal varices and twice for probable varicose aneurysms. The superficial femoral vessels were affected in all, and in all a cure resulted. (*See* Cases 102, 116, 117, 118.)

2. *Proximal ligature of the artery alone.*—This was the operation most frequently performed, and the results are shown in the following table:—

TABLE 42.—Showing the Results of Ligature of the Artery on the Proximal Side of the Communication (Anel's or Hunter's) for Arterio-venous Aneurysms.

Artery and Vein affected.	Artery Ligatured.	Kind of art. ven. aneurysm.	Result.	Remarks.
Popliteal (upper end) ..	Superficial femoral	Varicose aneurysm.	Cured	Case 95.
,, ,, ..	,, ,,	(?)	,,	Case 94.
(?) Internal carotid, internal jugular.	Common carotid ..	Varicose aneurysm.	,,	Artery doubtful (Case 99).
(?) Internal carotid, internal jugular.	,, ,, ..	,,	,,	Artery doubtful (Case 100).
External carotid, internal jugular.	,, ,, ..	,,	,,	Case 103.
Femoral artery and vein ..	External iliac	,,	,,	Not stated which femoral (Case 104)
Brachial artery and vein, high up.	3rd part of axillary	Aneurysmal varix	,,	Case 105.
Superficial femoral ..	Common femoral ..	(?)	Gangrene	Died after amputation (Case 106).
Popliteal	Superficial femoral	Varicose aneurysm.	,,	Amputation. Recovered (Case 107)
Superficial femoral.. ..	,, ,,	(?)	,,	Amputation — Recovered (Case 108)
Popliteal	Popliteal	(?)	,,	Amputation — Recovered (Case 109)
Deep femoral	Deep femoral ..	Varicose aneurysm.	Cured	Case 111.
Superficial femoral ..	External iliac ..	,,	,,	Case 113.
Axillary	Subclavian.. ..	,,	Gangrene	Amputation — Recovered (Case 119)
,, ...	,, ...	,,	,,	Amputation — Recovered (Case 120)
Superficial femoral.. ..	Superficial femoral	,,	,,	Amputation — Recovered (Case 122)
Common, superficial, and deep femoral arteries and common femoral vein.	External iliac ..	,,	Death from exhaustion.	Free hæmorrhage (Case 123)
Superficial and deep femoral arteries and veins.	Common and superficial femorals and veins.	,,	Gangrene	Amputation. Died (Case 93)

3. *Ligature of the artery alone above and below.*—This was done three times : one case was an aneurysmal varix and the other two varicose aneurysms ; one was cured, the second improved. In the third, gangrene followed ligature of the common femoral, the patient recovering after amputation at the hip-joint ; but this case does not properly come into this category, as the common femoral was tied because it was found impossible to place a ligature close above the communication. *Vide* No. 98. (Cases 91, 92, and 98.)

4. Ligature of the artery above and vein above and below was done once for aneurysmal varix of the popliteal vessels. A cure resulted. (Case 121.)

5. Ligature of the artery above and both vein and artery below. One case of doubtful nature affecting the superficial femoral vessels. A cure resulted. (Case 110.)

6. Amputation was necessitated in one instance, gangrene having followed the application of a tight bandage. (Case 112.)

It would appear, judging from these results only, that ligature of both vessels above and below the communication is the most successful method of treatment, but the number of cases recorded is not sufficient to justify such a conclusion being drawn. This latter statement may also be made of methods 3, 4, 5 and 6. On the other hand, the results of the second plan, ligature of the artery alone, above, are so unfavourable that there can be no doubt the operation under ordinary circumstances should not be performed. Out of 14 cases affecting the vessels of the extremities (*vide* Table 42), gangrene occurred in 8, 2 being in the upper and 6 in the lower extremity. Two of these, however, are perhaps hardly fair examples, as in one the common

femoral was tied, and in the other it was necessary to ligature some veins during the operation, but there is reason to believe that the above table does not include all the instances in which gangrene followed this method of treatment, some cases not having been recorded.

In Part II, "Surgical Volume of the Medical and Surgical History of the War of the Rebellion," pages 336, 337, an account is given of a case of aneurysmal varix treated by proximal ligature of the artery alone, and in a footnote on page 337a number of references to writings on the subject are given. Follin (Traité de pathologie externe, 1865, T. II, page 374) is quoted as having published a list of 10 arterio-venous aneurysms of the lower extremity, 5 of which were treated by placing a ligature on the cardiac side of the aneurysm, and all 5 ended fatally. He also collected 9 cases in the upper extremity similarly treated; 3 of these died, 5 relapsed, and only 1 was cured. The note concludes: "After the suspension of the current of arterial blood by a proximal ligature, the venous blood still entering the distal portion of the artery may block up the vessel and lead to gangrene, or else anastomosis restores the circulation in the distal portion, and a relapse occurs."

The method of treatment recommended in this report is ligature of the artery alone, above and below the communication with the vein, and a reference is given to a successful case published by Syme in the "Edinburgh Medical Journal," 1869. This is the procedure which will certainly recommend itself to surgeons in the future in the treatment of varicose aneurysms where it is possible to do it, whilst it is generally accepted that aneurysmal varices should not be submitted to operation, at any rate, until they have existed long enough to prove that the inconvenience they cause the patient will be permanent, and then the same operation should be performed.

Case 101 gives the condition of an aneurysmal varix 13 months old.

Case 96 the account of the *post-mortem* examination of one which had existed a month, the patient dying of enteric fever.

Case 115 is one of combined diffuse traumatic aneurysm and aneurysmal varix, the treatment adopted being really rendered necessary by the former condition, though it was not recognised before operation.

Table 43 and 44 show the injuries to vessels for which amputations had to be performed, and the conditions which rendered them necessary, while Table 45 gives the results of all the cases noted during the war.

Injuries to Blood Vessels.

TABLE 43.—Showing the Injuries of Vessels which subsequently necessitated Amputations.

Conditions for which treatment was required.	Total Number of Amputations.	Methods of Treatment employed.					Results.			
		Ligature of Artery above and below.	Ligature of Artery and Vein.	Proximal Ligature (Hunter's).	Ligature close above (Anel's)	Amputation, no ligature applied.	Totals.		Per cent.	
							Recovered.	Died.	Recovered.	Died.
Primary and recurrent hæmorrhage.	1	—	—	—	—	1	—	1	—	100·0
Secondary hæmorrhage	2	1	—	—	—	1	—	2	—	100.0
Diffuse aneurysms ..	4	1	—	1	—	2	3	1	75·0	25·0
Varicose aneurysms ..	11	—	2	5	3	1	9	2	81·8	18·1
Totals	18	2	2	6	3	5	12	6	66·6	33·3
Per cent. Recovered	66·6	50·0	50·0	83·3	100·0	60·0	66·6	—	—	—
Per cent. Died ..	33·3	50·0	50·0	16·6	—	40·0	—	33·3	—	—

TABLE 44.—Showing Results of Amputations and the Conditions for which they were performed.

Conditions for which they were performed.	Amputations.						Results.			
	Primary.			Secondary.			Totals.		Per cent.	
	Recovered.	Died.	Total.	Recovered.	Died.	Total.	Recovered.	Died.	Recovered.	Died.
Primary and recurrent hæmorrhage.	—	1	1	—	—	—	—	1	—	100·0
Secondary hæmorrhage	—	1	1	—	1	1	—	2	—	100·0
Diffuse aneurysm ..	—	1	1	3	—	3	3	1	75·0	25·0
Varicose aneurysms ..	1*	—	1	8	2	10	9	2	81·8	18·1
Total	1	3	4	11	3	14	12	6	66·6	33·3
Results per cent. Recovered	25·0	—	—	78·5	—	—	—	—	66·6	—
Results per cent. Died ..	—	75·0	—	—	21·4	—	—	—	—	33·3

* For recurrent hæmorrhage after ligature.

TABLE 45.—Showing Results of all Cases noted. (123 Cases.)

——	Cases.	Ratio per cent.	Remarks.
Recovered	108	87·8	Six of these were not treated by operation, and therefore do not appear in previous Tables.
Died	13	10·5	
Result unknown	1	0·8	No. 3.
Died of enteric	1	0·8	No. 91.
Totals	123	99·9	

GUNSHOT WOUNDS OF THE HEART.

Some few cases followed by recovery were noted in which, judging from the positions of the entrance and exit wounds, the heart was presumed to have been traversed by the bullet, but in none of them was the evidence that the track lay through the heart unequivocal. In one case, for instance, the entrance was over the centre of the cardiac area, and, with the man in the erect position and his shoulders "squared," the exit wound was so placed that the bullet must have passed through the heart. But he was not in that position when hit: the left arm was stretched forward to its extreme limit, pulling the scapula and the exit aperture in the skin to a position which then showed that the bullet track probably lay outside the ribs, and certainly it was not through the heart. In other cases the heart in diastole might have been wounded, while in systole it would have escaped. All the so-called cases of recovery from gunshots of the heart are open to doubts of this kind; there is, in fact, no well-authenticated case on record from the Boer War.

The following are the notes of cases of injuries to blood-vessels available from the Boer War:—

Class 1.—Contusion.

Axillary artery—Ligatured at site—Recovered.

CASE 1.—Private S., wounded 15th January, 1900; admitted 4 General Hospital, Mooi River, six days later. Entrance centre of ant. axillary fold; exit lower edge of post. fold; both scabbed over. (For damage to musculo-spiral nerve, *see* Case No. 1, under "Gunshot Wounds of Nerves.") The axillary artery accidentally found wounded in course of operation on the

nerve. There had been no hæmatoma in connection with the vessel previous to operation. Both ends of vessel tied at site. Recovered.—(Major S. F. Freyer, R.A.M.C.)

Subclavian artery—No operation—Recovered.

Case 2.—P., wounded 18th February, 1900; admitted 6 General Hospital 14 days later. Entrance just below junction of mid. and outer thirds left clavicle; exit on same side, between ninth and tenth ribs, just outside erector spinæ. No pulse in axillary, brachial, or forearm vessels, and no sign of aneurism at seat of injury. Patient recovered, but state of vessels not again alluded to.—(Civil Surgeon Mursell.)

Brachial artery—No operation—Result unknown.

Case 3.—R., wounded 13th December, 1900, through upper arm, just external to line of main artery. A soft thrill could be felt over the artery, in the line of the wound; radial pulse very faint; no swelling in bullet track. No further history.—(Imperial Yeomanry Hospital Report.)

Brachial artery—No operation—Compression—Recovered.

Case 4.—F., wounded 11th December, 1899. Bullet passed through upper arm, from outer to inner side, across line of brachial artery. Hæmorrhage arrested on field by tourniquet, which was left on all day. On 19th day exit wound was still open; forearm flexed at right angle; no radial pulse. Slowly improving on 37th day, under massage; no sign of aneurism; very faint pulse in radial.—(Major L. E. Nichol, R.A.M.C.)

Axillary artery—No operation—Recovered.

Case 5.—Private C., wounded 18th February, 1900; admitted 3 General Hospital a month later. Entrance 1 inch outside angle of right scapula; exit $2\frac{1}{2}$ inches below clavicle, and $1\frac{1}{2}$ inches from "centre of humerus," as arm hangs by side; both healed. Bullet had travelled along floor of axilla. No pulse in brachial, which is felt as hard cord all down arm; radial and ulnar pulses absent; bruit can be heard under clavicle; wrist-drop remains, but paralysis of other muscles which existed after injury has passed off now. A fortnight later, when invalided to England, pulsation was returning to brachial and radial arteries.—(Civil Surgeon R. Stuart.)

Class 2.—Primary and Recurrent Hæmorrhage.

Popliteal artery and vein; complete division—Died.

Case 6.—H., shot on patrol, through the popliteal artery, 10 miles from camp. Conveyed by trolley and train to hospital, where he arrived seven hours later. No attempt had been made to arrest hæmorrhage, and on admission he presented the ordinary symptoms of severe loss of blood.

In spite of all efforts he did not rally, and died 16 hours later.

Post mortem.—The artery was found completely divided $\frac{3}{4}$ inch above its bifurcation, and the ends had retracted, leaving a space of 2 inches between; vein also wounded; no attempt at formation of clot in proximal end of artery.—(Civil Surgeon H. Thomas.)

Superficial femoral artery and vein—Not bullet wound—Amputation—Died.

Case 7.—Private H., wounded 28th April, 1902; admitted same afternoon Lichtenburg Hospital. Entrance (piece of lock of rifle) in lower third of thigh, where femoral artery passes into popliteal; no exit. Improvised compress (piece of wood) on femoral removed, and circulation in leg, which was imperilled, encouraged. Recurrent hæmorrhage next evening. Amputation through upper third of thigh following day. Died same afternoon. On exploration of amputated limb it was found that the trigger of a rifle, which caused wound, had cut both main vessels as they pass back into popliteal space.—(Civil Surgeon J. Davey.)

Class 3.—Secondary Hæmorrhage.

Vessel uncertain; proximal ligature of common carotid—Recovered.

CASE 8.—Private L., wounded 15th August, 1901; admitted Port Elizabeth 10 days later. Entrance ½ inch below margin of left orbit; exit below tip of mastoid process on same side; severe secondary hæmorrhage took place from exit wound, and a large swelling appeared in pharynx, necessitating feeding by stomach tube. On 8th day, after admission, common carotid was tied, above omo-hyoid; swelling subsided, and there was no more hæmorrhage. Invalided a month later to England.—(Records Port Elizabeth Hospital.)

Axillary artery; proximal ligature of subclavian—Died.

CASE 9.—Corporal C., wounded 27th February, 1900; admitted 4 General Hospital three days later; Mauser wound from front to back, through folds of axilla; supposed to be healing under "first field dressing." On the morning of 9th March, 1900, he was found collapsed, and unconscious, from hæmorrhage which had taken place during the night. It was found that this was the fourth recurrence of the bleeding. The subclavian was at once tied. So little blood was there remaining in the system that the vessel could not be felt, and it was only seen faintly beating by the aid of a hand mirror. In spite of transfusion, bandaging, heat, and stimulation, patient died four hours later.—(Major S. F. FREYER, R.A.M.C.)

Anterior tibial artery; septic; ligatured at site—Recovered.

CASE 10.—Private W., wounded 24th January, 1900; admitted 4 General Hospital two days later. Entrance (Martini-Henry) on inner side, and behind tibia, at junction of mid. and lower thirds; exit opposite, on outer side of leg, both very large and septic; compound comminuted fracture of fibula. Secondary hæmorrhage set in four nights later, and was checked by plugging. Next morning enlarged exit, but, after removing fragments of fibula, source of bleeding not found. Posterior tibial was then cut down on, through entrance wound, and exposed for 2 inches, but found undamaged. Finally ant. tibial was exposed, by fresh incision in front; found lacerated, and tied above and below; after irrigation hæmorrhage recurred, and a ligature which had slipped was re-tied; septic wounds plugged with gauze. Hæmorrhage recurred 12th day. Amputation was considered at a consultation, as whole hand could now be passed through, under calf muscles, from entrance to exit wounds, which continued sloughing. Wounds again thoroughly irrigated, and loosely packed with iodoform gauze; limb wrapped in wool, and firmly bandaged from toes; fixed on a splint with foot-piece and well raised. Uninterrupted recovery. Invalided to England 59th day, with all wounds healed, and every promise of a useful leg.—(Major S. F. FREYER, R.A.M.C.)

Radial artery; septic; ligatured at site—Recovered.

CASE 11.—Private C., wounded 24th February, 1900; admitted 4 General Hospital two days later. Septic wound across front of wrist; secondary hæmorrhage set in the 19th day; radial artery found completely divided, and both ends tied; all the tendons of flexor sublimis found cut across, separated, and sloughing. At the late Sir W. Stokes' suggestion we attempted with kangaroo tendon, which he had, to bridge the intervals. Accordingly the wound was scraped, &c., and four pieces of kangaroo tendon inserted in the intervals. One of them came away afterwards, but the others held, and under massage, when the wound closed, the stiffness of wrist and fingers was passing off. The patient had to be invalided home the 51st day, so that we had no further opportunity of investigating the ultimate fate of the kangaroo tendons, or of re-operating on the tendon that shed its sutures.—(Major S. F. FREYER, R.A.M.C.)

Profunda artery; septic; proximal ligature of common femoral—Died.

CASE 12.—Lance-Corporal B., admitted 4 General Hospital for "multiple shell wound" of thigh. All wounds septic and sloughing; irrigated, and dressed twice daily. Profuse hæmorrhage occurred the fourth day from a wound on inner side of thigh; it ceased on removal of dressing, and was thought to be venous. Next day there was a large fluctuating swelling

there; an incision let out some clots of blood and pus, when profuse hæmorrhage from profunda set in; the common femoral artery was tied, but patient died three hours later.—(Civil Surgeon F. Pope.)

Case 13.—Private E., wounded 23rd February, 1900; admitted 4 General Hospital four days later. Entrance at outer aspect of anterior surface of thigh in upper third; direction of wound downward, backwards and inwards; bullet lodged; wound discharging pus and blood, and thigh swollen and discoloured; great pain in limb, which was kept semi-flexed. While being X-rayed, the 15th day, severe hæmorrhage set in; wound freely laid open; pus and blood clots removed, when uncontrollable hæmorrhage set in; common femoral tied; wounds irrigated, and counter-opening made at back of thigh. Died of exhaustion two days later.

Post mortem.—Profunda artery severed 4 inches from its origin, the wound in it partly occluded by cicatricial tissue; piece of flattened bullet found between biceps and semi-membranous muscles, 2 inches behind femoral artery; incision over common femoral almost healed.—(Major H. H. Johnston, R.A.M.C.)

Profunda artery; septic; proximal ligature of common femoral—Died.

Case 14.—P., wounded 18th December, 1900; admitted two days later. Entrance just below head of fibula; exit 2 inches above internal malleolus; wound septic; profuse secondary hæmorrhage next morning; failed to find source by enlarging wound; amputation; death from shock and effect of loss of blood shortly after; post. tibial artery was found divided 1 inch below its origin.—(Records 2 General Hospital.)

Posterior tibial artery; septic—Amputation—Died.

Case 15.—E., septic gunshot fracture of radius 3 inches below elbow; secondary hæmorrhage sixth day; ligature of brachial at bend of elbow; no recurrence of bleeding. Good recovery.—(Civil Surgeon A. J. Evans.)

Vessel doubtful; septic; proximal ligature of brachial—Recovered.

Case 16.—C., septic gunshot wound of thigh. Entrance 3 inches above knee, on inner side; no exit; secondary hæmorrhage on 10th day. Wound enlarged; clots turned out; no bleeding; wound plugged. After seven days, while straining at stool, bleeding recurred profusely. Unsuccessful search for bleeding vessel in wound, which extended amongst muscles up to hip; ligatured common femoral; no further recurrence of hæmorrhage. Good recovery.—(Records 2 General Hospital.)

Vessel doubtful; septic; proximal ligature of common femoral—Recovered.

Case 17.—Septic compound fracture of humerus, 2½ inches below axilla. Secondary hæmorrhage from large exit wound on back of arm; ligature applied at third stage of axillary; no recurrence of bleeding. Good recovery, with union of humerus. (*See* Case No. 24, "Gunshot Wounds of Long Bones.")—(Civil Surgeon A. J. Evans.)

Vessel doubtful; septic; proximal ligature of axillary artery—Recovered.

Case 18.—J., gunshot wound of neck; swelling below ear explored 19th day; found to be an aneurysm, and plugged. Hæmorrhage set in 48 hours later. The common carotid was then ligatured, but when plug was removed there was still some bleeding, so the sac was plugged again. Second plug left for 10 days, and on removing it there was no recurrence of hæmorrhage. Case did well.—(Civil Surgeon P. A. Haig.)

Vessel doubtful; common carotid artery ligatured and wound plugged—Recovered.

Case 19.—M., wounded 8th February, 1902, transversely through upper part of tibia; wound septic; secondary hæmorrhage 14th day. Failed to find bleeding vessel in wound; ligatured upper part of popliteal; no recurrence of bleeding. Good recovery.—(Records 16 General Hospital.)

Vessel doubtful; septic; proximal ligature of popliteal artery—Recovered.

Case 20.—Septic compound fracture of both bones of leg; secondary hæmorrhage 14th day. The post. tibial was thought to be the source; popliteal was ligatured; no recurrence of bleeding. Good recovery.—(Civil Surgeon Tweedie.)

Post. tibial artery(?); septic; proximal ligature of popliteal—Recovered.

Anterior tibial artery; septic; ligatured at site—Recovered.

CASE 21.—T., septic compound fracture of both bones of leg; secondary hæmorrhage on 14th day; both ends anterior tibial tied. Good recovery.—(Civil Surgeon STEVENSON.)

Brachial artery; septic; ligatured at site—Died.

CASE 22.—R., septic gunshot wound of upper arm; hæmorrhage from brachial fourth day; both ends tied in wound; venous oozing necessitated wound being opened up again; patient much exhausted, and in spite of saline injections into vein and rectum, he died 13 hours later.—(Major LOUGHEED, R.A.M.C.)

Posterior tibial artery; ligatured at site—Recovered.

CASE 23.—B., revolver bullet passed from side to side, through calf, fracturing fibula; secondary hæmorrhage from post. tibial, which latter was tied in wound. No recurrence; case did well.—(16 General Hospital Report.)

Branch of superficial femoral artery; septic; main artery ligatured above and below—Recovered.

CASE 24.—H., septic gunshot wound of thigh; secondary hæmorrhage, probably from branch of superficial femoral. Owing to condition of the parts, the main artery had to be ligatured above and below branch and divided between. Recovered.—(Civil Surgeon STEVENSON.)

Superficial femoral artery; septic; ligatured at site—Gangrene—Amputation—Died.

CASE 25.—B., hæmorrhage from superficial femoral in septic compound fracture of lower third of femur; artery ligatured in wound; gangrene followed; amputation upper third. Died.—(Civil Surgeon A. YOUNG.)

Posterior tibial artery; septic; ligatured at site—Recovered.

CASE 26.—X., gunshot wound; secondary hæmorrhage in septic wound; compound fracture of tibia; ligature of both ends of posterior tibial in wound. Good recovery.—(Civil Surgeon TWEEDIE.)

Superficial femoral artery; septic; proximal ligature—Died.

CASE 27.—Lance-Corporal L., wounded 18th February, 1900; admitted 2 General Hospital 19 days later. Had an amputation done through knee joint, by Professor Ogston. Flaps septic; temperature 103° F.; profuse secondary hæmorrhage; femoral tied at apex of Scarpa's triangle; transfusion, &c. Died two hours later.—(Records 2 General Hospital.)

Class 4.—Diffuse Aneurysm.

Axillary artery; ligatured at site—Recovered.

CASE 28.—Wounded at Elandslaagte. Seen at Wynberg 14 days later. Antero-posterior wound (Mauser) at upper end of humerus, bone not damaged; no severe hæmorrhage at time of wound. Diffuse aneurysm, occupying axillary space, suddenly formed on twelfth day, and anterior wound began to ooze blood. An incision was made over line of vessel, large quantity of clot turned out, and wound found in third part of axillary artery. The outer coats of the vessel had been grazed for the space of an inch, and the artery had given way in the middle of this. Vessel ligatured above and below, and divided between. Uninterrupted recovery.—(Surgeon-General STEVENSON, A.M.S.)

Superficial femoral artery; ligatured at site—Recovered.

CASE 29.—Private S., wounded 21st January, 1900; admitted 4 General Hospital, Mooi River, five days later. Entrance (Mauser) on post. and outer aspect of thigh, between its mid. and lower thirds; exit on anterior and inner aspect, direction slightly downwards; both cicatrized. Leg swollen; aneurysmal throbbing over Hunter's canal. Two days later a 4-inch incision was made over Hunter's canal; blood spurted profusely from a small round perforation in fibrous roof of canal just below the centre. Esmarch's tube was now put on, and artery was exposed, when a ragged laceration ½ inch long was found on anterior surface of latter close to anastomotica magna.

Had to tie below anastomotica, then latter branch, as well as main vessel above. Vein uninjured; very little blood effused. Healed by first intention; invalided to England 49th day.—(Major S. F. Freyer, R.A.M.C.)

Axillary artery; ligatured at site—Recovered.

Case 30.—Lieut. the Hon. A. H., wounded 15th March, 1902; transferred to 4 General Hospital, Mooi River, 28 days later.

Left arm practically powerless from injury to brachial plexus. Entrance (normal Mauser) on front of arm at junction with axillary fold, from which protruded a nipple of dried blood clot; exit 1½ inches from fifth dorsal spine; healed. Large pulsating swelling in axilla, with bruit of simple aneurysm; history of profuse hæmorrhage from entrance wound; face blanched. With arm drawn from side aneurysm was laid open by incision across axilla, and in line of main vessels; clot turned out, and vessel seized. The rent in artery, ¾ inch long, was situated between heads of median nerve, at junction of mid. and lower third of vessel.

Ligatured above and below; wound closed. Healed by first intention; perfect recovery as regards aneurysm. For damage to brachial plexus, *see* No. 14, "Gunshot Wounds of Nerves."—(Major S. F. Freyer, R.A.M.C.)

Superficial femoral artery and vein; ligature of both vessels at site—Recovered.

Case 31.—Private M., wounded 24th October, 1899, admitted same day to Civil Hospital, Kimberley; wounded by Mauser through soft parts in centre of thigh. A boggy swelling in thigh between wounds was incised 20 days later; blood clot was turned out, and a drain inserted. Secondary hæmorrhage during night; wound enlarged, and both artery and vein tied, above and below; "small pin-hole perforations" found in each. Able to go about on crutches two months later. Recovered.—(Lieutenant O'Gorman, R.A.M.C.)

Superficial femoral artery and vein; ligatured both at site—Recovered (leg weak).

Case 32.—Private H., wounded 18th October, 1901. Entrance in centre of thigh; exit in mid. ham, behind, bullet wounding vessels opposite middle of Hunter's canal. Aneurysm followed, occupying "lower and inner third" of thigh, but there was a good pulse in anterial tibial. On the ninth day Civil Surgeon N. Wilson made an incision 3 inches long, over centre of swelling; sartorius pulled inwards, and vessels exposed. Both were found wounded; ligatures were applied above and below the wound on each vessel. Healing took place by first intention, but a month later the circulation was still weak in the leg, which became blue if allowed to hang down.—(Records 2 General Hospital.)

Posterior tibial artery; ligatured at site—Recovered.

Case 33.—Lieut. B., transferred to 4 General Hospital about a month after receipt of wound. Entrance on outer side of leg, behind fibula, and 3 inches below its head; exit on inside of leg 4 inches above internal malleolus. Aneurysm of calf, due to wound of artery at junction of mid. and lower thirds.

A 6-inch incision was made behind tibia, and parallel to it, on inner side of leg, over middle of tumour; clot turned out, and both ends of post. tibial artery tied.

Wound healed aseptically, and "the operation was a complete success."—(Civil Surgeon Hulke and Major Hackett, R.A.M.C.)

Superficial femoral artery; proximal ligature of vessel—Recovered.

Case 34.—N., diffuse traumatic aneurysm in Hunter's canal of large size. Ligature of superficial femoral in Scarpa's triangle; two separate incisions made in swelling and clots removed. Sharp hæmorrhage took place from distal end of artery; wound packed with gauze. After 48 hours plug was removed; no further bleeding. Uneventful recovery.—(Lieut.-Colonel S. Hickson, R.A.M.C.)

Posterior tibial artery; proximal

Case 35.—Private D., wounded 30th April, 1902. Entrance 1 inch below head of tibia in front and on inner side; exit on outer aspect of calf, a little below middle of leg. No injury to bone.

ligature of superficial femoral—Recovered.

Diffuse aneurysm from wound of post. tibial artery, followed with recurrent hæmorrhage. On 8th May, 1902, an attempt to tie popliteal failed, and three days later, as an operation at site of injury was considered impossible—soft parts too disorganised—the femoral was ligatured in Hunter's canal. The clots were then turned out of the aneurysm, and the cavity filled with gauze. Perfect recovery.—(Lieut.-Col. HICKSON and Lieut. SHEEHAN, R.A.M.C.)

Superficial femoral artery; ligatured at site—Recovered.

CASE 36.—Van A., wounded by Lee-Metford. Wound had healed 34th day, but a diffuse traumatic aneurysm of the superficial femoral in Hunter's canal remained. Operated on three days later, clots turned out, and both ends of vessel tied. Healed by first intention; rapid recovery.—(Lieut.-Colonel S. HICKSON, R.A.M.C.)

Superficial femoral artery(?); ligatured above—Gangrene—Amputation—Recovered.

CASE 37.—Native. Diffuse traumatic aneurysm in Hunter's canal. Superficial femoral artery ligatured above at another hospital. Gangrene of foot on admission. Amputation of thigh; recovered.—(Lieut.-Colonel S. HICKSON, R.A.M.C.)

Superficial femoral artery and vein; ligatured both at site—Recovered.

CASE 38.—Traumatic aneurysm of superficial femoral artery and vein; pulse below was present, but weaker than on opposite side.

Artery and vein ligatured in Scarpa's triangle (? site of communication). "Did well."—(Civil Surgeon GARDNER.)

Popliteal artery and vein; ligatured at site—Recovered.

CASE 39.—H., wounded 25th February, 1902, through popliteal space. After three days swelling set in, without pulsation. On eighth day there was strong pulsation in swelling; tibial pulse not lost. Rested in bed for a month, when both ends of the vessel were tied at the seat of injury. The vein, which was also found wounded, was tied. Good recovery, without complications.—(Civil Surgeon GARDNER.)

Superficial femoral artery and vein; ligatured both at site—Recovered.

CASE 40.—Superficial femoral artery and vein ligatured for traumatic aneurysm at upper end of Hunter's canal, three weeks after receipt of wound. Both ends of each vessel were tied. Patient "did very well."—(Lieutenant PRESTCOTT, R.A.M.C.)

Brachial artery and basilic vein; ligatured at site—Recovered.

CASE 41.—Sergeant L., wounded 24th January, 1900; admitted 4 General Hospital, Mooi River, nine days later. Entrance 1½ inches above and a little outside int. condyle left arm; no exit, but short, thick bullet seen by X-rays lodged over deltoid muscle—a long raking wound due to his revolver going off accidentally.

Large hæmatoma all over arm; œdema of forearm and hand; partial anæsthesia of median supply; three days later cut down on the aneurysmal hæmatoma; basilic vein found wounded and bleeding; this was tied. Then Esmarch's tube was put on, and, after washing away clot, a laceration ½ inch long was found inside of brachial, in lower third. Tied this above and below, and divided between ligatures. For injury found in median nerve, *see* Case No. 3, "Gunshot Wounds of Nerves." Removed bullet; healed by first intention; perfect recovery as regards vessels when invalided to England 44th day.—(Major S. F. FREYER, R.A.MC.)

Anterior and posterior tibials; septic; ligatured at site; hæmorrhage continued—Amputation—Recovered.

CASE 42.—J., wounded 12th April, 1901; admitted three days later; septic wound from before backwards, through the tibia, 2 inches below tubercle; bone much comminuted; traumatic aneurysm on front of leg, outside wound. Incised aneurysm three days later, when it was found to pass through interosseous membrane to back of leg; ligatured both ends of anterior tibial; hæmorrhage continued; posterior tibial could not be got at; amputation. Recovered.—(Major LOUGHEED, R.A.M.C.)

CASE 43.—D., traumatic aneurysm of lower end of popliteal artery. On 10th day an unsuccessful attempt was made to ligature at injured spot, and the superficial femoral was tied in Hunter's canal. The case did well.—(Captain THURSTON, R.A.M.C.) — Popliteal artery; proximal ligature of superficial femoral—Recovered.

CASE 44.—P., traumatic aneurysm of ulnar artery in palm. "Ligature of both ends; recurrence; operation repeated. Cure."—(Civil Surgeon CARSON.) — Ulnar artery; ligatured at site—Recovered.

CASE 45.—W., traumatic aneurysm at bend of elbow; pulse absent below; artery found partly divided; both ends tied. Good result.—(Civil Surgeon BRINCKER.) — Brachial artery (?); ligatured at site—Recovered.

CASE 46.—W., diffuse traumatic aneurysm in Scarpa's triangle, inside femoral vessels, causing compression of femoral vein and consequent œdema of the leg. Incision made over swelling; clots turned out and a vessel the size of the radial—probably a branch of the profunda—was ligatured. Good recovery.—(Lieut.-Colonel SYLVESTER, R.A.M.C.) — Profunda artery; ligatured at site—Recovered.

CASE 47.—Traumatic aneurysm of axillary artery; ligatured both ends at injured spot. Recovered.—(Major MALLINS, R.A.M.C.) — Axillary artery; ligatured at site—Recovered.

CASE 48.—Traumatic aneurysm of superficial femoral artery in Hunter's canal; ligatured both ends at wounded point. Recovered.—(Imperial Yeomanry Field Hospital Records.) — Superficial femoral artery; ligatured at site—Recovered.

CASE 49.—Diffuse traumatic aneurysm of second part of axillary artery; pulsation and bruit present; radial pulse weak.
Ligatured both ends of vessel at site of injury, the 17th day. Recovered.—(Records 18 General Hospital.) — Axillary artery; ligatured at site—Recovered.

CASE 50.—Traumatic aneurysm of post. tibial artery. Incised for supposed suppuration; clots turned out, and both ends of vessel ligatured. Recovered.—(Major B. WILSON, R.A.M.C.) — Posterior tibial artery; ligatured at site—Recovered.

CASE 51.—Diffuse traumatic aneurysm of axillary artery. Ligatured both ends at wounded point. Good recovery.—(Civil Surgeon L. GREEN.) — Axillary artery; ligatured at site—Recovered.

CASE 52.—Diffuse traumatic aneurysm of post. tibial artery. Said to have appeared suddenly 39 days after Mauser wound through leg; pulse in foot good; ligature of both ends at wounded point. "Result good."—(Captain WADE BROWN, R.A.M.C.) — Posterior tibial artery; ligatured at site—Recovered.

CASE 53.—Traumatic aneurysm of post. tibial artery, complicating gunshot fracture of tibia; ligatured both ends of vessel in wound. Result successful.—(Lieut.-Colonel MACNAMARA, R.A.M.C. — Posterior tibial artery; ligatured at site—Recovered.

CASE 54.—G., wounded 17th June, 1901; admitted five days later. Wound had healed, but there was a traumatic aneurysm affecting the upper part of the popliteal artery; pulse in foot lost. Clots turned out; vessel found completely divided; both ends tied. Wound "healed without suppuration." Good recovery.—(Civil Surgeon WADE.) — Popliteal artery; complete division; ligatured at site—Recovered.

CASE 55.—Diffuse traumatic aneurysm of superficial femoral artery in Hunter's canal. Ligature of vessel in Scarpa's triangle. Cure.—(Major KEARNEY, R.A.M.C.) — Superficial femoral artery; proximal ligature of vessel—Recovered.

Superficial femoral artery; proximal ligature of vessel—Recovered.

CASE 56.—Traumatic aneurysm of superficial femoral in lower third of thigh. Ligatured vessel in Scarpa's triangle. Cure.—(Imperial Yeomanry Hospital Report.)

Popliteal artery; proximal ligature of superficial femoral—Recovered.

CASE 57.—Wounded 31st March, 1902. After 25 days, traumatic aneurysm of upper part of popliteal artery was detected. Ligatured superficial femoral in Hunter's canal next day. Cure.—(Records 16 General Hospital.)

Brachial artery; proximal ligature of axillary—Recovered.

CASE 58.—S., diffused traumatic aneurysm of upper part of brachial artery. Ligatured third part of axillary. Cure of aneurysm; weakness of forearm and hand; gradually improving.—(Records 16 General Hospital.)

Posteror tibial artery; proximal ligature—Recovered.

CASE 59.—Diffuse traumatic aneurysm of post. tibial artery. Proximal ligature of injured vessel. Recovered.—(Civil Surgeon IRVINE.)

Subscapular artery; proximal ligature of subclavian—Recovered.

CASE 60.—Traumatic aneurysm of subscapular artery. Ligatured third part of subclavian. Recovered.—(Lieut.-Colonel TWISS, R.A.M.C.)

Superficial femoral artery; proximal ligature—Recovered.

CASE 61.—R., traumatic aneurysm of superficial femoral artery in mid. thigh. Ligature of vessel at apex of Scarpa's triangle. Recovered.—(Imperial Yeomanry Hospital Report.)

Popliteal artery; proximal ligature—Recovered.

CASE 62.—Diffuse traumatic aneurysm of popliteal artery. Ligature of artery above. Complete recovery, without complication.—(Lieut.-Colonel WESTCOTT, R.A.M.C.)

Brachial artery; proximal ligature of axillary—Recovered.

CASE 63.—Diffuse traumatic aneurysm of brachial artery. Ligature of third part of axillary on third day. Perfect recovery.—(Lieut.-Colonel WESTCOTT, R.A.M.C.)

Axillary artery; proximal ligature of subclavian—Recovered.

CASE 64.—Large diffuse traumatic aneurysm of axillary artery; pulse below absent. On fifth day the third part of subclavian was ligatured. Complete recovery.—(Lieut.-Colonel WESTCOTT, R.A.M.C.)

Axillary artery; proximal ligature of subclavian—Recovered.

CASE 65.—Similar to above in every respect.—(Lieut.-Colonel WESTCOTT, R.A.M.C.)

Superficial femoral artery; ligatured above—Recovered.

CASE 66.—Gunshot fracture of femur, with traumatic aneurysm of superficial femoral artery. Artery ligatured above aneurysm. Recovery, with firm union of femur.—(Lieut.-Colonel WESTCOTT, R.A.M.C.)

Popliteal artery and vein—Amputation—Died.

CASE 67.—Boer prisoner, R., wounded 19th November, 1901; admitted to 15 General Hospital five days later. Entrance ½ inch external to head of right fibula; exit large and ragged, over inner condyle of femur. Popliteal space swollen, with blood clot; general swelling of limb; very collapsed. Rallied, and two days later wound explored; hæmorrhage from popliteal; amputation between middle and lower thirds of femur. Died next day.

Post mortem.—Both artery and vein found severed; ends of artery 2 inches apart.—(Major F. HEUSTON, R.A.M.C.)

Brachial artery and basilic vein; ligatured at site—Recovered.

CASE 68.—B., wounded 15th May, 1901; admitted 2 General Hospital ten days later. "Diffuse traumatic aneurysm" of brachial artery, with occasional hæmorrhage from wound, which was still open: radial pulse not lost. Next day both ends of artery and basilic vein tied. A piece was found to be cut out of the artery—partial division. Cure followed, and there was no trouble with circulation.—(Records 2 General Hospital.)

CASE 69.—Private B., wounded 30th April, 1900; admitted 8 General Hospital, nine days later. Wounded by Mauser (?) through popliteal space; had hæmorrhage, which came in big jets, for which patient stated limb had been tightly bandaged. Line of demarcation for gangrene of leg already forming in lower third; diffuse aneurysm of popliteal space. Amputation successfully performed through lower third of femur. Recovered. On cleaning away blood clot from the amputated part, finger passed into an aneurysmal cavity, 1½ inches in diameter, in communication with the nearly severed artery.—(Civil Surgeon W. A. STOTT.)

Popliteal artery—Gangrene—Amputation—Recovered.

CASE 70.—"Diffuse traumatic aneurysm" of superficial femoral artery in Hunter's canal. Ligatured both ends at wounded point. The vein also was wounded, and both ends of it were ligatured. Recovered.

Superficial femoral artery and vein; ligatured both at site—Recovered.

CASE 71.—Same condition as in last case. Same treatment adopted, except that as the aperture in the vein was small a lateral ligature was applied to it. Recovered.

Superficial femoral artery and vein; ligatured both at site—Recovered.

CASE 72.—A more circumscribed aneurysm in Hunter's canal. Both ends of vessel were tied. The vein was also wounded, and hæmorrhage from it was arrested by gauze plugging. Recovered.—(Civil Surgeon IRVINE.)

Superficial femoral artery and vein; ligatured both at site—Recovered.

Class 5.—Circumscribed Aneurysm.

CASE 73.—Lance-Corporal F., wounded 20th January, 1900; admitted 4 General Hospital nine days later. Entrance (Mauser) healed, on outer aspect of thigh, a little above patella; exit slightly larger than bullet, unhealed, in mid. popliteal space, a little to inner side. Bone probably perforated. Swelling and aneurysmal impulse in popliteal space; anæsthesia in calf, and in region of tendo achillis.

While being lifted on to operating table, two days later, profuse arterial hæmorrhage occurred. An incision, 4 inches long, was made between adductor and hamstring muscles; a clot of blood, the size of a hen's egg, was turned out, and on separating the heads of the gastrocnemius, the popliteal artery was found divided, except for a shred on the outer and posterior aspect; no wound of vein or nerves detected; both ends of artery tied, and wound closed.

Good recovery; well-marked pulse returned at ankle, but the constant neuralgia in the sole of foot had not passed off, when he was invalided, 65 days later.—(Major H. H. JOHNSTON, R.A.M.C.)

Popliteal artery; ligatured at site—Recovered.

CASE 74.—Mauser wound of radial artery, with profuse hæmorrhage, which was controlled by pad. When latter was removed, 14 days later, wound had healed, but there was a traumatic aneurysm of the vessel, 1 inch above wrist, with visible pulsation. On 41st day the sac was dissected out, and vessel was ligatured above and below. Good recovery.—(Civil Surgeon W. A. STOTT.)

Radial artery; ligatured at site—Recovered.

CASE 75.—Small traumatic aneurysm, of superficialis volæ, caused by wound from bullet splinter. Both ends tied at injured spot. Good result.—(Civil Surgeon GRANT.)

Superficialis volæ; ligatured at site—Recovered.

CASE 76.—Small traumatic aneurysm, in sole of foot, on internal plantar artery. Ligature of post. tibial, behind malleolus. Cure.—(Civil Surgeon IRVINE.)

Internal plantar artery; proximal ligature of post. tibial—Recovered.

CASE 77.—Circumscribed traumatic aneurysm of axillary artery—size of walnut. Ligatured third part of subclavian. Cure.—(Civil Surgeon IRVINE.)

Axillary artery; proximal ligature of subclavian—Recovered.

Superficial femoral artery; proximal ligature—Recovered.

CASE 78.—Circumscribed traumatic aneurysm of superficial femoral artery in Hunter's canal; ligature of vessel in Scarpa's triangle. Cure.—(Civil Surgeon IRVINE.)

Profunda femoris artery; proximal ligature of common femoral; septicæmia—Died.

CASE 79.—Comparatively circumscribed traumatic aneurysm of deep femoral artery. Common femoral ligatured; doing well, when a month later, the circulation in the limb was good, the wound became infected from a case in the next bed, and patient died of septicæmia.—(Civil Surgeon IRVINE.)

Popliteal artery; proximal ligature of superficial femoral—Recovered.

CASE 80.—Circumscribed traumatic aneurysm of popliteal artery. Ligatured superficial femoral, at upper end of Hunter's canal. Recovered without complication.—(Civil Surgeon MACKNIGHT.)

Brachial artery; proximal ligature—Recovered.

CASE 81.—Circumscribed traumatic aneurysm at bend of elbow. On 23rd day the brachical was ligatured, in lower third of arm. Good recovery.—(Civil Surgeon J. E. KER.)

Axillary artery; ligatured close above (Anel's)—Recovered.

CASE 82.—W., wounded 27th January, 1902, in right axilla. Circumscribed traumatic aneurysm, the size of a walnut, at lower end of axillary artery, slowly increasing in size; classical signs of aneurysm. On 16th day, when wound had healed, the artery was ligatured, just above sac. Tumour solid, and diminishing in size, when patient was invalided 38th day.—(Civil Surgeon A. J. EVANS.)

Axillary artery; ligatured above—Recovered.

CASE 83.—Private H., admitted Netley Hospital 23rd February, 1901; wounded seven weeks previously. Entrance on inner front of left upper arm; exit behind. An aneurysm of the third part of axillary followed. A proximal ligature, which stopped pulsation in the aneurysm, was placed on the vessel two months later; when sutures were removed aneurysm was quite solid. It was only the size of a small nut two months later, but the man was discharged the Service as unfit on 9th July, 1901.—(Major DICK, R.A.M.C.)

Popliteal artery; proximal ligature; recurrence of pulsation—Recovered.

CASE 84.—Private S., wounded 28th November, 1899; admitted to Netley Hospital three months later. Entrance (Mauser) ½ inch below right patella; exit in popliteal space. An aneurysm was noticed low down in popliteal space eight days after receipt of wound. On 19th June, 1900, the upper part of popliteal artery was tied; wound healed by first intention; tumour much reduced in size; some pulsation has returned; tumour the size of a marble two months later. "Passed fit."—(Major DICK, R.A.M.C.)

Popliteal artery; proximal ligature of superficial femoral; recurrence of pulsation—Recovered.

CASE 85.—Sergeant M., wounded 11th December, 1899; admitted 2 General Hospital seven days later. Entrance, Mauser (?), in middle of left patella; exit in centre of popliteal space. Profuse hæmorrhage from exit, which he checked himself by bandaging. An aneurysm the size of a hen's egg in popliteal space followed, and hæmorrhage occurred on the eighth day, when Civil Surgeon Pegg ligatured the main artery in Hunter's canal. Recurrent pulsation felt in tumour on 19th day, but this afterwards disappeared. Recovered.—(Records 2 General Hospital.)

External iliac; trans-peritoneal ligature of common iliac—Recovered.

CASE 86.—Private S., admitted 15 General Hospital for wound received a long time previously. Entrance, three fingers' breadth above Poupart's ligament, inside course of main artery; exit below crest of ilium, on same side. Since wounded, had been in Convalescent depôt here, where, by accident, a comrade fell over him, contusing his groin. A large tumour in the groin, with pulsation and bruit, indicated aneurysm of the external iliac artery. The common iliac was exposed by incision through peritoneum, tied by double ligature and divided between, as the proximity of the aneurysm did not allow of ligature of external iliac. No return of pulsation. Good recovery.—(Civil Surgeon A. A. MARTIN.)

Axillary artery; ligatured above—Recovered.

Case 87.—Private W., wounded 27th January, 1902. Entrance on outer side of humerus, just below teres muscles; exit in nipple line of chest, third interspace. Partial musculo-spiral paralysis, and an aneurysm the size of a walnut on axillary artery at junction with brachial.

On the 17th day, Civil Surgeon C. S. Wilson made a 3-inch incision in line of artery, and tied the vessel above the aneurysm without opening the sac; the nerve was not seen. Pulsation did not return, but function of musculo-spiral was not restored when invalided 22 days later.—(Records 2 General Hospital.)

Ulnar artery; ligatured at site—Recovered.

Case 88.—Private C., wounded 27th February, 1900; admitted 4 General Hospital 13 days later. Entrance (Mauser) over lower end of left ulna; no exit. Aneurysmal tumour on ulnar artery at entrance wound the size of a pigeon's egg; secondary hæmorrhage. Incision made over tumour and bullet extracted; blood clot removed; both ends of artery tied. Uninterrupted recovery; invalided three weeks later.—(Civil Surgeon H. Porteous and Major S. F. Freyer, R.A.M.C.)

Common femoral artery; ligatured external iliac—Recovered.

Case 89.—Private C., injured 21st January, 1902; transferred to 4 General Hospital, Mooi River, three months later. The injury was caused by his horse rolling over on him and bruising him against the pommel of saddle. There was an aneurysm the size of an egg on the common femoral artery, at Poupart's ligament. Pulsation; "simple" bruit; acute pain. The external iliac artery was tied. Wound healed by first intention; swelling rapidly subsided; no return of bruit, but suffered much pain in leg for a few days after operation. Walking about and free from pain six weeks later, when invalided to England. Heard afterwards that he made a perfect recovery, only a slight hardness remaining at site of aneurysm.—(Major S. F. Freyer, R.A.M.C.)

Ulnar and possibly radial arteries; proximal ligature of brachial—Recovered.

Case 90.—Lance-Corporal E., wounded 24th January, 1900; transferred to Netley Hospital three months later. Entrance on back of elbow joint; exit in front of it; elbow joint stiff. There was a well-marked aneurysm of the ulnar artery, and possibly of the radial also, at bend of elbow joint. Brachial artery ligatured in middle third. (No further notes; patient sent on sick furlough, S.F.F.)—(Major Dick, R.A.M.C.)

Class 6.—Arterio-Venous Aneurysms.

Superficial and deep femoral arteries, and at least one vein; ligatured superficial femoral above and below, and later proximal ligature of common femoral—Recovered.

Case 91.—Private N., wounded 5th February, 1900; admitted 4 General Hospital, Mooi River, three days later. Entrance (normal Mauser) on anterior and inner aspect of thigh 4 inches below Poupart's ligament, just inside line of femoral vessels. Exit diametrically opposite, but 2½ inches higher; both mere scars. Direction indicated perforation of femur, but there was no sign of fracture.

Large pulsating tumour at apex of Scarpa's triangle on inner side of vessels; loud varix bruit in tumour, and extending up vein. As bruit could also be heard in post. tibial it was considered that superficial femoral artery was involved.

Tumour increased in size, and on 33rd day a 6-inch incision was made along outer side of femoral artery, with its centre just above entrance; ligature passed under artery below origin of profunda; this checked all pulsation, and was tied. Another ligature was placed on artery below communication, but as close to latter as possible, while avoiding damage to vein or aneurysm. There was thus about 3½ inches of artery left in communication with vein and tumour between ligatures. A few days after operation a distinct "blowing" bruit was heard over tumour, and sutures gave way from tension. The bruit became more distant and tumour solidified, when, on 39th day, a second tumour had appeared of large size on outer side of thigh—the man had turned in bed suddenly during the night. On exploration, with a check (aneurysm needle) under common femoral, it was found that former ligatures had not loosened, and that vessel between had diminished to size of gooze quill, though

still unobliterated, and venous blood oozed from it when pricked. It was therefore the wounded profunda that caused recurrent bruit and second aneurysm. Ligature now closed on common femoral; both tumours solidified; no further return of bruit or thrill. Uninterrupted recovery; invalided to England 14th June, 1900.—(Major S. F. Freyer, R.A.M.C.)

Superficial femoral artery and vein; artery ligatured above and below; slight return of bruit.

Case 92.—Corporal P., wounded 27th February, 1900; admitted 4 General Hospital, Mooi River, eight days later. Entrance (normal Mauser) over lower third Hunter's canal. Exit diametrically opposite behind, but 2½ inches higher—both mere scars; range, 400 yards. Loud varix bruit over a small pulsating swelling in Hunter's canal; bruit extended up along femoral vein. On 10th day an incision was made along Hunter's canal, having entrance scar for centre; aneurysm needle passed under artery above communication, the vein and tumour being avoided; compression having stopped thrill and bruit, the ligature was drawn through. Vessel again exposed below tumour, but as close to communication as possible without danger of opening into aneurysm; ligature drawn through here also, and both now tied. Healed by first intention, but on 10th day, when sutures were removed, a slight bruit had recurred, and soon after a scarcely perceptible thrill as well. It was then evident that anastomotica magna had been left communicating with trunk between the ligatures. We intended to cut it off by a further small operation, but, as the case was a practical cure, patient was invalided to England to make room for another man.—(Major S. F. Freyer, R.A.M.C.)

Superficial and deep femoral arteries and veins wounded; ligatured common and superficial artery and veins—Gangrene—Amputation—Died.

Case 93.—Private H., wounded 24th January, 1900; admitted to 4 General Hospital nine days later. Normal Mauser in upper part of thigh; entrance and exit healed. Large pulsating swelling with well-marked thrill and bruit occupying Scarpa's triangle. Operation undertaken four days later by the late Sir William McCormac and Mr. Hulke. Common femoral first exposed for check ligature. Superficial artery was then dissected from scar tissue and ligatured above tumour. During the dissection severe hæmorrhage set in. As the profunda was also evidently wounded the ligature already under the common femoral was closed. Severe venous bleeding still continued, and it was suggested that the aneurysmal sac had been opened in the dissection. Permission for amputation had not been obtained, so all that could be done was to tie the main veins, and close the wound. Two days later, gangrene having set in, amputation was performed below the trochanters. Patient died same evening.—(Records 4 General Hospital.)

Popliteal artery and vein; proximal ligature of superficial femoral artery—Slight recurrence of bruit and thrill—Recovered.

Case 94.—Private A. Entrance (normal Mauser) just above knee joint; exit so situated behind as to indicate damage to main vessels in popliteal space. Painful swelling in popliteal space behind adductor tendon; thrill and bruit—the latter extended up femoral vein. On 1st May, 1900, the late Sir William Stokes put a proximal ligature on femoral artery at apex of Scarpa's triangle. Wound healed by first intention. Swelling and pain subsided, but a few days later a faint bruit had recurred, and this persisted with slight thrill as well. Patient made a good recovery, and neither thrill nor bruit was marked, when he was invalided to England 44 days later.—(Major S F. Freyer R.A.M.C.)

Popliteal artery and vein; ligature of artery above communication and division of intervening branch—Recovered.

Case 95.—Sergeant P., wounded 23rd February, 1900; admitted 4 General Hospital 17 days later. Normal Mauser entry and exit wounds on inner and outer aspects of thigh, close to knee joint, healed; well-marked aneurysmal swelling, bruit, and thrill at upper part of ham; no venous obstruction below, but considerable pain and "pins and needles" sensation in sole of foot. Allowed up on fourth and fifth days to test effect of exercise; swelling distinctly increased, and pain and tingling became more marked. On 47th day after wound "femoral artery was ligatured at extreme lower end of Hunter's canal, and a small artery, thought to be one division of the anastomotica magna, ligatured at same time." Healed by first intention.

There was never any return of pulsation, bruit, or thrill. Patient up and about when invalided to England a month later.—(Civil Surgeon S. HULKE.)

Superficial femoral artery and vein—Died of enteric fever—P.M. showed perforation of vessels, by Mauser, without extravasation of blood.

CASE 96.—Private E., wounded 25th February, 1900; transferred to 4 General Hospital, Mooi River, 15 days later, when he was found to be suffering from enteric fever. Entrance (normal Mauser) just below apex of Scarpa's triangle; exit diametrically opposite behind—both healed; "machinery murmur" and thrill felt at entrance wound, but there was no swelling whatever; the murmur extended up along vein, and could be heard loudly at Poupart's ligament. Patient died of enteric the 29th day from receipt of wound.

Post mortem.—Femoral artery and vein perforated from before backwards by Mauser bullet; the wound of entrance on ant. wall of artery was occluded by a small blood clot about the size of a pea, which was embedded in the track of the bullet on the post. surface of sartorius; the lumen of artery communicated with that of vein by a small circular perforation between the two, which was smooth and shining (lined by endothelium). The exit on post. wall of vein was nearly cicatrized. The track of the bullet, which had passed through the soft tissues only, was cicatrized. No extravasation of blood.—(Majors H. H. JOHNSTON and S. F. FREYER, R.A.M.C.)

Common carotid; and int. jugular vagus damaged—No operation—Improving.

CASE 97.—Private B., wounded 23rd August, 1901, at 40 yards range; transferred to 4 General Hospital 39 days later. Entrance (normal Mauser) midway between crico-thyroid membrane and ant. border of sterno-mastoid; exit on back, between base of spine of scapula and spinal column, 1½ inches from former, with arms crossed in standing position. Both wounds long healed. Felt faint on receipt of wound; blood spurted out from entrance until Dr. Patterson, V.M.R., arrived (20 minutes later, patient thinks) and put on compress; frequent vomiting for first 24 hours; aphonia. Now arterio-venous thrill is very marked in angle of junction of clavicle and sterno-mastoid. The bruit, which he compares to "ticking of a watch," does not keep him awake, unless he lies on injured side. There is darting pain from exit wound across axilla, which prevents him drawing a deep breath, and numbness over right chest. The case is evidently one of aneurysmal varix of common carotid and int. jugular with injury of vagus lying between. The aphonia was passing off and pain subsiding, when he was invalided a few weeks later, as at a consultation it was decided not to interfere.—(Major S. F. FREYER, R.A.M.C.)

Superficial femoral artery and both veins; ligatured artery on distal side as well as common femoral—Gangrene—Amputation—Recovered.

CASE 98.—Lance-Corporal R., wounded 24th February, 1900; admitted 4 General Hospital 20 days later. Entrance (normal Mauser) on outer side of knee joint; exit on inner side of buttock, close to ischial tuberosity—both healed. Aneurysmal varix, size of hen's egg, 1½ inches below Poupart's ligament; but direction of wound and early symptoms indicated damage to artery at upper end of Hunter's canal. Accordingly, after placing a temporary ligature on common femoral, Mr. Stanley Copley, assisted by the late Sir W. Stokes, then ligatured superficial femoral on distal side in Hunter's canal. He now found it impossible to reach upper end of superficial vessel, owing to overlapping of hæmatoma, and so had to close ligature on common trunk. Gangrene followed; amputation at hip joint; recovered. In the amputated limb it was found that the wound in the superficial femoral was only ¼ inch from the bifurcation of the common femoral, and that profunda vein also communicated with aneurysm.—(Civil Surgeon STANLEY COPLEY and Major S. F. FREYER, R.A.M.C.)

Artery uncertain, with int. jugular vein; proximal ligature of common carotid; improved; thrill returned.

CASE 99.—Wounded at Paardeberg. Entrance (Mauser) to right of pomum Adami; exit at ant. margin of left trapezius, and 2 inches below angle of jaw. Some hæmorrhage, which ceased without operation. Wound healed, leaving symptoms of an arterio-venous aneurysm at the point of bifurcation of common carotid. Swelling, thrill, and pulsation over an area 1½ inches in diameter, and loud machinery murmur audible to patient when

lying on injured side; left eyeball appeared prominent; voice weak and husky, with some cough, giddiness; pulse, 100, and irregular and somewhat irritable. It was thought that the lesion might be on the internal carotid, and on the 62nd day an attempt was made to place a ligature below it, but the sac of the aneurysm was found extended over the point of bifurcation. "The vein vibrated visibly, quivering in exact consonance with the palpable thrill." The ligature was placed on the main trunk beneath the omo-hyoid. Patient made a good recovery, and pulsation ceased but thrill persisted; six months later sac small; pulse, 110–120; thrill slight; voice strong and good. "Aneurysm is either at bifurcation of common, or on immediate commencement of internal carotid. Ligature of external carotid will probably cure it."—(Mr. MAKINS.)

Artery uncertain, with int. jugular vein; proximal ligature of common carotid; improved; thrill returned.

CASE 100.—Wounded at Paardeberg. Entrance (Mauser) at dimple of chin immediately below mandibular symphysis; exit at margin of right trapezius—track crossing carotids about level of normal bifurcation. Severe hæmorrhage followed, and later there was a large, diffuse pulsating swelling on right side of neck, with well-marked thrill, and machinery murmur. During next three weeks the swelling contracted, leaving an aneurysmal tumour in carotid triangle. Aneurysmal wall fairly firm; visible and palpable pulsation, well-marked thrill and machinery murmur—latter annoys him by buzzing when he lies on injured side; pulse 100, and somewhat irritable; voice weak and husky, with difficulty in swallowing solids.

Operation six weeks after injury—common carotid ligatured at upper border of omo-hyoid; no noticeable dilatation of jugular; on closing ligature pulsation and thrill ceased. On fourth day wound dressed; tumour was consolidated, and there was no pulsation, but a loud blowing murmur was audible, especially at posterior part of swelling. On the morning of fifth day patient said he again heard the whirr during the night. After 10 months no trace of aneurysmal sac remained, and except for purring thrill the neck was normal; pulse, 100; voice strong and good. Following his usual work.—(Mr. MAKINS.)

Vessels doubtful—No operation—Not improving.

CASE 101.—Admitted Netley about four months after receipt of wound. Entrance (Mauser) 2 inches below Poupart's ligament, in the line of vessels; exit at corresponding point behind.

Distinct pulsating swelling, of longitudinal shape, extending from 1½ inches above to 3½ inches below Poupart's ligament. This swelling is rather to the inner side of the course of the artery, but cannot be distinguished from it. The usual thrill is present, the buzzing murmur is very loud, and can be heard right down the limb. There is no dilatation of the superficial veins, and no swelling of the leg. The heart's action is, as a rule, increased in frequency—pulse 100, and irregularly intermittent—but it varies at different times. The patient says the affected leg is weaker than the other, but it causes no pain, and very little trouble. Operation refused. He has done no work of any sort during the nine months he has been under observation, and the tumour seems to have been slowly increasing in size.—(Netley Records.)

Superficial femoral artery and vein; ligature of both above and below—Recovered.

CASE 102.—D., wounded, 5th April, 1900; admitted 34th day with wound healed. Aneurysmal varix in Hunter's canal; weakness of leg, and shooting pains. Operation 69 days later: "Both vessels ligatured above and below the aneurysm." Recovered so that two months later he was able to walk well without a stick.—(Lieut.-Colonel S. HICKSON, R.A.M.C.)

External carotid and internal jugular; proximal ligature of common carotid—Recovered.

CASE 103.—B., "probable varicose aneurysm of external carotid" half the size of an orange, and increasing slowly; pulsation and thrill. Ligatured common carotid at seat of election on 42nd day. Tumour only size of walnut, and quite hard 45 days later, "apparently cured."—(Civil Surgeon WATSON.)

CASE 104.—Varicose aneurysm of "femoral artery and vein." Ligatured external iliac. Return of thrill noted on 42nd day, but tumour much reduced in size. Further history not given.—(Major WILSON, R.A.M.C.)

"Femoral" artery and vein; proximal ligature of external iliac—Improved.

CASE 105.—Aneurysmal varix of brachial artery, high up. "Ligature of third part of axillary, for relief of pain in the arm." This symptom was ameliorated by the operation, "but I doubt whether a permanent cure of the condition would result."—(Civil Surgeon IRVINE.)

Brachial artery; proximal ligature of axillary—Recovered.

CASE 106.—Arterio-venous aneurysm of superficial femoral artery and vein, at apex of Scarpa's triangle. Circumscribed sac; continuous thrill, and loud, rasping bruit. "Subjected to operation, and the common femoral was ligatured." Gangrene followed; amputation. Died.—(Civil Surgeon IRVINE.)

Superficial femoral artery and vein; proximal ligature of common femoral—Gangrene—Amputation—Died.

CASE 107.—C., Mauser wound through knee, from front to back; wound aseptic; leg put up in plaster. On 22nd day plaster removed; wound had healed, and an arterio-venous aneurysm was found in popliteal space. Operation two days later; "ligature of superficial femoral in Hunter's canal." Gangrene followed, extending up to margin of patella. Amputation of thigh performed 10 days later. Recovered.

Dissection showed that both vessels had been perforated from before backwards, and that, besides a small varicose aneurysm, there was a circumscribed aneurysm connected with the other (posterior) aperture in the artery.—(Civil Surgeon YOUNG.)

Popliteal artery and vein; proximal ligature of superficial femoral—Gangrene—Amputation—Recovered.

CASE 108.—E., Mauser wound of thigh, with arterio-venous aneurysm in Scarpa's triangle. "Ligature of superficial femoral artery above"; gangrene; amputation in lower third of thigh. Recovered.—(Lieut.-Colonel MACNAMARA, R.A.M.C.)

Superficial femoral artery and vein (?); ligature of artery above—Gangrene—Amputation—Recovered.

CASE 109.—H., wounded 3rd August, 1901. Entrance on outer side of popliteal space; exit on inner side, near edge of patella; femur perforated. Arterio-venous aneurysm in popliteal space followed. At Netley, 21st December, 1901, Major Dick, R.A.M.C., ligatured the popliteal by an incision along adductor magnus tendon, and gangrene of leg followed. He performed amputation of leg below tubercle of tibia 72 days later, but the flaps now became gangrenous. Finally, Surgeon-General Stevenson, C.B., amputated on 6th April, 1902, through lower third of thigh, after which patient recovered.—(Lieut.-Colonel SYLVESTER, R.A.M.C.)

Popliteal artery and vein; proximal ligature—Gangrene—Amputation and re-amputation—Recovered.

CASE 110.—Private A., wounded at close range 21st June, 1901; admitted Netley three months later. Entrance below and on inner side of apex of Scarpa's triangle; exit at opposite point of limb, on outer side. An arterio-venous aneurysm of femoral vessels resulted. Cut down at apex of Scarpa's triangle, and ligatured the superficial femoral artery above the aneurysm. An attempt was then made to apply a ligature below also, but venous hæmorrhage took place, and so the vein as well as the artery had to be ligatured below. This stopped the bleeding. Healed by first intention, and aneurysm had completely disappeared when, on 3rd February, 1902, he was brought before the Invaliding Board.—(Surgeon-General STEVENSON, A.M.S.)

Superficial femoral artery and vein; ligature of artery above and both vessels below—Recovered.

CASE 111.—Wounded 20th May, 1900. Entrance (Mauser) 4 inches below Poupart's ligament, a little outside line of artery; exit in buttock, just outside gluteal fold. Thrill followed, indicating arterio-venous aneurysm. Allowed up after three weeks, when large hæmatoma formed, aneurysm having

Profunda artery and vein; aneurysm laid open, artery ligatured above

and vein plugged—Recovered.

extended. Two months later cavity laid open and clot turned out, when it was found that the profunda was the artery involved. Blood welled up, but was checked by compression; ligature placed on profunda at its origin; cavity packed. Some suppuration followed, but the collateral circulation was well established, and the case recovered.—(Civil Surgeon CLARK.)

Brachial artery and vein; recurrent hæmorrhage—Gangrene—Amputation—Recovered.

CASE 112.—Sergeant W., wounded 3rd February, 1902; admitted 26 Stationary Hospital 24 days later. Entrance on outside of forearm, through upper part of supinator longus; exit in centre of bend of elbow. Had severe hæmorrhage, for which he was tightly bandaged. Hand became gangrenous, and forearm boggy and emphysematous; thrill of arterio-venous aneurysm on brachial at bend of elbow. Amputation above elbow. Recovered. —(Captain P. EVANS, R.A.M.C.)

Superficial femoral artery and vein (?); proximal ligature of external iliac; thrill returned, but not pulsation.

CASE 113.—Boer prisoner, F., admitted 22 Stationary Hospital 19th March, 1902, for wound received five months previously. Entrance on outer thigh, 4 inches below great trochanter; exit on inner aspect of same, at junction of upper and middle thirds.

Large tumour, with visible pulsation and thrill, in front of upper third of thigh. As there was no venous obstruction, it seemed doubtful whether the condition was varicose aneurysm or ordinary traumatic aneurysm, but for practical purposes the latter diagnosis was made. External iliac ligatured 70 days later, when aneurysm consolidated. Though thrill returned later, pulsation had ceased, the tumour was disappearing, and he was able to walk several miles without inconvenience.—(Major B. WILSON, R.A.M.C.)

Common carotid artery and int. jugular vein—No operation—Non-progressive.

CASE 114.—Lance-Corporal W., admitted to 10 General Hospital, 6th March, 1902. Entrance in right side of neck, below level of cricoid cartilage; exit in upper third right arm. Bled profusely from neck when hit, and afterwards a large blood tumour formed there. Now tumour has disappeared, but bruit and thrill remain—arterio-venous aneurysm of common carotid, and internal jugular. Bruit can be heard as high as ear, and down to clavicle; no inconvenience, except that he hears bruit when he puts his head on that side; the headache which he suffered from at first has passed off.—(Captain W. FAICHNIE.)

Femoral arteries and vein, and sciatic artery; ligatured former; recurrent hæmorrhage—Amputation—Recovered.

CASE 115.—Boer prisoner, C., admitted 2 General Hospital, wounded five weeks previously. Entrance mid-left buttock, exit apex Scarpa's triangle. "Varicose" aneurysm at apex of Scarpa's triangle; superficial femoral artery and vein tied above and below communication between them; hæmorrhage took place from depths of wound; then profunda tied, but bleeding still continued; ligature of common femoral and forceps on profunda vein appeared to stop it.

Hæmorrhage recurred the same afternoon four hours later; amputation was then performed below trochanters. Recovered.

The sciatic artery was found to have been wounded in the buttock, and the blood had followed track of bullet to front of thigh and formed a pulsating tumour there close to the arterio-venous aneurysm.—(Major NISBET, Queensland Army Medical Corps.)

Superficial femoral artery and vein; ligature of both and excision—Recovered.

CASE 116.—Aneurysmal varix in mid-thigh, superficial femoral vessels. Two femoral veins were found, with one of which the artery communicated. "As they could not be separated, the artery and vein were tied together, above and below, and the intervening part excised." Good recovery.—(Imperial Yeomanry Field Hospital Report.)

Superficial femoral artery and vein; ligature of both, above and below—Recovered. Two cases.)

CASE 117 and 118.—Two cases of varicose aneurysm of superficial femoral artery and vein. Both treated by ligature of artery and vein above and below an excision of sac. Circulation in each case restored in a few days. "Perfect recoveries."—(Imperial Yeomanry Hospital Report.)

CASE 119.—B., healed Mauser wound from before backwards through axilla, in neighbourhood of third part of axillary artery. Thrill and aneurysmal swelling seven days later; pulse at wrist weak; numbness and pain in arm; ligature of third part of subclavian; dry gangrene to above elbow followed; amputation below the aneurysm, which was then consolidated. Recovered.—(Imperial Yeomanry Hospital Report.)

Axillary artery and vein; proximal ligature of subclavian—Gangrene—Amputation—Recovered.

CASE 120.—B., traumatic aneurysm, third part of axillary artery. Thrill present; rapidly increasing swelling, but radial pulse not lost; ligatured third part of subclavian; gangrene followed; amputation. Recovered.—(Imperial Yeomanry Hospital Report.)

Axillary artery; proximal ligature of subclavian—Gangrene—Amputation—Recovered.

CASE 121.—Wounded at Paardeberg. Entrance (Mauser) at lower margin of patella; exit at centre of back of thigh—lower end of femur perforated.

Much œdema of foot and leg followed, and "thrill" was discovered the third day. After three weeks, an aneurysm the size of a pigeon's egg was palpable at the inner part of the top of the popliteal space, with strong thrill, especially when knee was flexed and machinery murmur; entrance healed, exit oozing serous fluid. On admission to Herbert Hospital, Woolwich, patient complained chiefly of pains in leg and foot. The aneurysm was cured by ligature of the artery close above and of the vein above and below the communication.—(Lieut.-Colonel LEUTAS.) (Case quoted by Mr. MAKINS.)

Popliteal artery and vein; proximal ligature of artery, and ligature of vein above and below—Recovered.

CASE 122.—Wounded 11th February, 1900, by bullet, which passed through inner side of thigh above its middle. On arrival at Woolwich, patient was found to have a varicose aneurysm at upper end of Hunter's canal. On the 109th day the femoral was ligatured just above the communication; gangrene followed; amputation. Recovered.—(Case quoted by Mr. MAKINS.)

Superficial femoral artery and vein; ligature of artery above—Gangrene—Amputation—Recovered.

CASE 123.—Sergeant B., wounded 23rd August, 1901; admitted Kroonstadt 11 days later. Entrance over apex of Scarpa's triangle; exit in buttock. An aneurysm the size of a cocoanut occupied Scarpa's triangle, and gave a venous thrill on palpation. Next day hæmorrhage set in from entrance wound. An attempt was made to tie the common femoral, but it was found covered by the aneurysm. The external iliac was then tied. This controlled pulsation, but there was still free bleeding. The sac was then opened and clot turned out, but owing to venous oozing and hæmorrhage from profunda, several pairs of forceps had to be left in wound, which was plugged. Died same evening.

Post mortem.—Common femoral found perforated just above origin of profunda. Aneurysm involved, common, superficial and profunda arteries, and common femoral vein.—(Civil Surgeon F. POPE.)

Common femoral artery and vein, and profunda artery (?); proximal ligature with opening of sac—Died.

SECTION X.

By Lieut.-Colonel Sylvester, R.A.M.C.

GUNSHOT INJURIES OF PERIPHERAL NERVES.

Owing to pressure of work during the war, and the absence of means of testing electrical re-actions, also to the fact that many patients have necessarily been invalided before the ultimate results of the injuries or of the treatment adopted have become evident, it is regretted that this Report is very imperfect. Considerable assistance in its compilation has been afforded by an excellent paper on the subject contributed by Civil Surgeon A. Young, and also one by Civil Surgeon L. G. Irvine.

A nerve may be injured by gunshot:—

1. Primarily—Directly by the bullet or by fragments of bone causing—
   - (*a*) Concussion;
   - (*b*) Contusion;
   - (*c*) Perforation; or
   - (*d*) Partial or complete division.
2. Secondarily by pressure of contracting scar tissue in the bullet track, or by implication of the nerve in callus.

Direct injury. Division.

Instances of contusion are given below—Cases 16, 18, 19, and 20; of partial division, 8 and 9; of complete division, 10, 11, and 12; and of perforation, 1, 2, 3, 4, 5, and 6.

Perforation.

It is interesting to note that a clean perforation may be made in a nerve as small as the median by the modern bullet, and it appears probable that the nerve fibres are sometimes pushed apart rather than torn in this form of injury; cases of this kind are likely to become affected by cicatricial changes later. (*See* Case 5 and Cases 1, 2, and 3.) In two of the latter complete recovery followed, and in the other only partial recovery has taken place up to the present time.

By bone fragments.

Only two instances of injury by splinters of bone have been met with (Case 6), and one reported by Civil Surgeon L. G. Irvine, mentioned below at page 249.

Concussion.

It is generally agreed that a bullet passing near, but not actually touching, a nerve, may, by "concussion," occasion such changes in it as to impair or destroy its conducting power, although there may be no injury to the nerve trunk evident to the naked eye. (*See* Cases 21 to 28.) To this opinion there is, however, one dissentient, Civil Surgeon A. Young, who devotes considerable space in his paper to the consideration of this question. His arguments against the occurrence of this form of injury are briefly as follows:—

"Cases usually described as 'concussion' are really contusions. The effects of a contusion are not limited to the actual part struck, as may be seen in an ordinary bruise, and though there may be no injury evident to the naked eye, yet there may be, and probably are, changes which would be capable of microscopical histological proof. In fractures of the bones of the extremities, a class of injuries in which concussion is said to be most typically present, the density and resistance to impact of the firm bone are such as to diffuse in an extensive way the vibratory force of the bullet; but such being conceded, it seems unnecessary to separate even this variety from the class of contusions. In such fractures the damage to soft tissues of all kinds on or near the line of the bullet track, as well as in the vicinity of the fractured bone, is bound to be great. The soft tissues far removed from the bone may be extensively contused; why not the nerve trunks also? . . . It was not uncommon for a single

nerve to be picked out from even a closely-related complex, the remaining trunks of the latter giving no evidence at all of implication; or, in other instances, for a number of trunks to be caught when a single nerve trunk closely associated with them escaped altogether. Why, in the former instance, all the trunks but one of a closely-related plexus should escape, and in the latter all but one show signs of damage, is not easy to understand on the assumption of mere concussion." *

These views are illustrated by a carefully-recorded series of cases, 45 to 48, 50 and 51.

? Concussion or contusion.

It would appear that these differences of opinion depend chiefly on the meaning attached to the word "contusion." If it is limited to the effect produced on the adjacent tissues by actual contact of the bullet with them only, then it must be conceded that the vibratory force (or concussion effect) of the passage of the missile is capable of producing the more or less widespread damage to the nerve trunk seen in some of these cases. On the other hand, if with "contusion" is included the concussion effect, there is no necessity to form a separate class of such injuries.

The great majority of surgeons would say that a paralysed nerve, which, when exposed at the seat of injury, showed no sign of damage to the naked eye, was "concussed"; and that such a paralysis can last considerably longer than the two weeks mentioned by Civil Surgeon Young in Case 51, is certain. (*See* Cases 24 and 26, in which the nerves were exposed by operation and found to be, to all appearances, perfectly normal.)

These injuries common in Boer War.

This form of lesion, whether called slight concussion or contusion, was very common in wounds of the limbs during the war. The notes of gunshot wound cases at Netley contain frequent entries to the effect that patients had suffered from paralysis to a greater or less extent after the receipt of injury, which, on arrival there, usually from three to six months after, had generally much improved or completely disappeared. Sometimes one nerve, sometimes a group of nerves, was affected, and the resulting paralysis had cleared up entirely or partially, or, in some rarer instances, remained permanent for as long as the patients were kept under observation. Some of these cases, when operated on, showed no evidence of contusion or other direct lesion, the bullet tracks being at some distance from the nerve trunks.

2. *Secondary Injury—Pressure by Cicatricial Tissue or Callus.*

No instance of true secondary paralysis, due to either of the above causes, has been recorded. Although nerves have frequently been found to be involved in scar tissue, or pressed on by callus, the paralysis always appears to have dated from the time of the original injury. No doubt, however, a nerve primarily injured by either of the causes under this heading may become secondarily affected by pressure, and its recovery delayed or possibly prevented. (*See* Cases 29 to 34.)

Conditions Influencing the Character and Course of Nerve Injuries.

Effect of Range.

1. The range, or what is the same thing, the velocity of the bullet.

The shorter the range the more severe was the disturbance of nerve function, the nerve trunks participating in the more extensive injury, whether by concussion, contusion, or division caused to the tissues generally.

Concussion cases in War of the Rebellion.

It may be noted here that in the American Civil War the occurrence of concussion was recognised, and it was then considered that its effects on the function of the affected nerve might be as severe and lasting as if the nerve fibres themselves were divided (Weir-Mitchell, Morehouse, and Keen, "Gunshot Injuries of Nerves," 1864), although the velocity of the rifle-bullet then in use was not high.

* On the other hand, these curious effects produced on the functions of nerve trunks by bullets are no more easy of comprehension on the assumption that they are due to contusions. It is quite as difficult to understand why a contusion should affect some portions of a closely-related nerve complex and not others as it is to recognise why a concussion should do so.—(Editor.)

Degree of direct lesion.

2. The greater extent of laceration of tissue caused by the bullet expanding, deforming after ricochet or after striking bone, &c.

Suppuration.

3. The occurrence of suppuration in the wound. Both these latter factors influenced the results very considerably; partly by the extent of the original injury, and perhaps still more so by the subsequent formation and contraction of cicatrical tissue, as well as by increasing the liability to neuritis when suppuration occurred.

Symptoms and Diagnosis.

In slight cases of contusion or concussion, there may be only a temporary and unimportant interference with the function of the affected nerve. (*See* Case 48, and many others.)

Pain and hyperæsthesia.

If the injury be more severe signs of nerve irritation are often present, indicated by hyperæsthesia or actual pain (*see* cases by Civil Surgeon Irivine, given below), and later by trophic changes of the ordinary type, more especially in cases complicated by neuritis, with or without suppuration; the nerve is often thickened at the injured spot, and may be tender to the touch. As a rule, both sensory and motor functions are affected in mixed nerves, even in the less severe cases, but in Case 47 no loss of sensation was at any time present.

Signs of complete division.

A completely divided nerve presents the usual symptoms: complete motor and sensory paralysis below the division which comes on immediately, and is permanent; absence of response to electrical stimuli, enlargement of the end of the upper section, and, later, trophic changes.

Only one instance of absence of the bulbous thickening of the proximal and wasting of the distal ends has been recorded—No. 11; as a rule these are present, and the thickened upper end may be palpable through the skin.

Of concussion or contusion.

It must be remembered that a severe contusion or concussion, or a partial division of a nerve, may be followed by complete loss of its functions, at any rate for a time, and the course of the case will need watching before coming to a conclusion as to the extent of the damage. All Faradic irritability has not, as far as the available evidence goes, been lost in these cases, although almost complete paralysis may have existed for months: it has, however, been usually considerably diminished in degree (Cases 26 and 27). Generally speaking, instead of the rapid lessening and final absence of response to the faradic current, permanent paralysis and rapid muscular wasting, which follow complete division, the tendency will be after a short time towards recovery, partial or complete, although the process may be long continued, sensation almost always beginning to recover first.

Effects due to callus and scar tissue.

The secondary effects of gunshot injuries, as mentioned above, may complicate a primarily caused paralysis. The situation and character of the wound, its extent, the amount of scarring, the presence of excessive callus or irregular union of fractures, considered in relation to the anatomical course of the affected nerve, will enable an opinion to be formed as to the probable amount of influence exercised by these conditions on the course of the case. Finally, the actual state of the damaged nerve may be ascertained by an exploratory operation.

Prognosis.

Prognosis, in the slighter forms of injury, would appear to be fairly good. Cases 41 to 56, which were not submitted to operation, and which were considered to be slight contusions or instances of concussion, show complete recoveries. The result in 2 was not known, as the patients were lost sight of, and in 4 (Nos. 41, 42, 54, and 55) there was no improvement. Two of these patients have recently been communicated with, as the notes of their condition taken when they passed through Netley—"only partial wasting, presence of Faradic irritability, and no trophic changes"—led to a favourable prognosis being given, particularly in No. 42. The result, however, according to the men's own statements, has not been such as to justify the opinion, as they both say they are "no better," but the opinions of pensioners in this connection sometimes require to be discounted.

Not hopeful in severe cases.

When the injury is more severe the prognosis is by no means so hopeful, and the question of the results to be obtained by operative measures has to be taken into consideration. In 9 instances which were severe concussions or contusions (Nos. 16, and 21 to 28), satisfactory improvement is only noted

in 3, but the others were not under observation long enough to make sure what the final termination might be.

Perforation, in some instances at least, when the nerve is not involved in scar tissue, appears to occur without occasioning much permanent damage. (*See* Cases Nos. 1, 2, 3, 4, 5, and 6, in 2 of which complete recovery is stated to have taken place; in 2 it was not nearly complete; and in 2 the end results could not be ascertained. Except in Nos. 1 and 2 perforation is doubtful, as the notes of the cases show.)

Partial divisions, and the secondary results of gunshot injuries, except in the slighter cases, may require operation, whilst complete division will always do so, to afford any possibility of even partial recovery.

Treatment.

Importance of asepsis in the wound.

In the first place, an aseptic condition of the wound must always be aimed at. The evil effects of suppuration, as regards the tendency to neuritis and the increased formation of cicatricial tissue, with the subsequent contraction which follows union by granulation, have already been mentioned. In addition, the delayed healing of the wound will prevent the early employment of massage which in so many cases of nerve injury is of the utmost value. Civil Surgeon A. Young has specially noted this in his report, and recommends that it should be begun as early as possible—massage not only of the paralysed parts but of the wound area as well. Its good effect is referred to in the notes of many cases. Electricity, if available, will also be useful.

The Question of Operation in Nerve Cases.

Operation clearly indicated in some cases.

Where undoubted complete division has occurred, there is no difference of opinion as to the necessity for operation with a view to suture as soon as an aseptic result can be obtained; also at a later period there may be no doubt as to the advisability of freeing a nerve from constricting scar tissue or callus. But when the conditions are less well marked it is important to decide how long a time should be allowed to elapse before an exploratory operation is performed for the purpose of examining the damaged nerve and treating any morbid condition found to exist. From one to three months have been mentioned by different writers; probably two months would allow of an opinion being formed as to the prospects of recovery, and the rule may be laid down that if by that time there are no signs of progressive improvement, circumstances being favourable, the operation should be done.

In others at a late period.

It has been suggested that the contraction of the scar of the operation wound might add to the patient's troubles, but the risk of this is small, and when the wound remains aseptic and heals by first intention there should be none.

Results to be expected.

It is difficult to come to any conclusions from the recorded cases as to the results which may be expected from these operations on nerves, because, as before stated, the patients have usually not been long enough under observation. As far as they go, however, they are encouraging, and the prospects of recovery are so often hopeless if operations are not undertaken, that there can be no doubt they ought to be performed when the indications point towards interference.

Suture in eight cases.

There have been 8 cases of suture recorded—(Nos. 7, 10, 11, 12, 13, 15, 30, and 39). In 3 of these the restoration of function was satisfactory (one being a bayonet wound); in 2, partly satisfactory; and in 3, there was no improvement as long as they remained under observation.

Freed from cicatrix in 17 cases.

Of freeing nerves from constriction by scar tissue, callus, &c., there have been 18 cases—(Nos. 4, 5, 6, 8, 9, 17, 18, 19, 23, 29, 31, 32, 33, 34, 36, 37, 38, and 40). In 3, complete recovery is said to have taken place, and partial recovery in 9; 2 were not improved; and in 5 the result was not ascertained.

As to the methods of performing these operations the ordinary rules of surgery must be followed.

Operation for complete division.

In cases of complete division, perineural sutures are considered by Civil Surgeon A. Young to be better than those passing through the nerve substance when the divided ends can be readily brought into apposition

(Case 13); his method of splitting the intervening fibrous tissue when the divided ends will not come together, is also worthy of note (Case 11). When in cases of constriction by fibrous tissue, or partial division, or both, the nerve is found bulbous at the injured point, the question arises, Should the swollen part be excised or not? The course to be followed would appear to depend on the amount of function remaining. If the nerve is practically destroyed, it is better to excise and suture, but if not, to be content with removing the constricting tissues.

The following remarks by Civil Surgeon L. G. Irvine on cases treated by him are inserted here. After dealing with concussion and quoting a case (No. 28) given below, he continues:—

Remarks by Civil Surgeon Irvine.

"The other cases of injury to nerve trunks which I observed, I may briefly summarise. Including the case just detailed, they number 17, and they fell into two classes: In the first, the symptoms pointed to complete section of the nerve trunk; in the second, to a partial injury only, by laceration, contusion, or constriction by cicatricial tissue. In the former class there was complete anæsthesia and paralysis of motor power in the sensory and motor distribution of the nerve. Six cases were of this type, 4 being cases of musculo-spiral paralysis complicated by fracture of the humerus. Two of these were operated on, and the continuity of the nerve was in each case found to be entirely destroyed to the extent of an inch or more, a firm mass of fibrous tissue marking the direct track of the bullet. In both cases suture was attempted, but in one approximation was imperfect. The other patients were not operated on. Of the remaining 2 cases of this type, one was a case of paralysis of the ulnar nerve in the forearm, when operation showed the same condition of breach of continuity as I have just described. Here also nerve suture was attempted, but the ends of the nerve could not be brought fully together. The last case was that of apparent section of the sciatic nerve, already detailed (28), in which operation revealed no apparent gross lesion of the nerve trunk. Although this case possesses much interest as showing the effects of concussion or slight contusion, yet the evidence of the other cases tends to show that complete paralysis of the functions of a nerve from this cause is comparatively uncommon although the condition may enter as a partial factor into many cases of nerve injury. One can scarcely say that the operation of nerve suture gave much hope in these cases of any future return of function in the nerve; nevertheless, the operation is, I think, a justifiable one, and should be undertaken if, after the lapse of a few weeks, no improvement takes place.

"Of the second type of nerve injury, that of partial destruction of a nerve trunk, I saw 11 cases, the ulnar nerve being involved in 3, the median in 1, the median with the ulnar in 1, both popliteal nerves in 2, and the external popliteal in 1, the sciatic in 1 and the musculo-spiral in 2.

"The general symptoms were similar in all. In most there was great pain, tingling, and hyperæsthesia over part or the whole of the sensory distribution of the nerve, with paresis or paralysis of a number or the whole of the muscles supplied by it. Sometimes anæsthesia was present in place of hyperæsthesia. At the outset, and usually for 10 days or a fortnight, the pain and hyperæsthesia were intense as a rule, requiring in almost every case the use of opium or morphia. After a time amelioration of this symptom, as a rule, set in; the motor power, when it did recover, did so more tardily. In one case where both popliteal nerves were involved, and in a second where the external popliteal was alone implicated, there was steady progress towards recovery of complete function without operation.

"But in the case of laceration or contusion of the great sciatic in the buttock (Case 28), pain and hyperæsthesia of the inner side of the foot were very persistent, and the paralysis of the long flexors and extensors of the toes and of the peronei and intrinsic muscles of the foot, had shown practically no improvement at the end of three months after receipt of the injury. In such a case I am convinced operative interference was indicated.

"In 6 of the other cases the nerve was exposed by operation. The conditions found were interesting: in one case the ulnar nerve was implicated in the upper arm. It was freed from cicatricial tissue, and stretched, but although the symptom of pain was ameliorated, there was still practically

complete paralysis of motion and sensation in the parts supplied by the nerve six months later. In a similar case, in which pain was again the prominent symptom, the ulnar nerve was exposed. No actual loss of substance was found, but the nerve was constricted by a strong band of fibrous tissue, above which was a slight bulbous expansion of the nerve trunk; the nerve was freed and relief of pain followed. Again, a similar condition was found in the third case of injury to the ulnar nerve in the forearm, the nerve being compressed by a firm band of fibrous tissue binding it down to the deep flexors. There was no loss of substance. There had been anæsthesia in this case over the distribution of the ulnar nerve in the hand and wrist, and sensation gradually and steadily returned when the pressure had been relieved.

"In a fourth case the median nerve had been injured, and pain was again an urgent symptom. The nerve was exposed in the course of a bullet wound in the upper part of the forearm, and found cut across to the extent of one-third, and bound down by cicatricial tissue; the nerve was freed, and marked improvement of the sensory symptoms followed.

"In a fifth case a spicule of bone from a fractured humerus was found to have transfixed the musculo-spiral nerve.

"The last case was only a partial operation—nerve stretching—and was not performed at the seat of injury. Benefit was only temporary.

"On the whole the results of operative interference in these cases have been encouraging. Sensory improvement has, as a rule, been much more mark d than motor improvement. I am inclined to think that where the symptoms point to contusion or laceration of the nerve, and where the sensory symptoms remain severe at the end of a month, or where by that time no improvement has then taken place in the motor symptoms, interference is called for."

The following notes give as full details of the cases recorded during the Boer War as are available:—

Gunshot Wounds of Nerves.

Perforations.

Case 1.—Private S., wounded 15th January, 1900; admitted 4 General Hospital, Mooi River, six days later. Entrance (Mauser) ½ inch above centre of ant. axillary fold; exit in kink of post. fold—both scabbed over. Marked wrist-drop, but triceps not paralysed nor sensation entirely lost on backs of fingers. Musculo-spiral—Aseptic—Explored—Complete recovery.

On 26th January, exploratory incision made across axilla. In following musculo-spiral nerve back through the cicatrix, with the finger, as it winds under the main artery, it was seen to be glued to latter by a small tarry-looking blood-clot, the separation from which caused profuse hæmorrhage. The rent in the artery was cut through after tying vessel above and below, and when the blood was cleared away a small round perforation was found in the nerve where adherent, which admitted the blunt end of a probe. About one-third of the nerve fibres were cut across in the perforation. Nerve trunk cleaned and replaced in its bed. Wound healed by first intention. Wrist-drop improving two months after, when invalided to England.

After six months "muscular-spiral paralysis had disappeared" (Netley Records). Now (1904) he writes to say that his arm and hand have perfectly recovered, adding, "I can hardly tell that my hand was ever crippled at all."—(Major S. F. Freyer, R.A.M.C.)

Case 2.—Sergeant S., wounded January, 1900; admitted 4 General Hospital, Mooi River, 24th January, 1900. Healed Mauser wound, transversely through upper arm, passing in front of humerus. Numbness and partial paralysis of muscles supplied by median nerve; pain in nerve distribution, especially on hot days. Median—Aseptic—Explored—Recovering.

About a fortnight after injury, the nerve was explored in the bullet track, and found to have been perforated by the bullet. The perforation was central and admitted an ordinary probe. Some of the nerve fibres had been cut across in the perforation. Nerve merely replaced in its bed, and wound

closed. Healed by first intention; when invalided after two months, little, if any, improvement.

Now (1904) serving; great improvement, but some slight paralysis apparently remains, as "he says he cannot clench his fist, and there is some wasting of the muscles, though the finger joints are not stiff."—(Civil Surgeon F. R. MARTIN and Major S. F. FREYER, R.A.M.C.)

Median—Aseptic—Explored—Complete recovery (not Mauser).

CASE 3.—Sergeant L., wounded 24th January, 1900; admitted 4 General Hospital, Mooi River, nine days later. Entrance 1½ inches above and a little outside internal condyle left arm; X-rays showed revolver bullet lodged over deltoid muscle—raking wound—due to his revolver going off accidentally.

Large hæmatoma over arm, with œdema of forearm and hand; partial anæsthesia of median supply, but flexor muscles apparently unaffected. For lesions of vessels, *see* Case No. 83, "Gunshot Wounds of Blood Vessels." Operation on 12th day. A slit was found in median nerve which left three-quarters of trunk sound on outer side and a small strand of fibres on inner side; less than a quarter of the fibres were thus cut across in the irregular perforation made by the bullet, apparently. Nerve merely replaced in its bed. Wound healed by first intention.

Invalided to England. Now (1904) serving; perfect recovery; "sensation and motion normal."—(Major S. F. FREYER, R.A.M.C.)

Internal popliteal—Septic (?)—Released from cicatricial pressure—Recovering.

CASE 4.—At Mooi River (4 General Hospital), Mr. Stanley Copley cut down on the internal popliteal nerve (13th July, 1901, Private T.) to release it from cicatricial pressure in an old scar following a Mauser wound (septic?). He found also a string of cicatricial tissue leading from entrance and exit wounds through the nerve trunk in such a manner as to suggest that the nerve had been perforated by the bullet. Improvement followed soon after, but later history not to be obtained.—(Major S. F. FREYER, R.A.M.C.)

Popliteal—Aseptic—Compression relieved—Recovered.

CASE 5.—M., wounded 24th January, 1900; admitted General Hospital, Maritzburg, seven months later. Entrance (Mauser) in mid-line, post. aspect right thigh, 1¼ inches above flexture of knee joint; exit on outer aspect of leg, ¾ inch in front of head of fibula. "Wound had been aseptic and long healed"; marked atrophy right gastrocnemius and some wasting of peronei; complete anæsthesia of greater part of outer border of sole of foot, inner aspect of heel and dorsal and plantar surfaces of three outer toes. Popliteal nerves explored; internal "found much thickened, firmly embraced in dense scar tissue, and there was evidence that it had been perforated by the bullet"; external only slightly involved; both dissected free and scar tissue removed as much as possible. Healed by first intention; systematic massage. After a month, muscular power fully restored; sensation practically normal; discharged to "duty."—(Civil Surgeon A. YOUNG.)

Note.—Patient says he is still (February, 1904) troubled with the wound, but exact condition not ascertained.

Sciatic—Septic—Released from callus—Improved.

CASE 6.—W., wounded 3rd December, 1900; compound fracture of femur in mid-third; motor and sensory paralysis below knee joint followed wound; six months later wound healed and fracture united, but paralysis persisted.

Sciatic nerve explored; "found buried in a mass of cicatricial tissue and closely adherent to the femur at the seat of fracture." The nerve was released, and a small spicule of bone embedded in it was removed. "At one spot it appeared to have been perforated by the bullet." Under massage and electricity improved a good deal; able to walk with a special boot. Invalided after three months.

Now (November, 1903) leg is said to be very weak, to swell after walking, and to be subject to profuse perspiration.—(Netley Hospital Records.)

Partial Division.

CASE 7.—Entrance 2 inches above and ½ inch behind external condyle of humerus; exit ½ inch lower on arm, at inner edge of biceps. Musculo-spiral—Aseptic—Sutured—Recovering.

Complete posterior interosseous paralysis, and lowered radial sensation. After three weeks no change but deepening of anæsthesia, and formication when wound manipulated. Nerve explored by Mr. Watson; "found V-shape notch cut in its outer border"; the margins of notch were refreshed, and the gap closed. Radial sensation fairly good 10 days later, but motor symptoms continued. After nine months, steady but very slow improvement.—(Mr. MAKINS.)

CASE 8.—R., wounded 18th February, 1900, through upper arm; admitted 30th day. Ulnar—Released from cicatrix—Recovering.

Paralysis of ulnar nerve. Nerve explored, and "found involved in dense scar tissue; at point of impact of bullet there was a loss of one-third of its substance" transversely; dissected free. Two months later area of anæsthesia diminished; hand much stronger and more useful.—(Imperial Yeomanry Hospital Report.)

CASE 9.—C., wounded 18th February, 1900. Entrance 2 inches outside sternal end of clavicle; exit below spine of scapula, over infra-spinous fossa. Musculo-cutaneous—Released from cicatrix—Result unknown.

Paralysis of muscles supplied by musculo-cutaneous. The plexus was explored, and "the upper cord found injured and involved in cicatricial tissue"; dissected free. No further notes.—(Civil Surgeon STUART.)

Complete Division.

CASE 10.—X., Mauser wound through back of thigh, from side to side, at junction of mid. and lower thirds. After six weeks admitted with wound suppurating and complete paralysis of external popliteal nerve. When, four weeks later, the wound had healed, nerve was explored—found divided and sutured. Very little improvement when invalided a month later.—(Imperial Yeomanry Hospital Report.) External popliteal—Septic—Sutured—Result unknown.

CASE 11.—P., wounded 27th February, 1900; admitted 11 days later. Wound (Martini-Henry), through right forearm, just below int. condyle, had healed on admission. Complete motor and sensory paralysis in ulnar distribution; atrophy; skin pale and scaly, tending to ulcerate. On 33rd day nerve exposed—"found completely divided, with interval of 2¼ inches between the ends, which were buried in dense cicatricial tissue"; no bulbous swelling of proximal end, and distal not much shrunken. Exit wound had suppurated. Ulnar—Aseptic—Sutured—Recovering (not Mauser).

Fibrous cicatrix split longitudinally in several places, and ends approximated as much as possible by catgut sutures.

Healed by first intention; trophic changes gradually disappeared; motor power gradually but fully restored, and sensory function beginning to improve when (date not given) invalided to Canada.—(Civil Surgeon A. YOUNG.)

CASE 12.—H., wounded 5th March, 1900, by Mauser at 500 yards range. Entrance in middle of back of right arm, 4 inches above elbow; exit on inner surface, 6½ inches above int. condyle. Complete paralysis of ulnar nerve. Ulnar—Aseptic—Sutured—Not improved.

On 30th day nerve explored—found completely divided; sutured.

A month after the paralysis was not improved; invalided to England, and finally "discharged from the Army, the function of the nerve not having been restored to any extent."—(Major LOUGHEED, R.A.M.C.)

Date of discharge not given. This case possibly was not long enough under observation.

Median (bayonet wound)—Aseptic—Sutured—Recovered (?)

CASE 13.—B., wounded by bayonet 17th May, 1900, in flexor surface right forearm just above wrist; admitted 75th day; wound healed. Complete motor and sensory paralysis of median below the wound; thenar eminence much shrunken; skin blanched; desquamation, local thickenings, and lowered temperature of fingers affected; numerous small ulcers on fingers, with tendency to "clubbing."

On 83rd day nerve explored—found completely severed; proximal end bulbous, distal shrunken and thread-like; both embedded in scar tissue. Dissected free and pared till healthy fibres appeared, leaving gap of 1 inch; ends sutured perineurally. Union by first intention. Sensation restored in 24 hours; trophic changes in great measure corrected in a few days; motor function restored more gradually, but satisfactorily. At end of January, 1901, function of hand practically quite normal; a little clubbing of fingers remains.—(Civil Surgeon A. YOUNG.)

Note.—In answer to letter of inquiry, 21st January, 1904, it is stated that this man's hand is still feeble and much crippled; he cannot, for instance, "turn the handle of a door with it."

Direct Lesion: Its Nature not Ascertained in Some Cases.

Brachial plexus—Aseptic—Explored—No nerve completely divided—Recovering.

CASE 14.—An officer. (*See* Case 30, "Gunshot Wounds of Arteries," for entrance and exit wounds, and damage to axillary artery with resulting aneurysm.) The whole arm and hand practically was paralysed, with loss of sensation, as evidenced by a severe scald of hand from his having dipped it into hot water, soon after receipt of wound, to relieve intense pain, without noticing that the water was scalding hot. The rent in the artery lay between the heads of origin of the median nerve.

When, during the operation on the aneurysm, the axillary space was being flushed out, no injury to any nerve in the plexus was seen. As patient was very weak, there was no time for a minute examination of the various nerve trunks of the plexus for other lesions. Healed by first intention; pain much relieved by operation on aneurysm. When sutures removed 10th day he was able to move arm from side, but no further perceptible improvement in nerve functions when invalided to England 68th day from receipt of wound. Massage continued, with electrical treatment. Developed "glossy skin," with wearying pain, mental depression, &c. After 18 months arm and forearm normal; wrist-drop, "glossy skin," and mental depression passed off; thumb improving, but fingers still useless, and sensation incomplete below wrist. Could hold a stick between thumb and hand; allowed to rejoin his regiment.—(Major S. F. FREYER, R.A.M.C.)

Median—Aseptic—Excision of neuroma with suture—Recovering (?).

CASE 15.—C., wounded 1st September, 1900, by fragment of cartridge casing; admitted 12th day. Median nerve damaged just above wrist; stiffness of flexors of fingers; difficulty in opposing thumb; anæsthesia of palmar and dorsal aspects of terminal phalanx of forefinger, and of palmar aspect of that of thumb; slight blanching of palmar skin of thumb and forefinger; gradually became worse. Operation 47th day; neuromatous thickening which had developed round a small fragment of metal was excised, and nerve sutured. Healed by first intention. When invalided 11 days later sensation perfect in middle finger, in thumb as far as terminal phalanx, and in forefinger as far as middle phalanx; power of opposing thumb recovered; trophic changes much improved.—(Civil Surgeon A. YOUNG.)

Musculo-spiral—Explored—No lesion found—Result unknown (not Mauser).

CASE 16.—Shell fragment entered axilla causing large extravasation of blood, and paralysis of musculo-spiral nerve. Operation; "the piece of shell was found in contact with nerve, but latter showed no sign of injury." Sensation returned shortly after, but in the six weeks previous to invaliding, there was no improvement in motor paralysis.—(Civil Surgeon J. W. SMITH.)

Median—Septic—Released from cicatrix—Improving (not Mauser).

Case 17.—L., wounded 2nd July, 1900, from explosion of cartridge and fragment of metal lodging in palm of hand. Deep suppuration; anæsthesia of finger supply of median nerve; some wasting of thenar eminence; inability to oppose thumb. On 17th day pus evacuated and metal removed; anæsthesia, motor defects, and trophic changes became more marked. Twenty-three days later scar in palm dissected out and nerve and its branches freed from cicatrix; healed by first intention; with massage, in 18 days, palmar sensation satisfactory; still comparative atrophy of thenar eminence and stiffness of fingers. Invalided to England. When seen later slight clubbing of ends of thumb, fore and mid fingers, which had a deeply-coloured congested appearance.—(Civil Surgeon A. Young.)

Median and radial—Aseptic—Released from cicatrix—Recovered.

Case 18.—Wounded 18th February, 1900; admitted Netley 3½ months later. Entrance inner side left forearm 3 inches above wrist; exit in front of lower end of radius—both healed; loss of sensation in median and radial distribution; median explored, "found slightly thickened"; dissected free of "some scar tissue." Rejoined his regiment for duty after two months.—(Netley Records.)

Ext. popliteal—Septic—Released from cicatrix—Not improved?

Case 19.—R., wounded 11th December, 1899. Entrance (Mauser) in centre of patella; exit behind and slightly below head of fibula; complete paralysis of external popliteal nerve. On 26th day the "wound having healed," the nerve was explored; found enlarged and thickened at one spot and constricted below this, but no divided part could be seen; adherent to bullet track; released from adhesions. When invalided to England 28 days later no improvement had occurred. Finally discharged from army still suffering from paralysis.—(Major Lougheed, R.A.M.C.)

Musculo-spiral—Aseptic—Explored—Swollen and congested—Recovered.

Case 20.—Wounded 21st February, 1900, through upper arm. Complete paralysis of musculo-spiral nerve, wasting of muscles, wrist-drop and anæsthesia of radial distribution area. After six weeks no improvement; nerve explored; "found swollen and pinkish, but no sign of it having been even partly divided"; sheath incised.

This man passed through Netley the same year, and it is noted that there was still some weakness of the extensors, though they were rapidly improving; rejoined for duty.—(Surgeon-Captain Stuart, V.A.)

Brachial plexus—Aseptic—Explored—No lesion seen—Recovering.

Case 21.—O., Mauser wound from before backwards through axilla; admitted third day. Wound healed; wrist-drop; loss of power in all fingers, of flexion and extension at elbow joint, and of sensation in ulnar and musculo-spiral areas.

The nerves were exposed seven days later, but none had been injured, as far as could be seen. Some weeks later, slight improvement, but arm still useless; after six months, very slow improvement.—(Imperial Yeomanry Hospital Report.)

Brachial plexus—Aseptic—Explored—No improvement.

Case 22.—X., Mauser wound through axilla. Severe pain in course of the radial nerve; "after a long course of treatment by local applications, &c.; nerves in wound track were explored, but with no good result."—(Imperial Yeomanry Hospital Report.)

Brachial plexus—Aseptic (?) Explored—Released from scar tissue—Slight improvement.

Case 23.—G., wounded 1st April, 1900, through axilla; admitted 12th day. Axillary plexus implicated, and artery also affected—pulse absent; unable to flex or extend elbow; wrist-drop; unable to adduct or abduct fingers, or extend metacarpophalangeal joints; very slight power of flexion of wrist and fingers; partial anæsthesia of skin of forearm.

After 7½ weeks no improvement; nerves exposed, but only very slight amount of scar tissue found implicating them; released from latter. There was very little improvement five weeks later.—(Imperial Yeomanry Hospital Report.)

External popliteal—Aseptic—Explored—No lesion seen—Recovering.

Case 24.—T., Mauser wound through left thigh, May, 1902. Paralysis of ext. popliteal nerve. After three months nerve exposed in bullet track, but found quite healthy as far as could be seen. Arrived at Netley December of same year; put on regular course of massage, with electrical treatment. A month later paralysis began to improve, and in three months very little dragging of toes in walking, though extensors were still much weaker than on other side.—(Netley Records.)

Ulnar—Aseptic—Explored—No lesion seen—Completely recovered.

Case 25.—H., wounded 19th October, 1900. Entrance in mid. right scapula; exit under outer third of clavicle, same side. Ulnar paralysis, with much pain in distribution of nerve.

"On 14th day nerve exposed, and found to all appearance quite healthy." Massage and electricity were employed perseveringly, and recovery was complete seven months after receipt of wound.—(Netley Records.)

Ulnar—Aseptic—Explored—No lesion seen—Not improved after 18 months.

Case 26.—C., wounded 23rd March, 1902. Entrance (Mauser) at junction of mid. and lower thirds of arm, over inner side of biceps; exit 2 inches above and a little posterior to internal condyle. "Wound healed without suppuration."

On arrival at Netley seven months later, the ulnar nerve was paralysed below the elbow; main en griffe was well marked; Faradic contractility was present in all muscles, but a much stronger current was necessary to produce it than on the sound side. Massage and electricity used perseveringly for three months, but with no improvement. On 18th February, 1903, 11 months after injury, the nerve was exposed, but was found to all appearances quite healthy; it was not involved in any way in the bullet track. The patient left the hospital 18 months from date of wound, "his condition being practically the same as when admitted."—(Netley Records.)

Great sciatic—Aseptic—Explored—No lesion seen—Recovered.

Case 27.—J., wounded 28th May, 1900, through thigh (Martini flesh wound) at junction of upper and mid. thirds. Foot dropped immediately, and there was great pain.

After three and a half months the great sciatic nerve was exposed—"found slightly displaced, but otherwise normal." Operation wound took three weeks to heal. Arrived at Netley two months after operation; paralysis of leg; both flexors and extensors responded to strong Faradic current; some voluntary power in flexors, but none in extensors.

Improved slightly under four months' massage and electrical treatment; sent to Convalescent Home; after three months more he joined for duty.—(Netley Records.)

Great sciatic—Aseptic (?)—Explored—No lesion seen—Recovering (?).

Case 28.—X., wounded 18th February, 1900. Track of bullet (Mauser) crossed line of great sciatic nerve in mid-thigh. Anæsthesia of outer part of leg and foot; paralysis with wasting of large muscles of calf, long flexors and extensors of toes, peronei and intrinsic muscles of foot.

Nerve explored on eighth day; "the hæmorrhagic track of bullet was found passing in close proximity to it, and there was extravasation in tissues around; a slight fibrous band lay over the nerve, but the latter was quite intact." Fibrous band divided. Slight return of sensation and motor power in a few days, but no further improvement as long (time not given) as he remained under observation.—(Civil Surgeon L. G. Irvine.)

Musculo-spiral—Aseptic (?)—Relieved from callus pressure—Recovering.

Case 29.—A., Mauser wound through soft parts of back of arm, just below spiral groove, injuring bone, but not fracturing it. Complete paralysis of musculo-spiral nerve below (time not given); thickening behind humerus in track of wound.

Nerve exposed by operation; found embedded in callus; dissected free. Sensation returned after a month; "some fingers could be extended," and improvement appeared to be continuing.—(Imperial Yeomanry Hospital Report.)

Median nerve—Septic—Resection and

Case 30.—W., wounded 23rd July, 1900; admitted 39 days later. Injury to median nerve. No improvement three weeks later; nerve was

exposed and found buried in mass of scar tissue, to which it was so adherent that resection and suture were performed. suture—Result, improved.

In seven weeks after operation considerable improvement; sensation had returned, though not perfectly, and movements were better. After 14 months still later the account was: "Hand evidently not recovered, though it was better than it was before."—(Imperial Yeomanry Hospital Report.)

Case 31.—Gunshot fracture of humerus, with musculo-spiral paralysis. After fracture had united, paralysis did not improve. Nerve explored—found bound down to bone by dense scar tissue for 2 inches. Eventually complete recovery took place.—(Imperial Yeomanry Field Hospital.) Musculo-spiral—Aseptic—Released from callus (?)—Complete recovery.

Case 32.—C., wounded 18th July, 1901. Fracture of humerus. When fracture had united, 43 days later, he was found to have musculo-spiral paralysis. Two days later nerve was exposed, and found bound down by fibrous bands in bullet track; nerve much attenuated, softened, and of a bright pink colour; dissected free. Musculo-spiral—Aseptic—Released from cicatrix—Recovering.

Slight improvement noticed 23 days after operation; massage begun. Fair power had returned to all the muscles two months later.—(Major Lougheed, R.A.M.C.)

Case 33.—G., gunshot fracture of humerus received 21st April, 1900; arrived at Netley three months later. Fracture united; musculo-spiral paralysis. The nerve was exposed eight months after receipt of wound; found bound down by cicatricial tissue at seat of fracture; relieved and stretched. Musculo-spiral—Aseptic—Released from callus—No improvement.

Very little improvement three months after operation; invalided. Now (1903) writes, "My arm is practically the same as when I was discharged from the army."—(Netley Records.)

Case 34.—P., wounded 6th February, 1901, through axilla injuring median, musculo-cutaneous, and ulnar nerves. Nerves exposed in axilla eight months later; not found divided; dissected free from "a certain amount of scar tissue" in the wound track, and stretched. Invalided six weeks later. Writes (November, 1903), "There is no improvement whatever in my arm; the fingers are tightly drawn into the palm, and I cannot feel anything. The arm and hand are withered."—(Netley Records.) Median, musculo-cutaneous and ulnar—Aseptic—Explored—Not found divided—Released from scar—No improvement.

Case 35.—Private C., wounded 18th February, 1900; admitted 6 General Hospital 11 days later. Entrance (Mauser) on outer side of forearm 2 inches above wrist; exit at juncture of mid. and upper thirds of forearm on ant. surface. Felt "like a heavy blow" when hit. Ulnar—Aseptic (?)—Exploration—No lesion seen—Result unknown.

Partial paralysis of ulnar nerve.

On exploration failed to find any divided nerve; profuse hæmorrhage took place from ulnar artery, which was found partly divided and was tied.—(Civil Surgeon J. O. Skevington.)

Case 36.—Lance-Corporal R., wounded 4th December, 1899; admitted 2 General Hospital 12 days later. Entrance (Mauser?) in centre of patella; exit behind and slightly below head of fibula. The wounds, which were small, circular, and clean, did not heal for another week. External popliteal—Septic—Released from cicatrix—Result unknown.

Complete motor paralysis of external popliteal nerve, with partial loss of sensation; tender bulbous enlargement felt on it above and behind head of fibula. On 34th day explored by Civil Surgeon Pegg; "nerve found enlarged and, below this, narrowed but not divided."

Released from adhesion to bullet track healed by first intention; no improvement apparent a month later when invalided.—(Records 2 General Hospital.)

Case 37.—Private B., admitted 1 General Hospital with septic wound. Entrance in middle of forearm on outer aspect; exit at inner edge of ulnar 2½ inches from its lower end. Symptoms of complete ulnar paralysis. Two months later, when wounds had healed, an exploration of nerve was made Ulnar—Septic—Released from cicatrix—Result unknown.

found involved in scar, thickened and indurated for $\frac{1}{3}$ inch, but not divided; released; wound healed by first intention; final result not known.—(Civil Surgeon E. THORNTON.)

Great sciatic—Released from cicatricial pressure—Recovering.

CASE 38.—Entrance left loin; exit at lower margin of buttock. Immediate and complete motor and sensory paralysis of internal popliteal nerve.

After 14 days hyperæsthesia developed in distribution of internal popliteal nerve; superficial pain greatest in sole of foot; muscles of calf very tender. The pain increased, and 24 days later patient's suffering was so great that Civil Surgeon Thornton explored nerve. It was embedded in firm cicatricial tissue close to sciatic notch, which compressed the nerve to such a degree that a "waist" was apparent upon it.

Nerve when set free resumed its former outline; patient relieved for a few days, but neuralgia then returned in greater intensity than ever. Morphia injected, but with little effect; patient became hysterical. Some five weeks later a sudden improvement took place, but there was still deep tenderness in calf and hyperæsthesia of sole of foot; invalided to England. A year later he walked fairly well, but with foot-drop, and still complained of tenderness in the sole.—(Mr. MAKINS.)

Median, ulnar and musculo-spiral—Aseptic—Explored and resected—No improvement noticed ten months later.

CASE 39.—Wounded in lower part of upper third of arm, fracturing humerus. Immediate and complete loss of power and sensation below. The humerus after three weeks was united, but paralysis was still complete in distribution of median, ulnar, and musculo-spiral nerves; wasting of forearm and hand; "thickening" in lower third of arm. After four months explored by Civil Surgeon Eve. All nerves and vessels of arm united in one firm bundle of cicatricial tissue; median nerve thickened and enlarged for $1\frac{1}{2}$ inches; ulnar indurated, but continuous; musculo-spiral intact, but at its entrance into groove a mass of callus was felt.

A sclerosed and thickened portion of median $3\frac{1}{2}$ inches long was resected; also 1 inch of sclerosed ulnar, and both were sutured. A small traumatic aneurysm found on brachial artery and vessel ligatured above.

No improvement 10 months later in median or ulnar distribution; electric reaction present in musculo-spiral group.—(Mr. MAKINS.)

Musculo-spiral—"Complete paralysis"—Aseptic—Released from cicatrix—Result unknown.

CASE 40.—Lance-Corporal G., wounded 23rd July, 1901. Entrance in post. surface of arm 2 inches below axilla; exit in centre of pectoral margin 3 inches from insertion of muscle. Complete paralysis of musculo-spiral nerve since receipt of wound.

On the 72nd day an incision was made along the lower border of pectoralis major in the axilla by Civil Surgeon C. S. Wilson, exposing musculo-spiral, median, and ulnar nerves. No nerves were found divided, but they were liberated from "some thickened tissue" found in bullet track. Wound closed, with drainage at lower part. "Operation wound quite healed, but no improvement in nerve functions when he left," 16 days later.—(Records 2 General Hospital.)

Sciatic—Septic—Released from cicatrix—Recovered.

CASE 41.—Trooper G., wounded 30th October, 1901. Entrance (deformed Mauser) 2 inches behind and 3 inches above head of fibula; no exit, but bullet removed from thigh in line of ant. sup. iliac spine, and 3 inches below latter. Original wound suppurated, and took three weeks to heal. Had drop-foot, with pain and leg drawn up for a year, when entry wound was explored; "sciatic nerve found firmly bound down in scar tissue and released." Rapid recovery followed, and drop-foot passed off in 10 days. Walks well now (21st July, 1905), though he cannot yet fully flex toes, and has had little toe amputated a week ago on account of contraction.—(Major S. F. FREYER, R.A.M.C.)

Cases not Explored.

Ulnar—Septic—Not explored—No improvement.

CASE 42.—S., wounded through forearm from before backwards in upper third, fracturing ulna; arrived at Netley, 21st January, 1900. After two months more wound had healed, leaving ulnar paralysis; slight Faradic irritability remaining in abductor indicis and nim. digiti; reaction of degeneration not complete. In November, 1903, there had been no improvement; hand of little use, and causing great pain at times.—(Netley Records.)

Musculo-spiral—Aseptic (?)—Not explored—No improvement.

CASE 43.—A., wounded 23rd February, 1900; musculo-spiral paralysis from "flesh wound" of upper part right arm; arrived at Netley 104th day; wound healed; "diminished Faradic irritability in muscles supplied by musculo-spiral. Therefore progress is favourable, and power should return in three or four months." Patient writes in November, 1903: "My arm is about the same, except that it has got a little thinner."—(Netley Records.)

Musculo-spiral—Aseptic—Not explored—Recovered.

CASE 44.—H., wounded (Mauser) 11th December, 1899. Fracture of humerus, with musculo-spiral paralysis; arrived at Netley 77th day; wound healed and fracture united; no deformity or callus; regaining power slowly; massage and electricity persisted in. Rejoined his regiment for duty the 225th day.—(Netley Records.)

Brachial plexus—Aseptic (?)—Not explored—Discharged "unfit."

CASE 45.—S., wounded 18th February, 1900. Entrance in front in floor of mouth; exit 1 inch below spine left scapula and "$3\frac{3}{4}$ inches to left of mid. dorsal region." Brachial plexus or its branches damaged; paralysis and wasting of deltoid, and of supra and infra scapula muscles; no noticeable sensory disturbance, and no wasting of muscles except those mentioned. Invalided to England; "discharged medically unfit eight months later."—(Civil Surgeon A. YOUNG.)

Ulnar—Septic—Not explored—Recovered.

CASE 46.—O., wounded 7th June, 1900. Entrance $1\frac{1}{2}$ inches directly above internal condyle of humerus; exit 1 inch above flexure of elbow, in middle of front of arm; when admitted eighth day, wounds were suppurating; evidence of damage to ulnar nerve.

Partial loss of power and sensation in distribution of nerve; no trophic changes in skin.

Functions gradually recovered, and in a week were well advanced.—(Civil Surgeon A. YOUNG.)

Brachial plexus—Aseptic—Not explored—Complete recovery.

CASE 47.—L., wounded 16th July, 1900, at 50 yards range. Entrance (Mauser) 3 inches to right of mid-sternum; exit $2\frac{1}{2}$ inches above post. axillary fold; admitted 15th day; wound had healed asceptically; general but only partial loss of power in right hand, forearm, and arm; flexion, extension, promotion, and supination movements being weakened; no loss of sensation; complete recovery in another week. Condition in July, 1901, absolutely satisfactory.—(Civil Surgeon A. YOUNG.)

Musculo-spiral—Aseptic—Not explored—Recovered.

CASE 48.—C., wounded 20th May, 1900. Entrance (Mauser) on post. external aspect right arm, $3\frac{1}{2}$ inches above external condyle, and $\frac{1}{2}$ inch behind vertical line from latter, exit on ant. aspect of arm, $2\frac{3}{4}$ inches vertically above mid. of flexure of elbow; admitted 13th day; wound had healed aseptically.

Numbness and entire absence of sensation in area of distribution of upper and lower external cutaneous branches of musculo-spiral nerve; no obvious trophic change in affected skin.

After some days gradual improvement began, feeling of numbness passing off and anæsthetic patch steadily diminishing from above downwards. After regular massage, particularly of anæsthetic area, "patient was finally dismissed well."—(Civil Surgeon A. YOUNG)

Musculo-spiral—Aseptic—Not explored—Recovered.

CASE 49.—McA., wounded 18th February, 1900, at 800 yards range. Entrance (Mauser) 9 inches below right acromion, in line of outer margin of belly of biceps; exit on post. aspect of arm, 8 inches below acromion, and 5½ inches from tip of olecranon. Admitted 20th day; wound had healed aseptically. Damage to lower external cutaneous branch of musculo-spiral nerve, causing area of hyperæsthesia in its distribution. Under massage the hyperæsthesia had practically cleared up five days later, and he was discharged well.—(Civil Surgeon A. YOUNG.)

Cervical plexus—Septic—Not explored—Result doubtful.

CASE 50.—P., wounded 14th February, 1900; admitted 55 days later. Entrance (Mauser) in mouth, through upper left alveolar ridge; exit on back of neck ¾ inch to left of sixth cervical spine. Bullet supposed to have been deflected thus by ramus of lower jaw. Entrance had healed; deep suppuration in exit had to be incised. Ant. and post. primary divisions of upper and middle cervical nerves probably damaged, also spinal accessory. Head kept stiff and turned to right; pain and stiffness referred to right side of neck, and due to spasm of sterno-mastoid, evidently. Complete recovery took place gradually.—(Civil Surgeon A. YOUNG.)

Note.—This man had not recovered when he arrived at Netley, and was discharged from the Service.

Anterior crural and external cutaneous—Aseptic—Not explored—Result unknown.

CASE 51.—C., wounded 1st July, 1900; admitted 14th day. Entrance (Mauser) 1¼ inches below right Poupart's ligament, over situation of ant. crural nerve; exit over tip of great trochanter, 4 inches from entrance. Wounds had healed aseptically. Damage to external cutaneous nerve, and to mid. and internal branches of ant. crural, as evidenced by hyperæsthesia in their distribution. No improvement four days later, when lost sight of.—(Civil Surgeon A. YOUNG.)

Ulnar—Aseptic—Not explored—Recovered.

CASE 52.—R., wounded 18th February, 1900; admitted 8 weeks later. Entrance (Mauser) on radial margin left ulna, 4½ inches below tip of olecranon; exit on flexor aspect of forearm, over inner edge of ulna, 5½ inches above wrist. Wound had healed aseptically. Damage to ulnar nerve, as evidenced by hyperæsthesia of little and ring fingers; no motor defects, nor trophic disturbance. The hyperæsthesia soon disappeared under massage.—(Civil Surgeon A. YOUNG.)

Brachial plexus—Septic—Not explored—Result unknown.

CASE 53.—Corporal F., wounded 14th March, 1902; admitted Dundee Hospital 26 days later. Entrance ¾ inch to right of fifth dorsal spine, small and almost healed; exit on inner and front aspect of arm, at junction of axillary fold, gutter shaped and discharging.

Muscles of arm and forearm considerably atrophied; power of movement of fingers greatly diminished, especially the forefinger; anæsthesia of dorsal surfaces of thumb, fore, middle, and radial side of ring finger; palmar surfaces of last phalanx of thumb, fore, middle, and radial side of ring finger; stiffness of elbow joint, partial loss of sensation in other parts of arm. Under massage slight improvement when invalided 60th day.—(Lieutenant BABINGTON, R.A.M.C.)

Musculo-spiral—Aseptic—Not explored—Recovered.

CASE 54.—Major W., wounded 12th February, 1902. Entrance (normal Mauser) on outer aspect of right arm, about its middle; exit on post. aspect, 1½ inches below post. fold of axilla. Wounds healed aseptically, and apparently by "scab."

Suffered from wrist-drop and other symptoms of injury of musculo-spiral nerve. Examined by Medical Board four months later:—Full movement in elbow and wrist joints; no loss of sensation in arm; unable to close hand; great loss of movement in fingers and thumb; wasting of muscles of forearm and hand; pain and hyperæsthesia of thumb and forefinger.

Later on there was noticed some enlargement of proximal phalangeal joints, which interfered with full flexion and grasp. When last seen, about

two years after the injury, the hand could be flexed and extended, and was to all appearances normal.—(Major S. F. Freyer, R.A.M.C.)

Sciatic—Septic—Not explored—No improvement (?).

Case 55.—Captain S., appeared before Medical Board 18th April, 1904, for wound pension. Entrance at upper post. angle left trochanter; exit on convexity of right buttock, 4 inches from anus. Wound of entrance suppurated, and took two months to heal. Had sciatic pain, which still troubles him, and ulceration of skin over tendo achillis, which breaks out afresh every cold weather. The skin over latter place is blue and discoloured (trophic change). Sciatic suspected to have been either damaged by bullet or tied down by cicatrix. Under the care of a civil surgeon who does not propose operation.—(Major S. F. Freyer, R.A.M.C.)

Short saphenous—Septic—Not explored—No improvement.

Case 56.—Lieutenant S., appeared before Medical Board 18th April, 1904, for wound pension. Wounded 7th March, 1901. Entrance scar size of threepenny piece, 2 inches below head of fibula, and just in front of shaft; exit scar very small; 2½ inches lower down, in mid-line of calf. Wound suppurated, he states, and took about three weeks to heal. Has since been complaining of pain down the back of the calf on walking, with no improvement up to the present time. It is thought that one of the communicating branches of the short saphenous was damaged or tied down in cicatricial tissue. Under the care of a London surgeon who does not recommend operation.—(Major S. F. Freyer, R.A.M.C.)

Sciatic—Aseptic—Not explored—Recovered.

Case 57.—Private L., wounded 10th March, 1900. Entrance (normal Mauser) in centre of right leg, 4 inches below knee joint; exit in centre of lower part of popliteal space; bullet re-entered back of thigh 2 inches higher; final exit in front, at apex of Scarpa's triangle. He was lying on his back at the time, evidently with knee bent. Severe hæmorrhage followed, with drop-foot and intense pain on dorsum of foot. Wounds all healed by first intention; pain continued for three months, but it is noted at Netley on the 66th day that "drop-foot had almost disappeared; peroneal irritability lessened; probably no gross lesion." He also suffered from trophic sores on dorsum of foot. Now (15th June, 1904) inspected; appears to be perfectly recovered, although he says he has a little pain occasionally.—(Surgeon-General Stevenson.)

Musculo-spiral—Septic, with callus pressure—Not explored—No improvement.

Case 58.—Private M., wounded 19th February, 1900; arrived at Netley 71 days later. Entrance (Mauser) 3½ inches below acromion process, and 1½ inches to outer side of axillary fold; exit at middle of arm on same side (left), at junction of post. and inner surfaces. The entrance wound suppurated slightly, and the humerus was fractured into musculo-spiral groove. Arm put up in splints for a month. Musculo-spiral paralysis noticed when splints taken down.

Note at Netley.—"Musculo-spiral nerve injured, but Faradic irritability present in all muscles supplied by nerve . . . . sensation absent in radial supply; wrist-drop; prognosis favourable." Re-examined 18th June, 1904:—Wrist-drop persists. Upper end of united humerus projects over spiral groove at post. and outer aspect; nerve evidently tied down in callus; is averse from operation, but will consider it later.—(Major S. F. Freyer, R.A.M.C.)

CONCLUDING NOTE BY THE EDITOR.

Nerve injuries: an interesting class of case.

That the injuries of the peripheral nerve trunks seen in the Boer War were an interesting class of surgical cases is evident from the foregoing notes and observations by Lieut.-Colonel Sylvester, R.A.M.C., to whom this portion of the Surgical Report of the late war, as well as "Injuries of Blood Vessels," was allotted. Other things also became apparent—that the prognosis in cases of direct gross lesion of nerve trunks is not good as regards complete recovery; that operative interference does not afford as hopeful an outlook in gunshot

Other matters taught by experience of Boer War.

cases as was formerly supposed, or as it does in injuries due to other causes; that not nearly all the cases in which, at first sight, operation appears to be necessary for suture of a severed nerve is interference for that purpose required; that suppuration in the wound is one of the most unfavourable conditions which can occur; that the time which must be allowed to elapse before a final decision can be made as to the degree in which recovery may be hoped for is much greater than was supposed—years, sometimes, rather than months; and that, with time, more or less recovery of function may take place in cases at first looked upon as hopeless.

Concussion or contusion.

Regarding the merely academic question of the possibility of signs of nerve lesion being produced by simple "concussion," Civil Surgeon Young states that it has been said that it is "in cases of fracture of the bones of the extremities that concussion (of nerve trunks) may be said to be most typically present" (page 281). With the correctness of this view I do not agree: on the contrary, it is just in these cases that it is difficult to set aside the probability that the signs of nerve lesion are due to actual contusion by fragments of bone, and to conclude that the symptoms are the results of mere concussion or vibration. But when soft parts only have been traversed and more or less incomplete paralysis and anæsthesia below the site of injury result, and when cases of this kind are explored early and no visible lesion of the nerve trunk is found and the bullet track is clearly recognisable as being half an inch or more away from the position of the nerve, it seems to be allowable to suggest concussion, rather than contusion by the other soft parts between the nerve and the bullet track, as the cause of the symptoms. I have seen cases of this kind, and others are noted in this Report. But the important thing to know about them is that they tend to more or less recovery without interference, and further, that when not accompanied by any gross lesion, they cannot be placed in any better position towards recovery by operative procedures.

Perforations of small nerves.

Injuries of the various kinds given under the headings at the beginning of Colonel Sylvester's Report (page 244) have been met with in all campaigns, and all of them except perforations have been very fully described in "Gunshot Wounds and Injuries of Nerves," by Weir Mitchell, Morehouse, and Keen (Philadelphia, 1864). It is, of course, easy to understand the occurrence of perforation in the case of large nerve trunks, such as the sciatic, internal popliteal, &c., especially by a modern rifle bullet; but in the Boer War a certain number of cases of mere perforation of nerves as small as the musculo-spiral and median, the diameter of which is considerably less than that of a Mauser bullet, are known to have occurred, for the cases were explored and the apertures demonstrated at the operations (*see* Cases 1 to 6). In two of the six cases of perforation of small nerves the evidence was unequivocal (Nos. 1 and 2); in Cases 4, 5, and 6 there "were some indications that perforation had occurred," but the operations were performed some considerable time after the wound, and the evidence is not beyond question. But the acceptance of Case No. 3, where a revolver bullet of ·45-inch diameter is stated to have perforated a median nerve, a large specimen of which when flattened out does not measure ·25 inch across, is difficult if not impossible.

But whether Case No. 3 was correctly estimated or not is of less importance than the fact which becomes apparent from the consideration of the other cases of perforation, especially Nos. 1 and 2, viz., that cases of partial section of nerve trunks, as perforations may be considered, tend towards more or less complete recovery without operative interference; for, although these cases were explored, nothing was done for the repair of the injuries seen, and 2 (counting No. 3) completely recovered, and 2 others somewhat improved.

Cicatrix in aseptic perforation cases.

In all the cases of perforation of nerve trunks which were explored late, indications of a cord of cicatricial tissue were found in the track of the bullet through the nerves; but as this could not cause compression of the nerve it was of no consequence. It would probably be absorbed as time went on, and formed a foundation along which new nerve fibres would grow in the repair of those injured.

Cicatrix in septic cases.

On the other hand, the wounds in some cases had not remained aseptic, but had healed by granulation, and the cases were operated on to free the nerve trunks from the constricting cicatricial tissue which always forms under these circumstances.

Suture not always required where symptoms are marked.

One of the most important matters with regard to nerve injuries which experience of these cases in the late war soon made evident, was that not nearly all those in which there were marked signs of nerve lesion required operation to repair a partial or complete section. In the early days of the war, many cases with more or less complete paralysis and loss of sensation of the parts supplied by a nerve trunk, the anatomical position of which was in the immediate neighbourhood of the bullet track, were operated on, and the nerve found intact so far as the necessity of suture was concerned. In some of them signs of a bare graze by the bullet were found. A case implicating the great sciatic was of this latter kind; the bullet had passed through the soft parts of the upper third of the thigh; the symptoms were complete paralysis of the muscles on the front of the leg, with foot-drop, and loss of sensation over a considerable area of skin, and these were accompanied by extreme pain in the sole of the foot. On exploration the nerve had evidently been just grazed by the bullet, and at the site of this injury it had the appearance of being constricted by an invisible thread. The cicatrix of the graze was incised longitudinally, and the constriction almost disappeared; the pain ceased for some days and then returned. In this case, which happened quite early in the war, the operator and those with whom he consulted as to the treatment, considered that suture for complete section would probably be found necessary.

A case in point.

Exploration in many cases proved this.

In other cases, where the symptoms were similar, exploration showed no gross lesion of the nerve, and all injury except mere contusion appeared to be absent; and in others, again, it was clear that the bullet had passed at some considerable distance from the nerve trunk, and yet the communicated concussion, or contusion by the intervening soft parts, had caused symptoms to develop. No doubt the symptoms in these cases were not the classic ones of complete division—complete paralysis of all the muscles and loss of sensation over all the skin area supplied by the injured nerve; total loss of Faradic irritability within a week; wasting of the paralysed muscles; the presence of "the re-action of degeneration," and the usual trophic changes; but they were of a nature and severity to suggest the necessity of operation, and the expectation was that suture would probably be required.

Early operation only required in cases of complete or almost complete section.

But, as already mentioned, experience soon showed that, except in cases of complete, or almost complete, section, operation during the early stages of the course of these cases was useless, as the nerves themselves admitted of no reparative procedures, and required none.

Time which may elapse before recovery begins.

The time which must elapse before nerve function begins to return in these cases of incomplete injury is very variable; cases of slight concussion or contusion, or rather cases which, not having been explored, must be taken as such, sometimes showed signs of improvement within a few days or weeks; in others the lapse of a year or more did not preclude all hope that they might improve later. That this was so was proved by a case seen at Netley, where the man arrived nearly a year after injury with musculo-spiral paralysis as well marked as it had ever been, but with the loss of sensation much diminished. Improvement soon began under massage and the continuous current, and in three months he was discharged the Service with considerable power in the muscles of his forearm and sensation practically normal. This case had been explored in South Africa, and the nerve found apparently uninjured; nevertheless, more than 10 months elapsed before any improvement commenced, although massage and electricity had been employed before he arrived at home.

The outcome of this experience.

Indicated the position of operative treatment.

The frequent experience of cases with more or less complete loss of nerve function in the parts below the wound, in which amelioration or even complete disappearance of symptoms took place with time, as well as of others where exploration showed that no lesion amenable to repair by any surgical procedure existed, soon indicated the position which operative interference should occupy in the treatment of cases of injury to peripheral nerves; and made it evident that operations should only be performed in cases of complete or partial section, or where the nerve trunks were probably being compressed by cicatricial tissue or by callus, and where these conditions were strongly suspected of being present. In three of the cases noted which did not come under either of the above categories, suture was performed, one after the removal of a neuroma (No. 15); one after excision of a portion of the median so buried in scar tissue

that it could not be released (No. 30); and one after re-section of "sclerosed and thickened" portions of the median and ulnar nerves (No. 39). But these were exceptional cases; and, as a general rule, it may be taken as correct to say that only cases of the above kinds are at all likely to be put in a better position for recovery by operation.

Signs on which necessity of operation must be based.

In the diagnosis, then, of these cases and for the selection of those requiring operation, a knowledge of the signs of complete division, which have already been enumerated, is essential, and the behaviour of the muscles affords, in this connection, more reliable evidence than do observations on the sensory functions in the distribution area of the damaged nerve; for in many cases the anæsthetic area is not as complete, nor as definitely mapped out, as the occurrence of complete section would warrant one to expect.

Condition as regards sensation.

Condition of muscles the best evidence.

On the other hand, *all* the muscles previously supplied by a divided nerve are completely and immediately paralysed; their re-action to the Faradic current rapidly diminishes, and is completely lost within a week; they are at first flabby, then waste, and finally undergo atrophy and degeneration into mere fibrous tissue. An examination, therefore, into the patient's voluntary power over particular muscles supplied by the nerve is of use towards the recognition of complete section or otherwise; for instance, many cases of injury to the musculo-spiral high up were seen, in which all power of extending the wrist was lost, while the patients still retained power over the triceps—evidence that complete division had not taken place.

Impossible to distinguish between partial division and contusion.

It is impossible to distinguish between partial division of a nerve and mere contusion, judging from the symptoms without exploration; but it is probable that refreshing the edges of a notch, or partial division and bringing them together by suture, would be advisable in these cases, as was done by Mr. Watson in Case No. 7.

Other cases in which operation is required.

The other class of cases in which operation is required is comprised of those in which compression of the nerve trunks is being caused by contracting cicatricial tissue, or their functions are being interfered with by callus in fracture cases. In all of these cases, so far as we know, the nerves have probably sustained contusions or even more severe lesions at the time of the wound, and the symptoms dated from that time, for none are on record in which symptoms depending on such pressure developed secondarily and after the lapse of time. The symptoms in these cases are those of incomplete lesion, and operation is indicated when it is suspected that they are being kept up by pressure. The condition of all others likely to give rise to the formation of such cicatricial tissue is the occurrence of suppuration during the healing of the wound. The cicatrix of the track of the bullet in a case which heals aseptically is a mere string of no great thickness, which is unlikely to produce pressure; but when suppuration takes place it may be very extensive, and is practically certain to compress nerve trunks in its immediate neighbourhood.

For compression by cicatrix.

Effect of suppuration in production of cicatricial tissue.

Existence of other conditions in nerve cases.

The excessive pain, hyperæsthesia, and the mental depression so graphically described by Weir Mitchell as frequently being the results of gunshot injuries to nerves, were not seen to any extent in South Africa; but in some of the cases seen later in hospitals at home, pain, sometimes of a severe character, was a distressing symptom. In only one of the latter (No. 14), so far as records go, were the above symptoms seen in anything like the degree mentioned by Weir Mitchell, and in this case they completely disappeared after 18 months, as the functions of the nerves were slowly regained.

Trophic changes.

Signs of the usual trophic changes in the skin were seen in a considerable number of cases in South Africa, and in quite 75 per cent. of cases which still showed symptoms when seen at later periods in the hospitals at home; but the severity of and degree in which these were present varied greatly, some of the slighter cases showing them in a marked manner, while some cases in which the signs of nerve lesion were more pronounced had not developed them to so great an extent.

In the skin.

"Glossy skin," disappearance of hair and of wrinkles over the joints, and patchy bluish-red discoloration were common, and these were usually accompanied by clubbing and deformity of the nails. The formation of bullæ and ulcerations were only occasionally seen, and so far as positive evidence has been obtained, there was no association between glossy skin and the severe pain spoken of by Weir Mitchell. There are no records of a rise in temperature in the affected parts soon after the injury,

but in all the cases seen later at Netley the surface temperature was less than that of the opposite limb. Speaking generally as regards trophic changes in the nerve cases seen in the Boer War, it is certain that they occurred in cases in which the injuries were of the less severe kinds as well as in those of complete division. Swelling and subsequent ankylosis of joints were not common as trophic changes directly due to injuries to nerve trunks, but stiffness or ankylosis often occurred as the result of want of use or of long fixation by splints, as well as of contraction of the unopposed muscles of a limb.

In joints.

With regard to the effects of nerve lesions on joints, it was observed at Netley, in cases seen at a late period, and in which little or no return of function had taken place, that in cases with wrist-drop from injury to the musculo-spiral, and of foot-drop from injury to the external popliteal, the wrist and ankle joints behaved differently as regards their mobility; that while the wrist joint remained flaccid and capable of complete passive extension, the foot became firmly fixed in a position of extreme extension, the dorsum of the foot and the leg being in a straight line from contraction of the opposing calf muscles. Under these circumstances the limb was quite useless, because the foot could not be placed flat on the ground until the Achilles tendon was divided subcutaneously, and the foot fixed at right angles to the leg by means of a plaster apparatus. Many of these minor operations were done at Netley, and always with the desired effect of enabling the men to get about without difficulty.

Wrist-drop and foot-drop.

Division of the Tendo Achillis.

Operations on Nerves and Treatment Generally.

The general indications for operative interference in the later periods in nerve cases have been mentioned already, but, besides these, nerve trunks, especially superficially-placed ones, which, during the primary dressing of the wounds, are seen to be divided, should be immediately sutured. Otherwise, no operations either for suture of nerves, to free them from cicatricial tissue or callus, or mere explorations should be undertaken until lapse of time has proved their necessity, and until an aseptic condition in the operation wound can be guaranteed. When nerves are operated on while the wounds are septic, or when the operation wounds become septic, cicatricial tissue and neuritis develop which delay or prevent the return of their functions, and necessitate further operative procedures later on.

Nerves found divided at primary examinations.

Not to be operated on until asepsis is certain.

When suture of a divided nerve is performed as a primary operation any shredded portion remaining at the ends should be removed with a sharp pair of scissors, so as to enable them to be accurately approximated. In cases of secondary suture the upper end of the distal segment should be refreshed, and so much of the bulb on the lower end of the proximal segment removed as will expose normal nerve fibres, that is usually at least three-quarters of it.

Suture of nerves.

The materials most suitable for use in suturing divided nerves are chromic gut and small round needles. Two sets of sutures are usually employed, one passed through the whole substance of the nerve about $\frac{1}{4}$ inch from the ends and at right angles to its length, and the other through the sheath only. One suture of the former kind is sufficient for small nerves, but two, at right angles to each other, may be used for the larger trunks; they should be tied only sufficiently tight to bring the ends in contact. The edges of the sheath should then be brought together by means of the second set of stitches, as many being employed as may be found necessary for the purpose. Previous to suturing a divided nerve, it should be stretched, as the segments usually retract from each other, and it is advisable that the tension on the sutures be as light as possible.

The materials used in suturing.

When, on exploration, a nerve is found to have been notched or partially divided, the edges of the notch should be refreshed and united by suture; but it is inadvisable to excise the uninjured portion merely for the purpose of making the cut ends even and parallel.

Notched nerves.

In a certain number of cases it is found that the destruction of the nerve substance is so great that continuity cannot be restored even after forcible stretching. Under these circumstances various devices have been resorted to—(1) Nerve grafting, the graft being obtained from a dog or a rabbit; (2) approximating the ends as much as possible by means of chromic gut

When the ends cannot be brought together.

sutures, and covering these with decalcified-bone cylinders; (3) splitting the upper end and turning down a piece of sufficient length to enable union to be made; (4) implanting the ends of the divided nerve into the side of an adjacent nerve—the ulnar into the median, for instance; and (5) resection of sufficient of the bone of the limb to enable the ends of the nerve to come together.

The results not very satisfactory.

The success achieved by any of these methods has not been very encouraging, but they are the only means available, and should be tried. The two most hopeful of them are grafting, and the interposition of strands of catgut between the ends, and both act in the same way, merely as a foundation for the growth of new axis cylinders and blood-vessels, the materials themselves becoming absorbed. None of these procedures, so far as the records show, were carried out in South Africa.

The results of suturing.

Suturing of nerves is known to have been performed during the Boer War in eight cases for partial or complete division, or after excision of injured portions, and the results were as follows:—

——	Recovered.	Improved.	Not improved.	Unknown.
Cases (8)	0	5	2	1
Ratios per cent.	0	62·5	25·0	12·5

Operations for the release of injured nerves from implication in cicatricial tissue or callus were performed in the Boer War in 18 cases, according to the appended notes, and the results of these procedures were as follow:—

——	Recovered.	Improved.	Not improved.	Unknown.
Cases (19)	3	9	2	5
Ratios per cent.	15·8	47·3	10·5	26·3

The site of the incision.

The incision for exploration of an injured nerve should be through the cicatrix and in the line of the known anatomical position of the nerve trunk. The ends of a divided nerve should be freed from cicatrix, stretched and sutured; nerves not divided, but found embedded in cicatricial tissue or callus, should be dissected free of these materials, stretched and replaced. If the operation wound runs an aseptic course, improvement in the symptoms is likely to occur, but, if not, it naturally happens that scar tissue is only increased in amount, and no good effects are produced. After these operations the limb should be put up in a fixation apparatus in the position which affords the greatest relaxation of the nerve trunk which has been interfered with.

The evil results of suppuration.

The results obtained by suture.

The degree of success which has hitherto followed the operations of primary and secondary suture of nerve trunks has been fairly good. Mr. Bowlby ("Injuries and Diseases of Nerves," 1889) gives figures which show that of 81 cases of primary suture 39·5 per cent. were "successful," 27·1 per cent. partially so, and only 17·3 per cent. of failures (in some of these 81 cases the result was not ascertained); while of 73 cases of secondary suture 43·8 per cent. were successful, 35·6 per cent. partially so, and 20·5 per cent. failed. But most of the cases referred to by him were clean-cut sections of nerves by glass, or sharp instruments, and not cases of the more extensive injuries likely to be produced in gunshot wounds. The success to be expected in the present day in similar cases should be far greater than when Mr. Bowlby wrote, in consequence of the greater probability of avoiding suppuration now than in former times, suppuration being then the great cause of failure.

The time for operation.

Operations on nerves, either for suture or to free them from pressure, should be performed only when it becomes evident that interference is necessary and when an aseptic condition of the wound can be guaranteed; in the

majority of cases the latter condition will not be present until the wound has been soundly healed for some time. Deeply-placed nerve trunks, which there is reason to believe have sustained even severe gross lesion, should not be interfered with at the primary dressings of the cases; secondary operations after the wounds have healed are more likely to be successful because they are more likely to remain aseptic, and therefore six weeks or two months should be allowed to elapse before operations are undertaken. Moreover, time may show that operations may be postponed in some cases, and in others that they may be omitted altogether.

Period required for return of function.

It is impossible to foretell with any accuracy the time beyond which hope cannot be entertained of more or less recovery of the functions of injured nerves, whether they have been operated on or not. In some the numbness, pain, paralysis, and anæsthesia diminish rapidly, and may have quite disappeared under a week, cases probably of slight concussion or contusion; in others the time required for any sign of improvement in motor power to present itself may be months, or a year, or even more. Mr. Bowlby (*loc. cit.*, page 160) would not give up hope for "two or three years, and not then if any improvement had taken place"; but the longest time noted in South Africa was a little over 10 months.

Sensation returns first.

Diminution of the anæsthetic area is the first good sign to show itself, but motor power does not always improve when sensation does, nor to the same extent even when it begins. Hyperæsthesia and pain appearing with an increase of the sensation area are also promising signs. Some reaction to the Faradic current remaining in some of the muscles is a sign of great value, as indicating the absence of complete section, but neither current can be used in forming a prognosis as to return of function, because motor power returns long before reaction to electricity becomes apparent.

General treatment of nerve cases.

In the general treatment of gunshot injuries of peripheral nerves the limb should be kept warm and dry by being wrapped in cotton wool; splints should be applied to keep it at rest, and to prevent the effect of contraction of the unopposed muscles in producing extreme flexion or extension of joints and ankylosis in bad position, but special care must be taken to avoid constriction by bandages, in consequence of the greater tendency of the skin to break down in these cases. Asepsis in the wound is of the utmost importance, as in its absence secondary implication of the nerves in scar tissue is certain to occur and necessitate operative interference later on.

Massage and electricity.

From the first, or as soon as they can be borne in cases accompanied by severe pain, passive movement of joints, massage and the use of the continuous current at a low tension should be persistently employed.

Burns and scalds.

A word of warning as to the care of these cases is suggested by our experience in the Boer War. The parts being anæsthetic, especially the feet and hands, are liable to extensive injury by being exposed to too great heat, the patients not observing what is happening in consequence of the absence of pain. In some of the cases slight burns or scalds took place in this way, and in one of burn of the foot the damage was so great as to necessitate amputation below the knee.

Tables 46, 47, 48, and 49 give some of the details of the cases of nerve injury noted in South Africa.

TABLE 46.—Showing the comparative frequency of Injuries of the various Nerve Trunks. (62 nerve injuries in 58 men.)

Nerve Injured.	Number of Injuries.	Rates per cent.
Musculo-spiral	16	25·8
Ulnar	12	19·3
Median	9	14·5
Sciatic	7	11·2
Brachial Plexus	7	11·2
External Popliteal	4	6·4
Internal Popliteal	1	1·6
Popliteal	1	1·6
Musculo-cutaneous of arm ..	1	1·6
Cervical Plexus	1	1·6
Anterior Crural	1	1·6
Short Saphenous	1	1·6
Radial	1	1·6
In 58 cases..	62	—

Note.—The higher comparative frequency of injury to the musculo-spiral is, no doubt, due to its close relation to the bone and its consequent liability to implication in fracture cases.

TABLE 47.—Showing Certain Details for each kind of Injury. (58 Cases.)

Nature of Lesion.	Perforation.	Division.		Direct lesion, its nature uncertain in some cases.	Cases not explored.	Total.	Percentages.
		Partial.	Complete.				
Number of cases..	6	3	4	28	17	58	—
Aseptic	4	3	3	23	10	43	74·1
Septic	2	0	1	5	7	15	25·8
Explored	6	3	4	28	0	41	70·6
Recovered ..	2	—	—	6	8	16	27·5
Improved	4	2	2	12	1	21	36·2
Not improved ..	—	—	1	5	6	12	20·7
Result unknown ..	—	1	1	5	2	9	15·5

Table 48.

Showing Results of Explorations of Nerves and the Procedures carried out. (41 Cases.)

Number of Cases.	Injuries Found.	Operative Procedures carried out.			Results.				Results per cent.			
		Merely explored.	Sutured.	Freed from cicatrix and callus.	Recovered.	Improved.	Not improved.	Unknown.	Recovered.	Improved.	Not improved.	Unknown.
6	Perforations	3	—	3	2	4	—	—	33·3	66·6	—	—
3	Partial Division	—	1	2	—	2	—	1	—	66·6	—	33·3
4	Complete Division	—	4	—	—	2	1	1	—	50·0	25·0	25·0
28	Direct lesion, its nature uncertain in some cases	12	3	13	6	11	6	5	21·4	39·3	21·4	17·8
Totals. 41	.. ..	15	8	18	8	19	7	7	—	—	—	—
Totals. Per-centages	.. ..	36·5	19·5	43·9	—	—	—	—	19·5	46·3	17·1	17·1

The Condition in Nerve Cases after Considerable Lapse of Time.

"End results" in nerve cases.

It has been found extremely difficult to ascertain the "end results" in these cases, and in the vast majority of them no information could be obtained. In some of the cases already noted the condition when last seen is given, and Table 49 gives the results of others as far as they are available.

The symptoms originally those of severe direct lesion.

In all the cases in this table the original symptoms were those due to injuries to the nerves specified, and they were present in such marked degrees as to suggest complete section or, at least, severe direct lesion by the bullets or by fragments of bone.

In 5 out of 22, complete recovery took place; in the remainder the symptoms which still continued will probably be permanent; some of the patients were in a very helpless condition at the time of last report.

TABLE 49.—Showing Condition 1 to 4 years after Receipt of Wound.

Number of case.	Date of wound.	Nerve injured.	Wound healed by	Date of last report.	Condition as regards motion and sensation.
1	11.7.00	Sciatic	(?)	11.8.04	No sensation outer side of leg, or in sole of foot; no motion below hip joint; knee ankylosed in straight position, foot extended and fixed, muscles atrophied. Very helpless.
2	19 12.01	Brachial plexus.	1st intention	—.8.04	Motion and sensation much impaired.
3	28.10.99	Musculo-spiral, ulnar, and median.	Granulation	6.7.04	No motion and but little sensation in distribution area. Operated on in London Hospital, "musculo-spiral freed from callus, and ulnar sutured"; drop-wrist and paralysis of flexors of fingers.
4	8.1.01	Musculo-cutaneous of leg.	Granulation	16.7.04	No sensation outer side of leg below knee; "no motion in foot or ankle."
5	6.3.01	Musculo-spiral.	Granulation	—.7.04	Partial sensation on back and front of forearm; no power of extension over wrist joint; hand powerless as to grip.
6	10.12.00	Sciatic	1st intention	—.7.04	Partial return of sensation; foot-drop, movement of ankle limited; pain in front of leg.
7	26.10.00	Musculo-spiral.	Granulation	—.7.04	Some hyperæsthesia; motion practically normal.
8	24.7.00	Brachial plexus.	1st intention	20.7.04	"Some improvement took place."
9	28.3.00	Sciatic	1st intention	16.7.04	Hyperæsthesia of front and outer surfaces of leg; feeling of "pins and needles"; very tender to touch; sole painful; no power over movements of foot.
10	21.2.00	Sciatic	Granulation	9.7.04	Complete recovery.
11	18.2.00	Sciatic	Granulation	14.8.04	No improvement took place. Attempt made in London Hospital to suture the nerve failed; bones of foot became diseased, and amputation was performed.
12	23.2.00	Ulnar	Granulation	13.7.04	Complete recovery.

TABLE 49—*continued.*

Number of case.	Date of wound.	Nerve injured.	Wound healed by	Date of last report.	Condition as regards motion and sensation.
13	20.1.00	External popliteal and small sciatic.	1st intention	16.7.04	Loss of sensation from buttock to calf and outer side of leg; "loss of power in hamstring and calf muscles, and complete paralysis of flexors and extensors of toes."
14	22.2.00	Musculo-spiral.	Granulation	12.7.04	Sensation practically normal; weakness of extensors of wrist joint; paralysis of muscles supplied by posterior interosseous.
15	10.3.00	Sciatic	1st intention	15.6.04	Complete recovery.
16	19.2.00	Musculo-spiral.	Granulation	18.6.04	No improvement in sensation or motion.
17	30.10.01	Sciatic	Granulation	21.7.04	Considerable improvement took place, but foot extensors continued weak.
18	15.1.00	Musculo-spiral.	1st intention	1.1.04	Complete recovery.
19	24.1.00	Median	1st intention	19.1.04	Some paralysis still remains; muscles wasted; cannot clench fist strongly; joints not stiff.
20	24.1.00	Median	1st intention	19.4.04	Complete recovery; "motion and sensation normal; still serving."
21	19.6.01	Sciatic	(?)	25.2.02	"Wasting and paresis of leg muscles."
22	4.8.01	Sciatic	(?)	4.4.02	Extensors of foot wasted and weak; trophic sores appear and heal up. Weak re-action to Faradic current. General improvement still continuing.

SECTION XI.

By the Editor.

THE FIRST FIELD DRESSING.

Used in all civilised armies.

THE good effects to be expected from the use of a first field dressing for wounds received in battle are now so universally acknowledged that nothing need be said in this regard. First field dressings form part of the war equipment of the officers and men of all civilised armies, and without the employment of an application of this kind the advantages of modern surgical methods of treatment would be practically abandoned for men wounded in battle.

Results of their use.

Ideal results have not yet been obtained—perhaps, indeed, they never can be expected; but in South Africa the effects of the use of field dressings were extremely good, in that the vast majority of cases reached the field hospitals in an aseptic condition, and that so far as can at present be estimated, about 80 per cent. of them continued so.

The causes of infection.

Most of the 20 per cent. of cases which became septic at a later period did so in consequence of the necessary transport of wounded towards the rear and to the stationary and base hospitals, whether by wagon or well-equipped hospital trains.

Enforced transport towards the rear.

The experience of the Boer War demonstrated the fact that wounds became septic as the direct result of enforced transport, which loosened bandages no matter how well and firmly applied, and permitted dust and dirt to contaminate the wounds, with the usual result.

Difficulty of obtaining water for lotions at the front.

Another, and a very important, cause of the infection of wounds was on many occasions the impossibility of obtaining at the front water of a quality suitable for the preparation of antiseptic solutions, without an ample supply of which aseptic or antiseptic surgery is, of course, out of the question. The water on which the field hospitals and bearer companies' dressing stations had to depend for this purpose was often muddy and incapable of filtration through a Berkefeld filter, and it could not be boiled for want of fuel. Naturally, under these circumstances, wounds became infected during the necessary dressings; but the field dressings effected their purpose sufficiently well, and had it not been for these two very unfavourable conditions, the percentage of septic cases would have been much less than it was.

The dressing used in the Boer War.

The first field dressing used in the Boer War during the greater part of the time was according to the specification of 1891. It contained two pads to form the dressings actually in contact with the wounds.

1. A pad of gauze.
2. A pad of compressed flax charpie between layers of gauze.
3. A loose-wove bandage, 4½ yards long.
4. A piece of waterproof jaconet to be applied outside the dressings, and
5. Two safety pins.

All the dressing materials in this packet were impregnated with a solution of 1 in 1,000 of corrosive sublimate.

The dressing of 1900.

This was the first dressing supplied to the Army on its departure for South Africa, but towards the end of the campaign a first field dressing according to the specification of 1900 was substituted for it. In this the materials were the same, except that absorbent wool replaced the flax charpie, and the antiseptic was 2 per cent. by weight of salalembroth instead of mercuric chloride.

The objection to the use of waterproof jaconet.

The fault of both of these dressings was the use of a waterproof material to cover the gauze and charpie or wool applications to the wounds, and a little experience soon brought it to notice. Everything which tends to prevent evaporation and the formation of a dry crust of blood in the dressing immediately in contact with the wound, tends to promote suppuration and the

growth and multiplication of the micro-organisms with which the skin is always infected, and which cannot be removed before the first field dressing is applied on the battlefield. This could only be achieved by the careful sterilisation of the skin by the means used in an operating theatre, which naturally are unattainable at the first line of assistance in the field, and those microbes which are present on the skin must be left there and covered with the dressing. But there should be no collecting together of a further supply of infective matter from the outlying skin, beyond the area of the pads, by wiping away the blood in attempts at so-called cleansing of the skin; the dressings should be merely laid on the apertures and fastened there. Luckily the infective matter which remains beneath the dressings is not in such quantity nor of such virulence as to be able to propagate its species in the absence of moisture and under the restraining influence of the chemical germicide with which the materials are saturated, and so suppuration does not occur.

Skin germs cannot be removed.

Germs do not increase beneath the dressing.

But when the waterproof was used moisture was favoured; the blood and gauze or wool could not dry into a hard crust, beneath which healing would proceed safely, and the part covered by the dressing became a veritable "hot box" for the cultivation and increase of micro-organisms, producing, in a considerable number of instances, infection of the wound. As evidence of the certain danger of covering the dressings with waterproof material, it may be mentioned that it was a common experience, on removing the dressing of this kind, to find the wound and the skin around it covered with a thin layer of mud, a mixture of dust and sweat, especially when the men had been moved by train or wagon for any considerable distance. The use of the jaconet in South Africa was, therefore, soon discontinued, with a very appreciable improvement in the wounds as regards an aseptic condition, and it was omitted altogether (except as covering for the packet) in the field dressing according to the specification of 1904, which otherwise remained the same as that of 1900.

Effect of a waterproof covering.

Jaconet discarded.

Omitted from dressing of 1904.

The following is the specification of the dressing of 1904 :—

First Field Dressing.

(Pattern No. 3629, G/1904.)

Contents and materials.

1. Outer cover, sewn cloth.

Two safety pins, wrapped in waxed paper.

Inside cover of waterproof jaconet, the edges to be cemented with rubber solution, so as to render the packet air-tight, having a portion of one of the corners turned back and not cemented.

2. Gauze bandage, $2\frac{1}{2}$ inches by $4\frac{1}{4}$ yards, folded flat into $2\frac{1}{2}$ inches by 4 inches.

3. Piece of gauze 17 inches by 13 inches, weight not less than 72 grains, folded to suit the size of the package.

4. Compressed absorbent cotton wool, between layers of gauze (like Gamgee tissue).

Weight of absorbent cotton wool to be not less than 100 grains and not more than 110 grains.

5. The gauze bandage, the piece of gauze, the compressed absorbent cotton wool, and the layers of gauze to contain 2 per cent. by weight of Salalembroth, and to be tinted with aniline blue.

A new and improved first field dressing.

The first dressing of Pattern 3629, G/1904, was an improvement on the previous ones in that the waterproof covering for the gauze and wool pads was discarded from it. But, inasmuch as it is now evident that the consensus of opinion amongst surgeons is that, if an antiseptic dressing is applied to a wound, the best materials to employ are the double cyanide preparations, a new dressing was suggested in September, 1904, according to the following specification :—

Suggested First Field Dressing, September, 1904.

Contents :—

Outer cover, sewn cloth.

Two safety pins wrapped in waxed paper.

Inside cover of waterproof jaconet, the edges to be cemented with rubber solution, so as to render the packet air-tight, having a portion of one of the corners turned back and not cemented.

Loose-wove bandage, 2½ inches by 4¼ yards, folded flat into 2½ inches by 4 inches.

Piece of gauze, 17 inches by 13 inches, weight not less than 72 grains, folded to suit the size of the package.

Compressed absorbent cotton wool, between layers of gauze (like Gamgee tissue). Weight of the wool to be not less than 100 grains and not more than 110 grains.

The piece of gauze, the compressed absorbent cotton wool, and the layers of gauze to contain 3 per cent., by weight, of double cyanide of mercury and zinc, and to be tinted with carbolic solution of rosaniline.

Printed directions for use are to be upon the outside cover, and a printed label of directions for use is to be placed upon the inside cover.

The use of antiseptic powder or paste.

In discussing the question of the contents of the above packet, that of further safeguarding its efficiency by adding to it a quantity of antiseptic powder or paste was considered, but, for various reasons which might not be overlooked, was decided in the negative. As a substitute for powder in the dressing, a suggestion, which will probably be sanctioned, has been made to supply dredging-boxes containing boric powder to the bearer companies' haversacks, so that this antiseptic may be dusted on the skin and wound or on the first dressing itself before applying it.

Doubling the quantity of gauze.

To bring it as near perfection as a first-aid dressing can be, there should be two pieces of gauze of the weight and dimensions given above, instead of only one. There would thus be two similar dressings for typical small-bore entrance and exit wounds, viz., a piece of gauze and half the wool for each, and all the materials could be used as one application for extensive injuries, such as those due to shell fragments. This latter form of first field dressing is now practically sanctioned.

The experience of the late war demonstrated the importance of having a reliable first field dressing—the advantages of modern surgery are lost to the wounded in its absence. Nussbaum's well-known saying that "the fate of the soldier wounded in battle is in the hands of him who applies the first dressing," includes a statement that it equally depends on the efficacy of the dressing which is first applied.

SECTION XII.

By the Editor.

BULLETS AND OTHER MISSILES LODGED IN THE TISSUES.

Percentage of lodged bullets not known.

It is at present impossible to suggest what percentage of small-bore bullets lodged in the tissues of men wounded during the war. The ordinary service bullet hardly ever remains lodged at ranges under 1,700 yards, if it is not broken up against hard bone, as sometimes happens; but when it deforms, or especially when it is fragmented, pieces of it may remain even when fired at comparatively short ranges. The missiles most frequently found lodged are fragments of common shell, shrapnel bullets, fuse-plugs of either pattern of shell, fragments of deformable rifle-bullets, ricochet bullets, and ordinary small-bore bullets fired at long ranges, and probably the order of frequency of their lodgment is as given here, considering the number of cases wounded by each.

Service bullets only lodge at long ranges.

Missiles most frequently found lodged.

Ordinary service bullets frequently broke up or deformed.

Deformations they underwent.

The unaltered service Mauser frequently broke up or deformed against a hard diaphysis and lodged, mere fragmentation of a bullet being, therefore, very inconclusive evidence of the use of deformable missiles. Apart from actual breaking up of the service Mauser, the usual deformation it undergoes is flattening at the point or bending at the shoulder; many skiagrams to be seen at the end of the various sections of this Report show these changes in shape.

No explosive small bullets used.

No properly so-called explosive small-arm bullets were, so far as I can ascertain, used by the Boers, though both surgeons and patients frequently applied the term "explosive" to bullets which had produced severe injuries, especially at the exit side; but the ordinary service small-bore bullet is quite capable, when it meets with resistant bone, of producing injuries of such extent and severity as to have the appearance of being due to small-arm shells, though wrongly so.

Many patterns of soft bullets used.

The Boers used many kinds of soft-nosed and otherwise easily deformable bullets, but none containing a bursting charge. A bullet found in the Boer trenches having a copper cap or tube in the point was given me by Lieut.-Colonel Woodhouse, R.A.M.C., but there was no explosive material in the cap; it was a sporting-rifle bullet, and much larger than a Mauser, the copper cap being effective merely towards easy deformation.

Extraction of bullets.

The removal by operation of lodged bullets and other missiles is a subject which requires a few remarks. Soldiers are, in my experience, usually peculiarly desirous of having lodged bullets extracted, and repeatedly suggest that this should be done. It is probable that during the Boer War this operation was performed sometimes in accordance with requests of this kind rather than in consequence of any surgical indication pointing to its necessity.

Bullets seen in the wound or found under the skin.

It goes without saying that bullets which are discovered in wounds during the primary dressing of the cases, or which are found lodged close under the skin at the offside should be removed then and there; but, otherwise, there need be no hurry in their extraction, nor should search be made immediately to ascertain their precise positions. This may be looked upon as the correct procedure for two reasons:—(1) That a bullet may be lodged in structures on the functions of which it may produce no effect, it may become encysted and cause no symptoms, in which case it need never be removed; or (2) it can, if necessary, be more satisfactorily dealt with at a stationary or general hospital later on when the signs of the disability due to its presence become apparent.

Reasons against immediate search and removal.

Bullets causing no symptoms at first may require removal later, and why.

Although the wound leading to a bullet may heal during the treatment of a case, and although during that time it may cause no pain or inconvenience, it does not necessarily follow that it will not require removal at a later period. A bullet lodged in muscles which come into active movement when the patient

Lodged in muscles or joints;

Or in contact with nerve trunks;

In the chest;

Or within the cranium.

Only surgical conditions necessitate extractions.

begins to get about, or one partly or wholly within a joint, may produce no symptoms while the patient lies in bed, but may cause a re-opening of the wound and pain and limitation of movement when he again begins to use the parts in which it is situated, and under these circumstances the indications for its removal are quite clear; in a case, too, where a bullet is found to be in contact with or in the immediate neighbourhood of a large nerve trunk, and when symptoms of injury to the nerve persist, it should be removed. Bullets in the pleural cavity usually set up irritation, and these cases are peculiarly liable to develop into empyemata; in these cases also they must be extracted, and when lodged within the cranium, in accessible places and close to the surface, it may also be advisable to undertake operations for their removal. In fact, it may be said in general terms, that it is only when the surgical conditions due to their presence, or almost certain to supervene if they are not interfered with, clearly point to the necessity of extractions that operations should be performed in these cases.

Exploring instruments useless.

X-rays the means to employ for detection of bullets.

Cross-thread localiser and stereoscopic skiagraphs.

All exploring instruments, electrical and other, for the detection of lodged missiles may nowadays be set aside as out of date, and dependence placed entirely on the use of X-rays for this purpose. By their means, using Mackenzie Davidson's cross-thread localiser, the exact position of any foreign body within the tissues can be ascertained to a millimétre, or stereoscopic photographs may be taken which will afford means of a sufficiently exact estimation of the position of an object as large as a bullet to warrant the surgeon in operating for its removal without more accurate localisation. When using this method, small pieces of wire should be fastened on the skin above and below the bullet, so that its relative position to known points on the skin may be shown in the stereoscope, and thus a clear indication obtained for the operative procedure to be carried out. Before proceeding to localise the bullet, or to skiagraph it stereoscopically, its general position should be ascertained by means of the fluorescent screen, or by a single skiagraph, so that the part of the limb or body in which it is situated may be placed in the proper position over the photographic plate while these methods are being carried out.

The operation for extraction.

The incision for the removal of a bullet or other foreign body should be so placed that it may be reached by the shortest route, or where the structures to be dissected through are of the least anatomical importance, and it should be sufficiently free to enable the dissection to be made with ease. When lodged in loose tissues, such as the back of the thigh, &c., these and the bullet should be pressed towards the incision and firmly held there by the hands of an assistant, as otherwise the point of the exploring finger may be quite close to the bullet and yet receive no sensation of its presence. The important matter is that the localisation should have been carried out accurately, and that the surgeon should hold strictly to the line given by it. When bullets are lodged in bone, it frequently happens that some of the latter must be removed with a gouge and hammer before they can be freed; but usually the finger and a spoon-shaped instrument, or a suitable forceps, are the only means required. In extracting deformed or broken bullets care should be taken to disentangle them from the soft parts, which are certain to become engaged in the jagged portions of the metal, and that too much force is not employed in their removal.

For many skiagraphs of lodged missiles reference may be made to the illustrations at the end of the various sections of this Report, the two most curious instances being one where the bullet lodged in the bladder without producing any symptoms except retention of urine, and was eventually extracted from the meatus; and another which entered above the patella while the knee joint was flexed to a right angle, passed through the head of the tibia and into its medullary canal, finally lodging just above the ankle joint. The tibia was fractured at its narrowest part, but the bullet caused no trouble, and was not removed (Fig. 63).

SECTION XIII.

By the Editor.

THE EMPLOYMENT OF X-RAYS IN SOUTH AFRICA.

A CONSIDERABLE amount of valuable skiagraphic work was done during the war, evidence of which is now stored at the War Office in the form of a very large number of excellent negatives and prints of the cases submitted to this method of investigation. About 600 of these have been selected as showing, probably, specimens of all kinds of bone injury due to the modern rifle bullet, which it is hoped may be published as an atlas, the value of which to military surgeons can hardly be over-estimated.

Much X-ray work done in South Africa.

Material sent home.

When preparations for the war were being made and the hospital personnel was being allotted, care was taken to appoint to each general and stationary hospital one officer who had at least a sufficient elementary knowledge of the work to be able to take a skiagraph, and it was intended that he should devote all his time to X-ray work. But, in consequence of the unexpectedly large numbers of sick and wounded who had to be attended to, it soon became apparent that this plan must be abandoned, and special experts in skiagraphy obtained from home. This was done, and the following gentlemen were sent out:—Messrs. G. Catling, L. Sells, G. Paxton, and T. E. Eachus. But while it was found, as stated above, that it was impossible to permit officers of the Medical Service to devote their time especially to skiagraphy, to the neglect of their medical and surgical duties, many of them availed themselves of every opportunity of practising it, and much of the work was done by them. Amongst these were Brevet Lieut.-Colonel M. W. Russell; Majors W. B. Day, H. E. Hale, D.S.O., and H. C. Thurston, C.M.G.; Captains G. E. F. Stammers, H. C. Hime, J. J. W. Prescott, D.S.O., A. F. Carlyon, J. J. Lenahan, and A. E. Weld; Lieutenant and Quartermaster Bruce and Sergeant-Major Harwood, and others whose names cannot be ascertained, contributed their share to the large amount of skiagraphic material sent home at the close of the war.

Arrangements made at first for X-ray work.

Experts sent from England.

Work also done by officers R.A.M.C.

The X-ray equipment supplied to the hospitals in South Africa comprised 10-inch field service coils made by Mr. Apps or by Messrs. Cox and Co., having the ordinary spring-hammer interrupter; 6-cell Lithanode accumulators of 30 ampère-hours capacity; a fluorescent screen; Cox's "Record Tubes"; Mr. Mackenzie Davidson's couch and portable cross-thread localiser, and the necessary photographic material. This was found suitable in every particular. Mr. Mackenzie Davidson's motor mercury break was supplied in some instances late in the campaign, and worked to perfection; but even its inventor admits that it is hardly sufficiently portable for use on active service.

The apparatus supplied.

The re-charging of accumulators and the weight and absence of portability in the apparatus generally are the difficulties usually to be overcome in the employment of X-rays on a campaign; but continuous-current electric lighting installations were so common in South Africa, even small towns and all fixed hospitals being lighted by this means, re-charging accumulators was readily done. In the absence of a source of E.M.F. of this kind, an oil motor and a dynamo must be used for re-charging. Apparatus of this kind has been tried by the War Office; it has been found suitable, and can be adopted when occasion arises. It consists in a bicycle motor of 2½ H.P. and a dynamo wound to give a pressure of 15 volts with a resistance to govern the amperage. Both parts are fixed on a bed, from which they are detachable for carriage, and the apparatus weighs under 200 lbs., little enough for so useful a machine.

The difficulties to be overcome in X-ray work in the field.

Motor and dynamo for re-charging.

More portable accumulators.

In future 3-cell accumulators will be supplied instead of the 6-cell ones used in South Africa, as being more easily carried, and a reduction in the number of these required to work a 10-inch coil will be made possible by using Cox's new (1904) platinum interrupter instead of the spring-hammer break.

A new interrupter.

This new interrupter is a modification of Gaife's; it is excellent in work, giving a steady illumination of the tube, and the platinum points do not burn away rapidly, nor do they fuze together and endanger the insulation of the coil. But its great advantage from the army and transport points of view is

To work with fewer accumulators.

that it gives its best results with 12 volts from the accumulators, thus enabling the number of the latter to be greatly reduced as compared with what is necessary with any other form of interrupter.

X-ray apparatus only at fixed hospitals.

X-ray equipment was not supplied to movable field hospitals, but only to general and stationary hospitals, because patients being treated in the former do not require this method of investigation of their injuries, and because, if it were available, there could be but little opportunity of using it in places overcrowded with wounded men, and where surgical work must almost always be carried on at high pressure. The main objects of skiagraphy in gunshot cases are to ascertain the condition of fractured long bones, both before and after their permanent fixation by splints, and for the localisation of foreign bodies, whether they be detached fragments of bone, bullets, or other missiles lodged in the tissues previous to their removal, when this is considered necessary.

Reasons for this.

But the treatment of fractures in field hospitals is, for the most part, of only a temporary and provisional character, and does not necessitate the use of X-rays; and the extraction of foreign bodies can be done with infinitely greater safety at fixed hospitals, where patients arrive from movable hospitals within a day or two of the receipt of their wounds, and where localisations and operations can be carried out at comparative leisure.

The method of localisation used.

Mr. Mackenzie Davidson's method of localisation was the one employed in the Boer War, his couch and cross-thread localiser forming parts of the equipment; it is accurate to a millimètre, when the procedures included in it, which are quite simple and easily performed, are correctly and intelligently

Stereoscopic skiagraphy.

carried out. Stereoscopic skiagraphy was not much used, because it was not well known at the time; but now much experience has shown that the positions of such large substances as bullets and some fragments of bone are so closely indicated by means of it as to justify the surgeon in proceeding to remove them. A stereoscopic skiagraph shows the relation of the foreign body to other fixed points within the tissues, and when, in addition to this, other points are marked on the skin by means of pieces of wire, all the indications which are required for its extraction can be obtained.

Bullet detectors of all kinds, electrical and otherwise, may now be set aside as useless, and reliance exclusively placed on the use of X-rays to show the presence of missiles which have lodged.

This report is hardly the place in which to discuss the various methods of X-ray procedure in more precise terms, but it was necessary to refer to them in this short note in order to show that one of the great advances in surgery of modern times had not been neglected by the Army Medical Service during the Boer War.

SOME STATISTICS.

Table 50, 51, 52 and 53 show certain details regarding the casualties in killed and wounded during the Boer War, and are taken from the Appendices to the Minutes of Evidence given before the Royal Commission on the War in South Africa, pages 98 and 99, and from the War Office Return of Casualties up to and including May 31st, 1902.

TABLE 50.—Total Numbers sent to South Africa or Enlisted there for the purposes of the War.

Officers	17,559
N.C.O.'s and Men	430,876
Total	448,435

TABLE 51.—Casualties in Killed and Wounded.

——	Killed.	Wounded.	Total.	Ratio of Killed to Wounded.
Officers	518	1,851	2,369	1 to 3·5
N.C.O.'s and Men	5,256	20,978	26,234	1 to 3·9
Total	5,774	22,829	28,603	1 to 3·9

TABLE 52.—Casualties per cent. of Total Strength.

——	Killed.	Wounded.	Total.
Officers	2·9	10·5	13·4 ± 0·26
N.C.O.'s and Men	1·2	4·8	6·0 ± 0·03

The total casualties in killed and wounded per cent. of total strength = 6·3

TABLE 53.—Died of Wounds.

——	Wounded.	Died.	Death-Rate.
Officers	1,851	183	9·8 per cent.
N.C.O.'s and Men	20,978	1,835	8·8 „
Total	22,829	2,018	8·8 per cent.

APPENDIX.

By Archibald Young, M.B., C.M., B.Sc., Late Civil Surgeon South African Field Force.

INJURIES OF PERIPHERAL NERVES DIRECTLY OR INDIRECTLY CONNECTED WITH GUNSHOT WOUNDS.

In endeavouring to draw some general conclusions from this series of cases of gunshot wounds involving directly or indirectly the peripheral nerves, it is not intended to suggest that, in themselves, or as a whole, they exemplify all, or even the major part, of the pathological or clinical effects of such injuries.

Nor is it even suggested that, as regards the proper lines of surgical treatment, this series presents at all sufficient data to warrant the laying down of any definite or fixed principles which will be beyond the region of dispute.

In any of these directions the number of cases included is much too small to permit of any wide generalisation.

Embodying, however, as it does, a fairly representative, if rather limited, collection of nerve lesions due to gunshot wounds, which, in the course of a year's surgical work in South Africa, came directly under the care of the writer, it seems reasonable to suppose that the series may afford some material worthy of scrutiny, perhaps even of distinct value in itself, as well as fitted for inclusion in the more complete statistical and other records drawn from the whole compaign and the experience of many observers.

The cases included in this group not only came dierctly under the personal observation of the writer, but they were reported with a considerable degree of care. This being stated, it is necessary to add the three-fold qualification—(1) that in few of the cases did the patient come under the writer's care before the lapse of some days, or even weeks, from the date of reception of injury, so that the earliest period, following directly upon the injury, was seldom watched by the writer and reported from his own personal observation; for the earlier history, reliance had to be placed on the patient's own statement—not always a reliable or satisfactory one; (2) that, in one or two cases, even operative measures had actually been carried out before the patient came into the writer's charge in 3 General Hospital, so that a proper appreciation of the primary condition was rendered still more difficult (Randles, Case 13); (3) that there was available for the satisfactory or scientific investigation of muscles related to the nerves involved, no electrical apparatus such as, in civil practice, one would have most certainly employed. Alterations in Faradic or galvanic irritability of muscle were therefore not capable of demonstration, and the clinical pictures in a number of the cases are to that extent incomplete.

The series presented here includes 15 instances of nerve lesions ascribable directly or indirectly to gunshot wounds. The number does not at first seem very large for a year's work, especially in view of the fact that it is generally recognised that, with the modern small-calibre bullet, the proportion of injuries of the peripheral nerves has undergone very marked increase.

Still, it should be remembered that these 15 represent a percentage of 8·02 of all my recorded cases, *i.e.*, out of the 187 cases of gunshot injury of which I have records, 15 presented definite signs of peripheral nerve involvement. Many other gunshot wounds came through my hands, but, either because they were only under observation for a very limited period (perhaps only a single night) on their way down country, or because they were seen in a period of unusual stress or strain, they were not specially recorded by me. Doubtless they also contained their proportion of nerve lesions.

A percentage of 8·02 is quite a considerable one, and is a distinct advance on earlier records.

Of the 15 cases—

10 were caused by a Mauser bullet.
1 by a Lee-Metford.
1 by a Martini.
1 by a shrapnel; and
2 by fragments of cartridge casing (camp fire explosion).

Properly speaking, perhaps the last two ought to be omitted, as they were accidental occurrences not directly connected with hostilities. That would reduce the number of cases to 13, or a percentage of 7. It seems to me, however, that these camp fire explosions of cartridges, as they must in some degree continue to be inevitable, ought to be considered with the rest. Certainly, clinically, they presented many features occurring in the other forms.

To these 15 I would add still another one, viz., that of Barrett (Case 16), whose wound was not a gunshot one, but, as a matter of fact, was produced by a bayonet stab. The course of the case, the operative procedure, the after progress, and the late history (up to almost six months after operation) are so well known to me that the record is for that very reason all the more valuable. The clinical picture of the effects, motor, sensory, and "trophic" of severance of a peripheral (mixed) nerve was a strikingly complete and instructive one. The demonstration of the anatomical and pathological conditions found at operation was no less informative, and the order of functional recovery and the subsequent progress, as I was able to watch it from August, 1900, to January, 1901, are suggestive of not a few interesting points. I may say that Barrett was retained by me for several months, ending with 23rd January, 1901—when I embarked at Durban for home—as my private servant, and hence he was constantly under my observation during fully six months.

The whole series, then, includes 15 gunshot wound cases and one bayonet wound, associated with injury to peripheral nerves, 16 cases in all.

The remarks which follow have reference specially to the gunshot wound cases; that of Barrett—the bayonet wound—will only be referred to in illustration of particular clinical phenomena and special points in prognosis and treatment.

Effects or Influence of Range.

The range at which the bullets were received, and, therefore, their velocity and striking force, had an important bearing on the actual lesion produced.

As to the range, of course, the patient's statement had to be accepted, but a consideration of the size of entrance and exit wounds of the soft parts afforded a fair check.

Relation of range to extent of primary disturbance.

Taking the 10 cases of Mauser injuries for comparison, the range stated varied from 50 to 800 yards, and it may be said that, except in so far as affected by subsidiary factors, such as obliquity of direction, ricochet, accompanying damage to bone, &c., the degree of primary disturbance of nerve function varied inversely with the length of range.

Thus, in the case of simple contusion of nerve trunks, however severe, a short-range bullet was apt to produce much more extensive disturbance than a medium-range one, still greater ranges being successively less potent for harm.

In illustration, one might cite specially the cases of Lessey (Case 7) and McAllister (Case 5). In the former, the bullet, received at the short range of 50 yards, caused a sufficiently wide-spread disturbance of function to lead to a paresis (only temporary it is true) of the whole right upper extremity, while in the latter the range was much greater (800 yards), and the only nerve affected seemed to be the lower external cutaneous branch of the musculo-spiral, the closely associated upper cutaneous branch of the same trunk, and the contiguous branches of the musculo-cutaneous escaping altogether. In both of these the size of entrance and exit wounds was small, so that the vibratory force, the "explosive," far-reaching effect of the shorter-range

bullet was exerted much more decidedly on the deeper than on the more superficial tissues.

Where gross laceration, actual perforation, or division of nerve trunks occurred, of course, the short-range bullet led to much greater destruction of nerve tissue, much wider button-holing, and to the formation of a much greater gap in the continuity of the trunk affected, than one of medium range, whose travelling velocity and force of impact were still great, but whose flight had become more steady than earlier in its course. In this connection compare the cases of Marrey (Case 11) and Stoddern (Case 14). In the former, where the range was about 60 yards, the int. popliteal was widely button-holed and subsequently extensively fibrosed, while in the latter, where the range was at least 200 yards, the injury to the cord formed from the posterior branches of the fifth and sixth cervical nerves must have been strikingly localised. In the case of perforation or division, the resulting gap would be, to begin with at least, much greater in the short-range injury, the button-hole or actual severance being much more limited and clean-cut at medium range.

Relation of range to the later results.

The later results depended also in great measure on the amount of tissue laceration, so that the injury to nerves caused by a bullet at medium range would probably be followed by much less cicatricial change in and around the affected nerve trunks than would result from one received at short range.

Influence of suppuration.

But of greater significance than the range of the bullet in the production, or aggravation, of functional disturbance in the later stages, was the occurrence of suppuration, for if a wound healed without suppuration, secondary involvement of a nerve trunk in cicatricial tissue, or fibrosis of the trunk itself, was much less likely to take place, and certainly the extent of cicatricial compression was infinitely smaller.

It should be pointed out here that the strikingly localised nature of many of these nerve injuries is clearly related to the high velocity and small calibre of the modern projectile, and in these respects the Lee-Metford bullet differs but little from the Mauser. In the case of Wagstaff (Case 10) the wound was caused by shrapnel fired at a range of 3,600 yards, and not only was the humerus extensively shattered, but the musculo-spiral nerve was for a considerable distance greatly disorganised, and when exposed at operation (nine weeks later) was found widely and seriously fibrosed. This is in marked contrast to most of the examples of nerve damage by small-calibre projectiles, though the case of Marrey (Case 11) presented a little of the same character (but in much smaller degree).

Anatomical and Pathological Nature of the Nerve Lesion.

From what has already been said it will be understood that the anatomical nature of the nerve lesions varied within wide limits. The pathological effects were correspondingly varied.

The special forms which have been described by most observers are classified generally under the following heads :—Concussion, contusion, laceration—division (complete or incomplete)—and secondary implication, of nerve trunks.

In spite of the difficulty of adhering rigidly to any such classification or of assigning a given case to any one class, and of excluding it from all the others, it may be accepted as in the main affording a fair working system, with this reservation, that it is very doubtful whether, either pathologically or on strict anatomical grounds, it is possible to maintain that sub-division which has been placed first, viz., concussion.

It is by no means clear that any such condition as "concussion" of nerve trunks exists, or that it can, as a definite lesion, be demonstrated. Defined, as it usually is, as a disturbance of tissue, essentially "molecular" in its nature, it certainly is impossible of anatomical or histological proof, and, from the purely clinical standpoint, the symptoms—usually, though by no means constantly, of a transitory order—which are supposed to be characteristic of such a condition, are admittedly in close correspondence with the symptoms met with in many of those cases where, it is conceded, actual contusion of nerve tissue has occurred.

Concussion is stated by most writers to occur although the nerve is not actually struck by the bullet; in fact, it seems to be regarded as the essence of concussion that actual contact of the bullet with the nerve does not occur. Clearly, if actual contact does take place, and with force sufficient to give rise to any symptoms at all, the injury must then be regarded as a contusion. But even in a contusion of any part or organ the effects of the contusion are not limited to the point struck; they are much more diffuse than that. In an ordinary bruise the tissues for some distance around must necessarily be affected, show evidence of intra-cellular effusion of blood, serum, &c., and the swelling, œdema, and ecchymosis which these will entail.

Is it, then, too much to suppose that a nerve, or nerves, situated in the vicinity of a bullet track may be actually contused, or involved in contusion, even if themselves not directly impinged on by the projectile? According to the distance of such trunks from the bullet track, so also will the degree of the contusion vary.

To assume the existence of a special molecular disturbance to be termed concussion, seems unnecessary and unscientific. There may be, in slight cases, or in the case of nerves not actually contiguous to the line of the bullet track, no gross hæmorrhage into or around these trunks such as might be seen with the naked eye, but there may still be, probably are, distinct evidences—did they but admit of finer, microscopical, histological proof—such as intra-fibrillary effusion of serum, and increased tissue re-action in response to the external stimulus.

The special form of injury, however, in which concussion of nerves has been said to be most typically present is in fractures of the bones of the extremities.

In these, so it is said, the density, the resistance to impact presented by the firm bone, are such as to diffuse very widely the vibratory force of the bullet; but such being conceded, it seems unnecessary to separate even this variety from the class of contusions.

In such fractures the damage to soft tissues of all kinds, on or near the line of the bullet track, as well as in the vicinity of the fractured bone, is bound to be great, and the soft tissues far removed from the bone may be extensively contused; it is reasonable to suppose, therefore, that the nerves may be similarly involved.

The temporary loss of function which has been described as frequently occurring in cases of simple concussion of nerve trunks is often present where definite contusion can be demonstrated, or with absolute certainty assumed.

In this connection it is of interest to notice a statement made by Mr. G. H. Makins, F.R.C.S., in the volume published by him on his "Surgical Experiences in South Africa" (pages 364–7). Writing on this subject, Mr. Makins says: "Illustration of the occurrence of concussion was furnished by cases in which complete paralysis of a limb rapidly cleared up with the exception of that corresponding to a single individual nerve of the complex apparently originally implicated. Instances of severe contusion or division of one nerve of the arm, for instance, accompanied by transient signs of concussion of varying degrees of severity in all the others, were by no means uncommon."

Now, while accepting the clinical facts as to rapid clearing up of the symptoms referable to all but one trunk and the persistence of symptoms traceable to the latter, the correctness of the construction put upon these observations may be doubted. They might quite as well be explained by assuming the considerable, or gross, laceration of one trunk, with simple contusion of the remainder. One is quite familiar with the fact that the effects of contusion often clear up with remarkable rapidity.

Other cases, which seem almost like the actual converse of those quoted by Mr. Makins, must also be taken into consideration. Thus it was not uncommon of occurrence for a single nerve to be picked out from even a closely related "complex," the remaining trunks of the latter giving no evidence at all of implication, or, in other instances, for a number of trunks in close proximity to each other to be caught, while a single nerve trunk directly associated with them escaped altogether. Such occurrences are difficult to explain if "concussion" be the definite form of nerve injury which some observers have claimed. Why, in the former instance, all the

trunks but one of a closely-related "complex" should escape, and in the latter all but one show sign of damage, it is not easy to understand on the assumption of a mere "concussion." The indications are all in the direction of definite contusion or laceration of several, or isolated trunks, the others, though closely related, showing no evident signs of involvement; and if, in the one instance, such a contusion of a single trunk did occur, and in the other of several trunks, it might have been expected that the uncontused trunks or trunk respectively would be at least concussed—in virtue of their close proximity—and that they should have given at least transitory clinical evidence of this.

In illustration of this point my own records furnish several good examples.

Thus in the case of McAllister (Case 5), where the bullet track traversed an area containing quite a number of cutaneous nerves, and closely related to important motor nerves, a single cutaneous trunk, that of the lower external cutaneous branch of the musculo-spiral, was selected for damage, while the rest completely escaped. Now, the bullet track through the lower and external aspect of the arm was in the closest relation to not only the damaged trunk, as above, but also to the upper external cutaneous of musculo-spiral, near also to the musculo-cutaneous (trunk and branches), and to the main trunk of the musculo-spiral itself (*see* Fig. 3). These ought surely to have been concussed; yet they were not. In the case of Stoddern (Case 14) the bullet passed obliquely downwards and backwards in close relation to the upper cervical nerves, but especially to the lower cervical and the constituent trunks of the brachial plexus. And yet the damage inflicted was sufficiently focal or localised to pick out only the portion of the posterior cord formed from the fifth and sixth cervical nerves, the functional disturbance affecting only the muscular area of supply of the supra-scapular and circumflex nerves (*see* Anatomical Note, Case 14). And the injury was, to all appearances, a severe one, and most probably of the nature of severe laceration or division (partial or complete). In such a case one would certainly have expected a much more general or widespread involvement, considering the great number of special nerves and closely-connected trunks of the plexus all directly related to the affected cord (*see* Fig. 11). These ought to have been at least concussed. Yet there was no sign of disturbance of any of them.

Both McAllister and Stoddern, then, illustrate the picking out of a single nerve trunk or cord from the midst of a closely-related "complex," and the absence of any signs of concussion of the remaining cords of that "complex."

In illustration of the other type, viz., involvement of all the constituents save one trunk of a nerve "complex," the case of Clarke (Case 6) may be cited.

In this the bullet track was through much the same region as in the case of McAllister. Not only, however, was the lower external cutaneous branch of musculo-spiral contused, but also the upper external cutaneous branch of the same, and the posterior cutaneous branch of the musculo-cutaneous.

The interesting point was the escape of the anterior cutaneous branch of the musculo-cutaneous, which, at the level of the bullet track, is almost directly in contact with the posterior branch. Yet it escaped altogether. (*See* Figs. 4, A. and B.)

As bearing very strikingly on the same point may be mentioned the case of Cheetham (Case 3), where a Mauser bullet, entering the front of the right thigh at a point 5 cm. below and to the inner side of the right anterior superior spine, 1·5 cm. below Poupart's ligament, passed obliquely across in a slightly upward direction, towards the outer aspect of the thigh—its track probably in the main subcutaneous—to emerge over the tip of the great trochanter 10 cm. from the wound of entrance. In this case the cutaneous branches coming directly within the region traversed by the bullet were picked out and contused, viz., the external cutaneous nerve of the thigh (from lumbar plexus) and the middle and internal cutaneous branches from anterior crural. The deeper branches of the anterior crural, both cutaneous (internal or long saphenous to inner aspect of leg, &c.) and muscular (to muscles of thigh), escaped entirely, although at the site of the entrance wound they are all in intimate contact with the middle and internal cutaneous branches for the thigh (*see* Fig. 2). The branches which showed signs of implication were

certainly contused; the others ought, one would have thought, to have been in some way affected—ought, in fact, to have been concussed, and to have given definite evidence of concussion. They did not do so.

How can the complete escape of nerve trunks directly associated with the line of a bullet track, and closely in contact with others definitely affected, be explained? If "concussion" be worthy of acceptance at all as a distinct form of nerve injury, surely it is in such cases as these its effects might be looked for.

Further, it would be justifiable to expect more than mere peripheral involvement of selected nerve trunks.

They might be expected to be affected also in a backward or centripetal direction.

Thus in the cases of McAllister and Clarke it would be justifiable to expect the main trunk of the musculo-spiral to be affected by "concussion," not only as regards its peripheral distribution to forearm and hand, but also centripetally, so that its muscular branches to triceps ought to feel the concussion effects also; and in the case of Stoddern would one not be justified, considering the close relation of the bullet track to the edge of the spine, in looking for the occurrence of concussion of the spinal cord?

As the result, then, of a careful study of all these considerations, it may be concluded that it is useless, if not indeed actually unsound, to adopt any special "concussion" class of nerve implication associated with gunshot wounds. Hence the involvements of nerve trunks may be considered under two heads:—

A.—Those cases in which a nerve trunk or trunks received direct damage in the original bullet wound.

B.—Those cases in which a nerve trunk or trunks were not primarily affected, but became involved secondarily, either in cicatricial change in the neighbourhood, or in callus following fracture of an adjacent bone.

A.—Primary Implication of Nerve Trunks.

This would include the following classes:—

I. *Contusions of nerves.*

II. *Lacerations of nerves*, including a large variety of injuries, such as—

(*a*) Complete division.
(*b*) Partial division.
(*c*) Perforation, with or without any distinct considerable loss of, or destruction to, nerve substance.

In any of these the original damage might be complicated, and very notably influenced, by the occurrence and extent of cicatricial or fibrous change both in and around the affected trunk or trunks. Callus development too, just as in B, might lead to late involvement of nerve trunks, and the occurrence of such involvement would considerably complicate the position of affairs.

B.—Secondary Implication of Nerve Trunks.

This is meant to include only those cases where the original injury did not produce any actual lesion of a nerve trunk, but cicatricial change in the neigbourhood of the latter led to its compression, or callus developing in the vicinity, and following upon a fracture of a contiguous bone, led to the later inclusion and compression of the nerve.

In both A and B the occurrence, or not, of suppuration was of considerable import, particularly as regards the later results.

Where suppuration did occur not only was the resultant fibrous or cicatricial tissue of a very decided shrinking or contractile type, and the degreee of compression correspondingly great—the extent of functional disturbance being proportionately considerable—but the length of the nerve trunk or trunks compromised was necessarily much more extensive.

Special Nerves Injured.

The series of 16 cases includes injuries to the following nerves and plexuses. They are given in tabular form :—

Cervical plexus and branches...	2 cases	Thomas (Case 2). Pace (Case 4).
Brachial plexus and branches...	2 cases	Lessey (Case 7). Stoddern (Case 14).
Musculo-spiral—		
Main trunk	1 case.	Wagstaff (Case 10).
Cutaneous branches	2 cases	McAllister (Case 5). Clarke (Case 6).
Musculo-cutaneous	1 case.	Clarke (Case 6).
Median—		
Main trunk	3 cases	Randles (Case 13). Barrett (Case 16). Crowley (Case 12).
Palmar expansion	1 case.	Ligett (Case 9).
Ulnar	3 cases	Reid (Case 1). Osborne (Case 8). Pelkey (Case 15).
Anterior Crural—		
Cutaneous branches	1 case.	Cheetham (Case 3).
Internal popliteal External popliteal	1 case.	Marrey (Case 11).

It will be observed from the above table that the name of Clarke (Case 6) occurs twice. In this case not only were the cutaneous branches of musculo-spiral affected, but also the musculo-cutaneous (posterior cutaneous branch). (*See* Figs. 4, A and B.)

Further, it will be observed that only in the cases of two patients (Cheetham and Marrey) were the nerves of the lower extremity affected ; in other words, out of the 16 cases recorded, 14 were of injuries to nerve trunks or plexuses in the neck and upper extremity, a strikingly preponderating number. Out of the 16 no less than 7 are accounted for by injuries to the median and ulnar nerves. This is quite in keeping with the experience of most observers, and is probably in strict correspondence to the relatively greater frequency of wounds of the forearm.

Diagnosis of Nerve Lesion.

Just as rigid adherence to a definite anatomical or pathological classification is a matter of great difficulty, so also is it difficult to lay down any fixed or definite principles of diagnosis.

The symptoms and signs varied much, and widely divergent clinical pictures were the result.

The following statements may, however, be taken as pretty adequately borne out by the evidence of the cases collected in this series :—

A.—I. *Contusions.*

Where the lesion was very slight so also were the symptoms. There might be little more than a very slight lowering of function, motor or sensory, or both. Where the lesion was more considerable, added to the lowering of function, there were, as a rule, definite indications of nerve irritation. This was shown chiefly in hyperæsthesia or paræsthesia, sometimes in definite subjective pain.

In more severe cases the motor and sensory paralysis was greater still, and tended—at least for some days or even weeks—to become markedly worse, while the signs of irritation were, if present at all, merely transient.

The recovery of function in these cases was often slow, but usually satisfactory if secondary implication or neuritis did not occur.

In the most severe types of contusion the suspension of both motor and sensory function was immediate and absolute, and there were, as a rule, other accompanying signs of the profound tissue disturbance. Thus, neighbouring nerve trunks less severely contused might show different degrees of functional disturbance, and some, perhaps, evidence of irritation.

As regards the duration of the hyperæsthesia in the moderate forms of contusion, much variation occurred. Thus, in the case of Reid (Case 1), where the ulnar nerve was contused by a Mauser bullet which passed through the forearm, hyperæsthesia of the little and ring fingers persisted for seven or eight weeks, but was in the end, before dismissal of patient from hospital, completely recovered from. In McAllister's case (Case 5) the hyperæsthesia of the cutaneous district of the radial extensor aspect of the forearm supplied by the lower external cutaneous branch of the musculo-spiral had practically cleared up within five days after his admission to 3 General Hospital, or 3½ weeks from the date of injury. In other cases it was more decidedly transient still.

In the slightest forms of contusion, where no symptoms save lowering of function existed, both motor and sensory function were, as a rule, affected. In the case of Lessey (Case 7), however, although there was a general but partial loss of motor power of the whole right upper extremity—a general paresis which lasted from the time of injury till about a week after patient's admission to 3 General Hospital, Kroonstad, *i.e.*, fully three weeks—no evidence of deficient or altered sensation in the affected extremity was present at any time.

This is not easily explained, but is an interesting fact. The bullet track in this case was obliquely across and through the upper part of axilla, in close relation to the cords and branches of the brachial plexus, and the motor function of all was distinctly compromised without any detriment observable to sensory function.

Where the contusion was severe, and function, especially motor, considerably or absolutely suspended, recovery was often long delayed. The symptoms presented in those cases where secondary neuritis, with interstitial connective tissue formation, occurred in association with, or independently of, suppuration, were very pronounced.

They were usually marked by the occurrence of considerable "trophic" disturbance, wasting of muscles, blanching of skin over the cutaneous terminal distribution, lowered temperature, sweating, desquamation of epidermis, formation of blisters, and even superficial ulcers. Contracture of muscles, clubbing of finger tips, and thickenings of finger nails were also met with. Locally, the affected nerve might be thickened, even palpable as a fusiform swelling in the course of the affected trunk, and tender to the touch. Subjective pain at the injured spot, or referred along the nerve trunk, either peripherally or centripetally, might be present, and pressure on, or handling of, the injured trunk gave rise to tingling at the peripheral terminations of the latter. Where a nerve originally contused became at a later date included in callus, the phenomena were much of the same order as those just cited.

The most profound and persistent evidences of disordered function were undoubtedly those related to an accompanying suppurative process.

A.—II. *Lacerations.*

It was difficult to say where simple contusion ended and distinct laceration began, and, after all, the symptoms and signs which were met with where gross laceration occurred were quite of the same order as those characteristic of the more severe contusions.

In the case of Liggett (Case 9) and Wagstaff (Case 10), probably contusion and laceration both occurred.

In the former a fragment of cartridge casing was driven into the palm of the hand, and did, directly, considerable injury to the palmar expansion of median. (*See* Figs. 6, A, B, and C.) There was, however, the added complication of a suppurative process of some duration. The result was complete paralysis, motor and sensory, of the peripheral distribution of the median,

associated with distinct "trophic" disturbance—wasting of thenar eminence, blanching of skin, &c.

In the case of the latter (Wagstaff) the contusion was probably considerable, but the actual laceration of the musculo-spiral trunk must have been very extensive. This laceration was no doubt partly due directly to the bullet, but was also in great measure due to the widely-expanded bone fragments of the comminuted humerus. (*See* Fig. 7.) Later there were the added complications of (1) prolonged suppuration, and (2) involvement of the already much-damaged nerve trunk in the irregular callus.

In this case the functional disturbance was mainly motor and "trophic." Complete paralysis of motor function, shown in absolute loss of power of extensors of wrist and fingers and the long supinator (with complete wrist-drop) was accompanied by very marked wasting of muscles. Curiously enough, the sensory function was not demonstrably impaired to any extent.

Where distinct laceration occurred, however, the risks of neuritis, with resultant fibrosis of the affected trunk, and cicatricial change around it, were greatly added to. Suppuration was also much more likely to occur, simply in virtue of the usually larger and wider entrance wounds and the greater amount of damaged tissue.

Where complete division took place there was, of course, from that moment total suspension of the function of the nerve beyond the point of severance. A cutaneous nerve, if severed, left the area of skin supplied by it at once anæsthetic. Severance of a motor nerve implied at once complete paralysis of motor function; in the case of a mixed nerve, both sensory and motor functions were immediately suspended. Later there appeared well-marked symptoms of "trophic" disturbance, the phenomena being such as have been already cited under "contusion" complicated by the occurrence of neuritis.

The date of appearance of distinct "trophic" disturbance varied within very wide limits. It might show itself very early; on the other hand, it might appear somewhat late. Thus, in Barrett's case (Case 16), marked "trophic" disturbance did not become obvious till fully eight weeks from the reception of the injury. Yet it is worth recalling at the same time that, though late in appearance, it was rapid in development, and, in the end, most profound in degree.

In the case of Pelkey (Case 15) the ulnar nerve was completely severed just below the elbow (*see* Fig. 12), and motor, sensory, and "trophic" functions were alike involved. The period when this case came under my observation first was only 12 days after the date of reception of injury, and already wasting of muscles had begun, and blanching of skin was decided. For practically three weeks more the progress of events was watched, and the "trophic" change got steadily and considerably more pronounced.

In the case of Stoddern (Case 14) the division of the affected cord (from fifth and sixth cervical, posterior branches) was probably almost, if not quite, complete. (*See* Fig. 11.) Paralysis of deltoid, supra-spinatus, and infra-spinatus, muscles, was complete from the first, and by the time patient came into 3 General Hospital, *i.e.*, four and a half weeks later, wasting of these muscles was profound. The striking thing in this case was the entire absence of any sensory disturbance or of "trophic" changes in the skin over the outer aspect of the shoulder usually supplied by the circumflex nerve.

Where only partial division of a nerve occurred, the effects were more localised, though the early symptoms might suggest complete division. Where partial division took place, the unsevered portion was necessarily profoundly contused or lacerated, and the diagnosis might, for this reason, be cleared up only by a partial recovery of function.

Even this partial recovery could not, in itself, be taken as conclusive, for, unless watched for a prolonged period, it was impossible to say that the case was not simply one of contusion or laceration of a nerve trunk in which a part had been more severely damaged than the rest.

Perforations of nerve trunks occurred with some frequency during the late war, and must be classed with lacerations, though in some cases perforation took place without, presumably, any gross destruction of the fibres of the perforated nerve, the bullet, as it were, displacing the two portions of the latter to either side without seriously lacerating or carrying away any

of the nerve tissue. In others, no doubt there *was* a decided loss of nerve tissue.

The case of Marrey (Case 11) is an example of the former variety (*see* Figs. 8, and A and B). and it is noted that although the internal popliteal nerve was widely button-holed and extensively fibrosed for some 6 cm. of its length, as well as firmly involved in cicatricial tissue around it, patient was able to carry on his duties for fully six months after the reception of his wound. The primary button-holing of the nerve and the extensive contusion accompanying it gave rise to no immediate grave functional disturbance. It was only when the later fibrous, cicatricial change occurred in and around the nerve that serious functional and "trophic" symptoms supervened.

The case of Crowley (Case 12) may here be cited as having a distinct relation to those cases of perforation of nerve trunks, although it might, perhaps, just as reasonably be classed along with those of Liggett and Wagstaff. In Crowley's case, a small fragment of metal was projected into the forearm from a cartridge exploded in a camp fire. (*See* Fig. 9.)

This metallic fragment, it was subsequently discovered, was embedded in the median nerve, where it gave rise to a distinct fusiform, neuromatous thickening. A fortnight after the reception of the injury, motor and sensory disturbances, though not present at the first, were beginning to appear, and in the course of a month had become very pronounced. "Trophic" disturbance was, by this time, also very marked.

What part the presence of the metallic fragment played in the production of the neuromatous thickening is not at all certain. Probably, in the first instance, it merely partially perforated the nerve trunk, driving the fibres of nerve apart; around it there developed the usual encapsulating fibrous tissue, and this latter began its disturbing effect on nerve function in the ordinary process of its contractile metamorphosis.

As regards B—the *secondary implication of nerve trunks which were not in any way at all affected by the original injury*—my records furnish me with no data.

In all my cases the nerves involved were primarily so, even if the initial symptoms were slight. It might be expected, however, that, where a nerve trunk was implicated only indirectly, or secondarily, the symptoms would be those in the first instance of neuritis, pain, tingling, hyperæsthesia, &c., followed by progressive loss of motor and sensory function, wasting of muscles, "trophic" changes in skin, symptoms, in fact, very similar to those described already as devoloping in the later course of primary lesions of nerve.

As already stated, no means of electrical investigation of muscle irritability to Faradic or galvanic currents were available, and consequently nothing can be said, from personal experience, on this subject. It seems to have been generally admitted, however, by those who had opportunities of testing nerve-muscle reactions, that in cases where complete section of a nerve (mixed) had occurred, the only sign of pathognomonic importance, in the absence of any distinct bulbous swelling on the proximal end, was the complete loss of response to electrical stimulus from above.

It is also admitted that even where great wasting of muscles was present, in severe contusions of nerves, or secondary neuritis or perineuritis following these, the reaction of these muscles to electrical stimulation was seldom or never completely lost. Complete loss usually implied complete division.

Prognosis in Nerve Lesions.

In contusions of slight or moderate degree this was generally good, unless suppuration or definite neuritis supervened. Recovery might occur in periods varying from a few days to several weeks. Where the contusion was more severe, recovery was, as a rule, delayed, partly on account of the more profound disturbance of the nerve structure and function, partly from the greater blood effusions into and around its fibres, but chiefly on account of the greater degree of neuritis likely to result.

In cases of laceration the prognosis was, as regards the early and complete recovery of function, generally less hopeful, and where division of nerve trunks occurred, even when incomplete, recovery of function was practically impossible without special operative means.

If a nerve were simply perforated, without gross loss of nerve substance, there might be little immediate functional disturbance, or what little there was might be quickly recovered from. At a later period, however, neuritis, fibrosis of the perforated trunk, and cicatricial change around might seriously compromise its functional integrity.

In all varieties, fibrosis, cicatricial development in, or near, an injured nerve, and more especially if associated with suppuration, gravely affected the prognosis.

As regards the complications, then, equally as regards the cases of gross laceration or division of nerves, adequate operative measures were of chief importance in prognosis.

Order and Rapidity of Functional Return.

This varied greatly. In some cases, where recovery might have been expected to be delayed for a long period, there was relatively rapid improvement. In others improvement was extremely late in appearing, and slow in its progress.

In the case of anæsthetic areas related to contusion of cutaneous nerves, recovery of sensory function was at times preceded by a period of late hyperæsthesia, and by tingling, "prickling," &c.

The recovery of sensory function was usually much earlier than that of motor function. My records give, however, two instances which do not seem to bear this out. In the case of Pelkey (Case 15) where, be it remembered, the ulnar nerve was completely divided below the elbow (*see* Fig. 12), and where the method of operative treatment adopted was the ribboning or splitting, in a longitudinal direction of the intervening tissue, and telescoping the latter by suture so as to approximate, so far as possible, the divided ends, the order of recovery was different. There was, by the date of first dressing (11 days after operation), complete disappearance of all "trophic" manifestations on the skin of the fingers, wasting of muscles was being surely repaired, and motor function was already being restored. At the end of a fortnight from the date of operation there was still no vestige of sensory return. Even when patient was dismissed a few weeks later, though motor function seemed fully restored and "trophic" disturbance had vanished, sensory function had been only imperfectly recovered.

In the case of Randles (Case 13) some kind of injury had been received by the median nerve, for which he was operated on about a fortnight before he reached 3 General Hospital; when admitted there was still no functional return. Under vigorous treatment by massage recovery took place, the response being very speedy immediately such treatment was instituted. The motor function of the nerve returned, however, before the sensory, and certainly progressed much more steadily and rapidly once it had begun.

The want of conformity of these two cases with the usual rule is not easy to explain. With regard to the former it may be pointed out that the operative procedure adopted may have in some way influenced the order of functional recovery, but that can be merely matter for conjecture. Any suggestion as regards the second case would be quite futile in view of the fact that I have no definite knowledge of the actual nature of the original lesion.

Both cases are, however, admitted to have been quite exceptional. As a matter of fact, in most cases sensation was recovered *much earlier* than motor power, and of course where wasting of muscles was present in any degree this was to be expected.

In some instances, however, sensory return was so immediate and complete as to suggest very much the re-establishment of an electrical circuit temporarily broken. And even where sensation was so rapid in its re-establishment, the return was usually fully maintained.

Thus in the case of Barrett (Case 16) the right median nerve had been completely severed by a bayonet wound 11 weeks before the date of operative interference, and although prior to operation motor and sensory functions were absolutely suspended and "trophic" changes of the most striking character were present over the peripheral digital and palmar distribution of the affected nerve, yet, within 24 hours after the operation of nerve-paring and suture,

sensation had been almost entirely restored, and, within a few days, cutaneous trophic disturbance had practically disappeared.

This restoration was not transient, but was fully and satisfactorily maintained.

Treatment.

In the simpler contusions little active treatment was called for. Of course, in the first instance, the attainment of aseptic healing of the wound was of prime importance; efforts were therefore to be directed particularly to the exclusion of suppuration, and to the encouragement of healing by first intention. In the simpler forms of contusion little more was necessary. In the majority of such cases a spontaneous process of recovery of normal function was to have been expected, but, with a view to hastening this, massage was employed in quite a number of instances, as in the cases of Reid (Case 1), Thomas (Case 2), Cheetham (Case 3), Pace (Case 4), McAllister (Case 5), and Clarke (Case 6), and with satisfactory results. Massage.

In particular, it was found to allay muscular spasm and to rapidly relieve hyperæsthesia (Pace, Case 4), and after the first application or so it was found to have a decidedly soothing effect.

Its objects were to encourage absorption of effused blood in and around the affected trunk or trunks, and to counteract, in some degree, the tendency to involvement of the contused trunk in any fibrous tissue which might develop in its vicinity, but more especially it was intended to prevent adhesion of the scars of entrance and exit wounds to the affected trunk or trunks.

With these objects it was employed systematically and firmly, but gently. Not only was the area of the original wound and bullet track massaged, but the area of cutaneous distribution of, and the muscles supplied by, the affected trunk or trunks, were treated in the same way.

In the more severe contusions spontaneous recovery of function was delayed, and though in these cases natural restoration might have taken place unaided, yet here also massage was found of great service.

Operative Measures.—In some cases, however, operative treatment was called for, with the object of preventing, so far as possible, the later phenomena of neuritis and perineuritis. Thus a contused or lacerated nerve might be with advantage exposed, effused blood and damaged tissue cleared away, or bone fragments removed. This being done the chances of considerable secondary implication were thereby much lessened.

Where cicatricial compression of nerve trunks had occurred, or the ordinary fibrosis following neuritis and perineuritis of contused or lacerated trunks was clearly present, and showed progressive aggravation, operative measures were unmistakably called for.

When is Operative Treatment to be Adopted?—And here it is well to introduce the question as to when operative interference in such, or indeed in any form of nerve injury, should be undertaken. The usual view seems to be that, as a rule, operative interference should be delayed until all other means of treatment have been exhausted. The justification for such a doctrine seems to be in the main that functional return, though long delayed, may take place at very late periods, even after all hope of improvement without operative interference has been pretty well given up. While such justification might, perhaps, be admitted, my own view is that little harm could result from a much more liberal adoption of operative interference. Even, if at times, a nerve be cut down upon, and no gross disturbance found, little chance of harm exists provided aseptic technique has been observed; while if any gross mischief is present, the earlier such is repaired, adhesions freed, cicatricial tissue removed, or the nerve sutured if necessary, so much the sooner will satisfactory functional return be achieved.

This procedure would probably lessen the chances of considerable degenerative change occurring in nerve structure, as well as diminish "trophic" disturbance and contractures.

Where much fibrosis was found it was of advantage to free the affected trunk or trunks, stretch them, and to establish, if possible, a new position for them out of the reach of fresh cicatricial adhesions. Cicatricial tissue had to be freely dissected, not only from the nerve trunks, but as far as practicable from all the neighbouring structures.

If a nerve trunk was enveloped in callus, or seriously menaced by it, it was necessary to remove all exuberant callus, and to endeavour to make for the trunk a new bed or channel so arranged as to minimise the risks of any further involvement.

Finally, it was sometimes found advisable to displace the freed nerve from its original position, so as to minimise the risk of its incorporation in the scars of the original wounds, or in that resulting from the operation, *vide* case of Barrett (Case 16).

In the cases of Marrey (Case 11), Liggett (Case 9), and others, the extent of cicatricial tissue which required careful, even laborious, removal was considerable, but the time spent in the process was amply compensated for in the satisfactory result which followed.

The case of Wagstaff (Case 10) is an excellent illustration of the extensive damage to and involvement of a nerve trunk, both by callus and by dense cicatricial tissue (*see* Fig. 7). In the detailed description of the operation the condition of affairs as found, as well as the operative measures followed, are fully given.

Where actual division (complete or incomplete) had occurred, there was no question of the necessity for operative interference, and the remarks already made regarding the advisability of early operation hold even more decidedly in this class The chances of spontaneous recovery where complete severance of a nerve has occurred are practically nil; therefore delay in operation was, except in the presence of suppuration, inadvisable.

Of course, if in the earlier period following the injury the diagnosis of complete section could not be made with absolute accuracy, delay might be excusable, but it is just in such cases that exploratory incision would aid matters, by at once enabling a definite diagnosis to be made, and providing without delay for the adoption of the proper operative measures for uniting the divided ends.

The bulbous enlargements, neuromatous thickenings of the proximal ends so often met with where operation was delayed, implied the sacrifice of a greater extent of the continuity of the nerve than would have been necessary if operation had been carried out at an earlier date, for before uniting the ends it was necessary to remove these portions freely, until on the cut surface evidence of healthy nerve tissue was clearly visible.

It may be stated that in the case of Pelkey (Case 15), where the ulnar nerve was completely severed below the elbow, no such bulbous enlargement on the proximal end was found, but probably the period when operation was carried out—just a month from the reception of the injury—was too early for the development of such a neuromatous change.

Where practicable, the divided ends were brought directly into contact. The more accurately was this done, the more rapid, permanent, and complete was the functional recovery.

In cases where there was such considerable loss of nerve tissue that perfect apposition of divided ends was not possible, displacement of the trunk into a new position, where its course might be shortened, naturally suggested itself. The placing of a limb in such a position of extension or flexion as to relax the affected nerve as fully as possible was also clearly indicated.

If by this expedient the ends could not be brought quite into contact, nerve-lengthening might be necessary, or, if the gap between the ends were not too great, it might be bridged over by new nerve-growth, provided suppurative action or cicatricial change could be excluded.

In the case of Pelkey (Case 15) the gap was fully 6 cm., and for various reasons it was not thought advisable to displace the damaged ulnar nerve from the posterior aspect of the internal humeral epicondyle to the anterior surface, though that would probably have permitted of the ends being then completely approximated.

The expedient was adopted of "ribboning"—or splitting longitudinally—the intervening tissue; then, by sutures drawn only moderately tightly, and approximating in a measure the ends of the nerve, the intervening mass was partially telescoped, and the longitudinal splits converted thus into free spaces, along which it was hoped nerve-growth might be established. (*See* Figs. 12, A and B.) However explained, the result was at any rate satisfactory.

As Regards the Method of Suture.

In the cases of Pelkey (Case 15), and Crowley (Case 12), the sutures were passed through the whole thickness of the nerve trunk as well as the sheath. In the case of Barrett (Case 16), the divided ends of the median nerve were united by sutures passing through only the nerve sheath. The result in the last case was, both as regards the immediate effect and as regards the rapidity of functional restoration, much more satisfactory than in either of the first two, and my own view is therefore that, where practicable, perineural sutures only should be employed. Of course, if there is much difficulty in approximation of the ends, and there is likely to be any marked tension, it may be necessary to take a deeper hold on the nerve substance, and the suture or sutures must then be passed through the whole thickness (neural-perineural).

As regards the sutures themselves, where obtainable at all an absorbable material such as catgut ought always to be employed. An unabsorbable substance, such as silk, would imply the encapsulation of itself by fibrous tissue, and such fibrous change must necessarily deleteriously influence functional recovery. In all my cases of nerve suture catgut was exclusively employed.

After-Treatment.

With regard to the after-treatment of cases operated on, functional recovery was undoubtedly aided and expedited by careful and systematic massage of the scar area, of the cutaneous supply area of the affected nerve, of paralysed muscles, and of joints of the affected part.

Massage, &c.

Local massage of the wound region was not, however, instituted immediately after operation. A period of two or three weeks, during which the parts were kept as carefully as possible at rest, was first allowed to elapse.

The area of terminal distribution of the affected nerve might, if well removed from the seat of operation, be massaged with care from the very first.

Thus, in injuries of the median, the fingers might be gently rubbed and manipulated from the outset, provided that the more proximal parts were firmly controlled.

Just as the absence of electrical apparatus in 3 General Hospital made the clinical picture in several of the cases here recorded incomplete and unsatisfactory, so also the absence of this aid was felt in treatment.

Muscular function could only be promoted by medicinal, dietetic, and physical means. Of these, massage was the most efficient.

The Late Results in Nerve Lesions.

The late result, if it could be ascertained in all of these 16 cases, would be interesting.

As already said, I was able to watch Barrett (Case 16) for almost six months after his operation, and at the end of that time his hand was practically well, and function quite restored. The only sign of disturbance which then persisted was a little clubbing of the tips of the fore- and mid-fingers.

Liggett (Case 9), the palmar expansion of whose median nerve was severely contused, if not actually lacerated, by a fragment of cartridge casing, and crushed subsequently in cicatricial tissue, and in whom the expansion and branches were freed by operation in August, 1900, was only under my care for about three weeks, thereafter being sent down country. Since my return to Glasgow, however, I have had many opportunities of seeing him, and have, altogether, watched his progress over a period of fully three years. The improvement in function has been very satisfactorily maintained.

The only vestige of the old trouble which is now present is (1) a slight clubbing of the tips of the fore- and mid-fingers—still less of the tip of the thumb, and (2) a distinctly more deeply coloured, more congested, appearance of these fingers, as compared with the rest.

The only other of these 16 cases concerning the later history of which I have any direct knowledge is that of Lessey (Case 7), who called on me in the summer of 1901, *i.e.*, fully 10 months after he left 3 General Hospital, Kroonstad. His condition then was absolutely satisfactory, and there were

no evidences of the contusion of his right brachial plexus. The right arm was in every way, as far as function was concerned, like the left.

The other cases I have had no means of following out.

The Meaning of the so-called "Trophic" Function: Its Possible Relation to Vaso-constrictor and Vaso-dilator Supply.

An interesting question has been suggested by certain of the facts just noted regarding the late result in the cases of Barrett and Liggett, and they were by no means exceptional. The long persistence of the "clubbing of the tips of the fore and mid-fingers" in Barrett, and "of the tips of the fore and mid-fingers and less still of the tip of the thumb" in Liggett would seem to suggest some unrecovered balance in the original "trophic" function.

The long persistence of "a distinctly more deeply-coloured, more congested appearance of these fingers, as compared with the rest," would seem to suggest some unrecovered equilibrium between the vaso-constrictor and vaso-dilator functions of the damaged nerve and its branches.

Remember that these were by no means infrequent relics of profound nerve disturbance otherwise perfectly recovered from.

Is it too much to suggest that these so-called "trophic" disturbances in nerve lesions may in reality be due to disorganised vaso-constrictor and vaso-dilator functions, and that "trophic" function should be regarded as directly connected with the maintenance of a proper and equable balance between vaso-constriction and vaso-dilatation?

One more point may be adduced in furtherance of this view. In Barrett's case "trophic" disturbance was well marked over the whole palmar and digital area of supply of the damaged median nerve, and yet on the ulnar margin of the thenar eminence, though "trophic" change was as notable there as anywhere else, some sensation was still present, indicating probably that some cutaneous fibres derived from the ulnar nerve were there carrying on the function of sensation, though the said area was affected "trophically" in the median nerve disturbance.

Case 1.

Contusion of left ulnar nerve.

Hyperæsthesia fourth and fifth fingers lasting seven weeks.

No operation.

Rapid recovery under massage.

Private Reid.—Wounded on 18th February, 1900, at Paardeberg; range, 450 yards; Mauser.

Admitted to 3 General Hospital seven weeks later. Entrance wound (·5 cm.) on extensor aspect of left forearm, 10·5 cm. below olecranon; exit wound (·8 cm.) on flexor aspect, 10·5 cm. from entrance, and 14 cm. above wrist; aseptic course.

Hyperæsthesia of left little and ring fingers still present on admission; no "trophic" or motor disturbance. No operation. Hyperæsthesia quickly disappeared under simple massage of the forearm, especially of the wound area.

Note.—So-called "concussion" effects would hardly have persisted for seven weeks as in this case.

Case 2.

Contusion of lower cervical nerves (especially superficial cervical and branches). Also circumflex (from posterior chord of brachial plexus).

Hyperæsthesia right shoulder.

Colour-Sergeant Thomas.—Wounded on 29th March, 1900, at Karee siding; range, 700 yards; Mauser.

Admitted to 3 General Hospital three weeks later. Entrance wound on back of neck, just to right of the first dorsal spine; exit wound on front of neck, 3·5 cm. to right of the cricoid cartilage; both wounds small; aseptic course.

No operation. Massage. Result unknown.

Bullet track must have been in close relation to the right common carotid artery, internal jugular vein, pneumogastric nerve, sympathetic trunk, and cords of brachial plexus. Wounds healed on admission. (Fig. 1.)

From the scar of the exit wound a fibrous cicatricial mass led down to a very visible and palpable pulsating carotid artery. Beyond this there were no special symptoms of damage either to artery or vein during the time the man remained under observation. Hyperæsthesia over the anterior and outer aspect of the right shoulder-area of distribution of the supra-acromial and supra-clavicular branches of the superficial cervical nerve, and of the circumflex. Massage of shoulder and neck (from exit wound outwards and downwards). Subsequent result not ascertained.

Case 3.

Contusion—

1. External cutaneous nerve (from lumbar plexus);
2. Middle and internal cutaneous (from anterior crural).

Hyperæsthesia over the whole cutaneous area of supply of these.

Muscular branches and cutaneous branch to leg not affected. Massage.

Final result not known.

Trooper Cheetham.—Wounded on 1st July, 1900, near Lindley; range, 300 yards; Mauser.

Admitted to 3 General Hospital two weeks later. Entrance wound (1·5 by ·5 cm.), 5 cm. below and inside the right anterior superior iliac spine, 1·5 cm. below Poupart's ligament; exit wound (·5 cm.), over tip of right great trochanter, 10 cm. from entrance. Bullet track mainly subcutaneous; aseptic course.

Hyperæsthesia and paræsthesia (numbness, tingling, tenderness) over outer, anterior, and antero-internal aspects of right thigh. Massage of scars and front of thigh. Hyperæsthesia still present on dismissal a few days later; probably it would not long persist. No sensory disturbance in the leg (internal saphenous nerve therefore not affected). No muscular disability (muscular branches of anterior crural therefore not involved). Branches affected: external cutaneous (from lumbar plexus), middle and internal cutaneous (from anterior crural).

Note.—Had the symptoms been due to "concussion," the muscular branches and cutaneous branch to the leg should also have been affected. Only those nearest to, indeed actually upon, the bullet track were involved. (Fig. 2.)

Case 4.

Contusion of cervical plexus and spinal accessory nerve. Sepsis; abscess in neck. Healing protracted. Hyperæsthesia, &c., dissipated by massage. Recovery.

Private Pace.—Wounded on 14th February, 1900, at Jacobsdal; range, 300 yards; Mauser.

Admitted to 3 General Hospital five weeks later. Entrance and exit wounds both ran a septic course; abscess amongst deep muscles of neck. Entrance wound: a long furrow, or gutter, from right to left, in roof of mouth, penetrating left alveolar ridge; exit wound (2 by 1 cm.), on the back of the neck, 2 cm. to left of the sixth cervical spinous process. Bullet track from right to left, backwards and downwards across the roof of the mouth, through the upper left alveolar ridge, along the ramus of the lower jaw, thence downwards and backwards through the tissues of the

neck. Symptoms of irritation of upper and middle cervical nerves, also of spinal accessory (directly, or in virtue of its connections with branches of cervical plexus). Pain, stiffness, spasmodic torticollis on left side, also pain referred to the right side of the neck. Massage of neck employed to dissipate spasm and relieve pain. Complete recovery.

Case 5.

Contusion of lower external cutaneous branch of musculo-spiral nerve.

Hyperæsthesia of its area of supply.

Recovery rapid and complete under massage.

Private McAllister.—Wounded on 18th February, 1900, at Paardeberg; range 800 yards; Mauser.

Admitted to 3 General Hospital three weeks after. Wounds small; aseptic course. Entrance wound on right arm 22 cm. below acromion, in line of outer margin of belly of biceps; exit wound on the back of the arm, 8·5 cm. from entrance, 11 cm. above olecranon. Bullet track through muscular mass, springing from external humeral epicondyle and ridge running upwards from this. Area of hyperæsthesia along the radial portion of the extensor aspect of forearm, corresponding with the cutaneous distribution of the lower external cutaneous branch of the musculo-spiral nerve. The upper external cutaneous, though closely contiguous at the site of the wound, escaped.

Massage. Hyperæsthesia quickly disappeared.

Note.—Considering the close relation of the upper and lower external cutaneous branches at the site of the wound, the condition can hardly have been one of mere "concussion." (Fig. 3.)

Case 6.

Contusion (severe)—

1. Posterior cutaneous branch of musculo-cutaneous nerve.
2. Upper and lower external cutaneous branches of musculo-spiral.

Complete anæsthesia over area of supply of these.

Massage.

Gradual but complete recovery without operation.

Sergeant Clarke.—Wounded on 20th May, 1900, near Lindley; range, 80 yards; Mauser.

Admitted to 3 General Hospital 13 days later; wounds small; aseptic course. Entrance wound on the postero-external aspect of right arm, 9 cm. above external humeral epi-condyle; exit wound on the anterior aspect, 8·5 cm. from entrance wound, and 7 cm. vertically above the middle of the flexure of the elbow.

Area of numbness and complete anæsthesia over radial aspect of elbow, lower part of arm, and radial, radial-anterior, radial-posterior aspects of forearm. Progressive increase in size of this area for first few days after admission. (Fig. 4A.) No operation. Vigorous massage, several times daily, of wound area, scars, anæsthetic area, and forearm as far as wrist. Steady and maintained improvement, no anæsthesia remaining when patient was dismissed.

Note.—Had the condition here been one of "concussion" it is unlikely that the anterior cutaneous branch of the musculo-cutaneous would have escaped while the posterior branch was implicated along with the upper and lower external cutaneous branches of the musculo-spiral (Fig. 4B.)

Case 7.

Contusion of cords of right brachial plexus. Transient paresis of all upper limb muscles; no sensory disturbance.

Complete recovery of function. Received at same time severe injury to right leg, necessitating amputation.

Sergeant Lessey.—Wounded on 16th July, 1900, near Heilbron; range 50 yards.

Admitted to 3 General Hospital two weeks later. Wounds of (*a*) right leg, (*b*) right shoulder and axilla.

(*a*) ("Explosive" or soft-nosed Mauser.) A large, torn wound; compound comminuted fracture of tibia and fibula; rupture of anterior tibial artery; hæmorrhage; acute sepsis; extensive suppuration and general septic poisoning. Admission to 3 General Hospital in high fever. Attempts to save leg unavailing. Lister-Carden amputation; good recovery. A satisfactory stump.

(*b*) (Mauser.) Entrance wound (·5 by ·75 cm.) on front of right shoulder, 2 cm. below clavicle, 7·5 cm. to right of mid-sternum; exit wound (·5 by ·75 cm.) on posterior surface of shoulder, 6·5 cm. above fold of axilla. Both wounds ran an aseptic course.

Bullet track obliquely through upper (quadrilateral) space of axilla. Transient paresis of all the muscles of the right upper limb; sensory function unimpaired. Paresis completely recovered from in a few weeks.

Case 8.

Contusion of right ulnar nerve above elbow. Sepsis. Partial paralysis of motion and sensation; no "trophic" change in skin or muscles.

Progressive recovery of function without operation.

Private Osborne.—Wounded on 7th June, 1900, at Rhenoster; range doubtful; Lee-Metford.

Admitted to 3 General Hospital eight days later. Both wounds large; septic course; both had been opened up for evacuation of pus before admission to 3 General Hospital. Entrance wound, internal aspect of right arm, 4 cm. above internal humeral epi-condyle; exit wound, 2·5 cm. above middle of flexure of elbow. (Fig. 5.)

Partial loss of power, and defective sensation, over whole area of ulnar nerve supply. No complete paralysis of motion or sensation; no "trophic" change. No operation. Motor and sensory function rapidly and progressively recovered while the man remained under observation.

Note:—Final result not known.

Case 9.

Contusion of left median nerve (palmar expansion). Metallic fragment lodged in palm. Deep palmar suppuration. Secondary involvement of nerve in scar tissue.

Motor, sensory, and "trophic" disturbances, becoming progressively worse after evacuation of

Sergeant Liggett.—Wounded on 2nd July, 1900, camp-fire cartridge explosion.

Admitted to 3 General Hospital 13 days later. Fragment of cartridge casing lodged in palm of left hand; wound on ulnar margin of thenar eminence.

Injury to palmar expansion of median nerve; deep suppuration in the palm. (Fig. 6A.)

Loss of sensation: palmar aspect of thumb, forefinger, mid-finger, and radial half of ring finger; atrophy of thenar eminence, and inability to oppose

pus and extraction of fragment of cartridge-casing. Nerve expansion and branches freed, at a later date, from scar tissue. Progressive and maintained recovery.

the thumb; weakness of all the thumb movements; blanching of skin. Metallic fragment localised by X-rays lying over the proximal ends of the metacarpals of fore and mid-fingers. (Fig. 6B.) First operation (17 days after reception of wound), evacuation of pus; extraction of fragment; drainage.

Wound soon healed, but anæsthesia and paralysis of motion became progressively more marked, and "trophic" changes in skin and muscles more pronounced.

Second operation (40 days after first), old scar excised; nerve expansion and branches freed from scar tissue; wound sutured. (Fig. 6C.) Healing by first intention.

Slow, but progressive and maintained, improvement, and recovery of function.

Patient dismissed 19 days later; sensation almost normal; motor power still defective.

Patient seen frequently in Glasgow during following year; improvement maintained. When last seen the only vestiges of the old injury were:—

(1) Slight clubbing of the tips of the fore and mid-fingers, less still of the thumb.

(2) More deeply-congested condition of these fingers.

This might be explained by assuming either—

(1) The persistence of some slight disturbance of "trophic" function, or

(2) The existence of some unrecovered equilibrium between vaso-constrictor and vaso-dilator functions of the damaged nerve and its digital branches.

Case 10.

Severe contusion and partial laceration of musculo-spiral nerve. Subsequent involvement in callus, and active inflammatory process.

Operation on nerve delayed until 12 weeks after the injury, because of retarded bony union and acute sepsis.

Nerve freed and laid down in new site.

No improvement during the 3½ weeks patient remained in hospital.

Final result unknown.

Trooper Wagstaff.—Wounded on 3rd July, 1900, near Bethlehem; long range; shrapnel bullet.

Admitted to 3 General Hospital on the 22nd day after. Entrance wound (1·5 by 1 cm.) right arm, 8·5 cm. above external humeral epi-condyle; exit wound almost directly opposite. Compound fracture of humerus (middle and lower thirds), great comminution; no bony union on admission; entrance wound suppurating freely. (Fig. 7.) Complete paralysis of forearm muscles supplied by musculo-spiral; absolute "wrist-drop"; transient tingling in thumb and forefinger; no clearly-defined anæsthetic area; wasting of extensor muscles.

Fracture regarded as first consideration, and attention therefore given to it. Good bony union obtained in about 5 weeks (*i.e.*, about 8 weeks from injury); wound, however, still unhealed. In spite of massage, &c., "wrist-drop" remained absolute. Operation about 9½ weeks after admission; region of fracture opened up freely; nerve explored in lower and outer part of arm—found greatly damaged, stretched, thickened, and caught by callus and scar tissue; trunk cleared of all

callus and irregular bone, also of cicatricial tissue, then laid in a new situation. Wound closed except at one point, where a small gauze drain was introduced. Aseptic course. No functional improvement during the 3½ weeks the man remained under observation.

Note.—Operative inference was long delayed—(1) on account of delayed bony union, (2) because of the active suppuration. Even when carried out, it was not thought advisable to excise the damaged portion of the nerve on account of the doubt as to the practicability of exclusion of sepsis.

Fig. 7 represents fairly well the nature and extent of the comminution of the humerus, as ascertained by radiograph.

CASE 11.

Severe contusion and perforation of internal popliteal nerve.

Contusion of exernal popliteal.

Involvement of both in great cicatricial fibrosis; internal popliteal specially affected. Loss of motor and sensory functions gradual, but, after six months, considerable. Wasting of gastrocnemius and peronei. Anæsthesia irregularly distributed. Operation; nerves freed. Recovery very rapid. Patient discharged within five weeks.

Private Marrey.—Wounded on 24th January, 1900, at Spion Kop; range, 60 yards; Mauser.

Admitted to 3 General Hospital six months later. Wounded in left thigh, and right popliteal space; thigh wound of little importance.

Wound of popliteal space.—Entrance wound (1·5 cm.), middle of posterior aspect of thigh, 3 cm. above flexure of knee; exit wound, external aspect of leg, 1 cm. in front of and on level with upper end of fibula; aseptic course. Bullet passed across popliteal space from left to right, perforating the trunk of the internal popliteal nerve, and contusing the external popliteal.

Gradual but progressive loss of motor and sensory functions of both nerves.

Admitted to hospital because of difficulty in walking, "dragging" gait, and tendency to walk on the inner side of the right foot; wasting of gastrocnemius and peronei muscles; irregularly distributed anæsthesia—sole and outer border of foot, heel, and dorsal and plantar aspects of three outer toes; cicatricial matting of tissues in popliteal space easily felt.

Operation (10 days after admission).—Whole popliteal space exposed by turning down a large horseshoe flap; external and internal popliteal nerves dissected free of scar tissue, the latter cut away freely; internal popliteal for a distance of 6 cm. swollen to about four times its normal thickness, and the remains of a perforation discovered in it at the level of the entrance wound, the gap or button-hole being filled with dense fibrous tissue similar to that surrounding it. (Fig. 8A.)

Popliteal vein (closely incorporated in scar tissue) set free at same time; flap replaced and sutured. Healing by first intention; uninterrupted recovery; motor and sensory functions fully restored. Patient discharged 33 days later.

Note.—The irregular distribution of the anæsthesia is interesting. Neither it nor the paralysis of muscles could be ascribed to the distribution of either trunk, to the exclusion of the other. Nor

in the case of either nerve was the whole terminal distribution involved. (Fig. 8B.)

As regards the internal popliteal and its terminal cutaneous distribution.—The anæsthesia of the heel, greater part of sole, and outer toes on their plantar aspect was related to the calcaneo-plantar and external plantar branches, while the area of plantar anæsthesia passing to the internal margin of the ball of the great toe suggested also partial involvement of the internal plantar; the latter could, however, be only partially affected, for the plantar surface of the two inner toes retained full sensation.

As regards the external popliteal and its terminal cutaneous distribution.—The normal sensation preserved over the greater part of the dorsum and inner edge of the great toe indicated comparative escape of the internal branch of the musculo-cutaneous, and the preservation of sensation on the adjacent sides of the dorsal aspect of the great and second toes suggested escape of the anterior tibial. The anæsthesia of the third and fourth toes, on their dorsal surface, pointed to implication of some at least of the fibres of the external branch of the musculo-cutaneous. Doubtless the terminal distribution of the internal (or long) saphenous nerve (from anterior crural) upon the internal portion of the dorsum of the foot and great toe may have to some extent masked the degree of implication, both of internal plantar and musculo-cutaneous fibres.

As regards the external aspect of the foot and little toe, the external (or short) saphenous nerve —formed partly from internal popliteal and partly from external popliteal, through union of tibial communicating and perineal communicating branches—was probably in some degree involved. The exact share in the anæsthesia to be ascribed to each nerve must therefore remain somewhat uncertain.

Case 12.

Penetration of median nerve by a minute metallic fragment derived from cartridge casing.

Embedding of this in the nerve substance.

Neuromatous thickening around this.

Gradual development of motor, sensory, and "trophic" disturbance, related to whole terminal supply of nerve.

Operation 6½ weeks later. Neurectomy.

Neurorraphy (neural-perineural).

Recovery gradual, but progressive.

At dismissal, a fortnight

Private Crowley.—Wounded on 1st September, 1900; camp-fire cartridge explosion; minute fragment of cartridge casing embedded in trunk of median nerve.

Admitted to 3 General Hospital 12 days later.

Wound on flexor surface of left forearm, 6·5 cm. above wrist, ·75 cm. to ulnar side of palmaris longus tendon; aseptic course. Symptoms of nerve disturbance not very marked on admission.

A large hydrocele of right tunica vaginalis testis treated by radical operation (22nd September), and the progress of nerve disturbance carefully watched. In spite of systematic massage nerve symptoms became more marked.

Symptoms of nerve disturbance on admission.—Slight stiffness of fingers; deficiency in power of opposing thumb; anæsthesia on the palmar and dorsal aspects of terminal phalanx of thumb; slight blanching of the skin of thumb and fore-finger (palmar aspect).

later, sensation almost completely restored; motor power considerably, though not completely, recovered; "trophic" disturbance quite gone.

Symptoms five weeks later.—Motor, sensory, and "trophic" changes more pronounced; complete inability to oppose thumb; anæsthesia of palmar surface of thumb, forefinger, mid-finger, and radial border of ring finger, also of corresponding area of the palm; blanching of skin very marked, and a number of shallow ulcers on the thumb, fore and mid fingers; wasting of thenar eminence.

A skiagram taken about this time demonstrated the presence of a minute foreign body (metallic) at the level of the wound and in the line of the median nerve.

Operation (6½ weeks after injury).—Median nerve exposed at level of wound; neuromatous thickening displayed (Fig. 9); resection of this; end-to-end neural-perineural suture; healing by first intention. Subsequent course—pain and tingling in fingers for a day or two; function gradually but steadily restored.

At date of dismissal, sensation was perfectly recovered in the mid-finger, in the thumb as far as the terminal inter-phalangeal joint, and partially in the terminal phalanx, also in the forefinger as far as the middle joint.

Motor function was only partly restored, but was improving daily; opposition of thumb could already be carried out. Ulcers on fingers were quite healed.

Note.—The embedding of a minute metallic fragment in the substance of the nerve, and the production around it of a neuromatous thickening, is probably unique. (Fig. 9.)

Case 13.

Laceration (probably complete) of right median nerve.

Operation three weeks after injury.

Recovery of function delayed by œdematous swelling around nerve.

Steady improvement under influence of vigorous massage of hand and forearm—particularly of the region of the wound.

Private Randles.—Wounded on 14th February, 1900, at Jacobsdal; range 500 yards; Mauser.

Admitted to 3 General Hospital five weeks later; several wounds—right cheek, right axilla, right scapular region, and right forearm; aseptic course in all.

Forearm wound alone important.—A perforation from extensor to flexor surface. Entrance wound on the extensor surface of forearm, 2·5 cm. above tip of ulnar styloid, close to radius; exit wound on flexor surface, 7 cm. above radial styloid, close to radius; bullet probably passed through interosseous space. (Figs. 10, A and B.) Median nerve damaged; believed to have been severed; had been operated upon a fortnight before admission to 3 General Hospital. On admission there was no sign of return of function (motor or sensory), and there was great swelling and induration in the lower part of the forearm, especially about the operation wound.

Vigorous massage, instituted with a view to the dissipation of œdema and the freeing of the operation scar from the deeper structures. Gradual return of function, and maintenance of this during the time the patient remained in hospital.

Note.—Motor function showed signs of recovery distinctly earlier than sensory, and progressed

much more rapidly and steadily. This is a reversal of the usual order.

Case 14.

Laceration (probably complete severance) of a single cord of brachial plexus.

Absolute paralysis of deltoid, supra-spinatus, and infra-spinatus muscles. Marked atrophy of these.

No operation permitted.

Subsequent history not known.

Lance-corporal Stoddern.—Wounded on 18th February, 1900, at Paardeberg; range 200 yards; Mauser.

Admitted to 3 General Hospital 32 days later. Entrance wound, in floor of mouth; exit wound, on the back, on a level with the second dorsal vertebra, and 9·5 cm. to left of the middle line. Bullet track through tissues of neck close to spine.

Symptoms of nerve damage on admission.—Complete paralysis and marked wasting of the left deltoid, supra-spinatus, and infra-spinatus muscles; no other muscles of the upper limb or shoulder affected; no anæsthesia or paræsthesia. No operative interference carried out; it was negatived by the advice of a consultant, and the man was sent home. His subsequent history has not been obtained.

Note.—The failure to adopt operative treatment seems much to be regretted, especially having regard to the extremely localised nature of the nerve involvement and to the close anatomical relations of the various cords and branches of the brachial plexus in the area through which the bullet must have passed.

Anatomical note (*see* Fig. 11).

The following brief consideration of the anatomical explanation for the clinical signs which were present may be of interest:—

Apparently the only nerves damaged were the supra-scapular and circumflex. Of these the former is purely muscular, supplying supra-spinatus and infra-spinatus, while the latter, in addition to supplying the deltoid and teres minor muscles, furnishes sensory supply to a substantial area of skin over the outer aspect of the shoulder and upper part of the arm. The supra-scapular nerve may be said to have been thrown completely out of action, while the deltoid supply of the circumflex was entirely wanting; the condition of the teres minor does not admit of easy investigation. This selective effect of the lesion is not readily explained by accepting the view current amongst many anatomists in this country upon the particulate origin of the trunks, cords, and special branches of the brachial plexus. Shortly stated, the common view seems to be that the anterior primary divisions of the fifth and sixth cervical nerves join to form an upper trunk, the seventh forms a middle trunk, and the eighth cervical and first dorsal form a lower trunk; each trunk then divides into anterior and posterior branches, and from the union of all the posterior branches is formed the posterior cord of the plexus. Picking out of the fibres for the supra-scapular and circumflex from a composite posterior cord would seem to be unlikely of occurrence, without some accompanying involvement of adjacent fibres, and it seems necessary, therefore, to adopt a different explanation of the origin of

Common view re brachial plexus.

Brachial plexus, after Spalteholz and His.

the constituent trunks and cords of the plexus from that given above. The description of the plexus put forward by Spalteholz and His seems more in keeping with the state of the case. In their Atlas a *schema* of the plexus is given, and on it is founded the diagrammatic representation accompanying this paper. (Fig. 11.) According to these observers, the supra-scapular nerve arises from the junction of the posterior branches of the anterior primary divisions of the fifth and sixth cervical nerves, these branches being separated early from the anterior portions, their fibres probably seldom entering into the formation of a definite composite upper cord. The main portion of the circumflex nerve arises from the posterior cord, before the latter has been completed by the addition of the posterior branches of the seventh and eighth cervical, but is supplemented as a rule by a small branch from the seventh, while the first dorsal gives off no posterior cord fibres at all. Further, the supra-scapular and circumflex nerves not only arise quite close together, but have this also in common, that their fibres are mainly derived from the fifth and sixth cervical, though the circumflex receives in addition a small bundle from the seventh cervical. The bullet would seem therefore to have picked out the cord formed from the union of the posterior branches of the anterior primary divisions of the fifth and sixth cervical nerves before (to the proximal side of) its amalgamation with corresponding branches of the seventh and eighth cervical. This will explain the escape of the other branches from the posterior cord of the brachial plexus, viz., the musculo-spiral and sub-scapular nerves which derive their fibres almost exclusively from the seventh and eighth cervical nerves. *Thus the focal nature of the lesion admits of adequate anatomical explanation.*

The absence of circumflex anæsthesia may be explained in one of two ways :—(1) By supposing that the supra-clavicular and supra-acromial branches from the third and fourth cervical nerves, which ramify over the prominence of the shoulder, had in this case a larger distribution than normally, or that during the four or five weeks between the time of injury and the admission of the patient to 3 General Hospital they had taken over the circumflex area supply which may have been distinctly anæsthetic to begin with. (2) The sensory fibres of the circumflex may be mainly contained in that portion of the nerve which is derived from the seventh cervical and may thus have escaped altogether.

It is difficult to conceive of a more likely condition than this for the occurrence of most widespread "concussion" symptoms, considering the close proximity of other nerve cords and branches, yet neither history nor clinical condition, as I saw it, gave the slightest indication of anything of the sort.

Case 15.

Laceration (complete severance) of right ulnar nerve below elbow. Motor, sensory, and "trophic" disturbances extreme. Operation.

Size of gap (6 cm.) precluded complete approximation of divided ends; intervening fibrous tissue "ribboned" and telescoped; ends brought by suture to within 2 cm. of each other.

Early and satisfactory return of motor and "trophic" functions; sensory return delayed, but in the end satisfactory.

Private Pelkey.—Wounded on 27th February, 1900, at Paardeberg; range 50 yards; Martini.

Admitted to 3 General Hospital 12 days later. Entrance wound (1 cm.), right forearm, ulnar border, 7 cm. below tip of olecranon; exit wound (2·5 by 1 cm.), right cubital region, 8·5 cm. from entrance wound, just in front of and below the internal humeral epicondyle; bullet track obliquely across inside of elbow and upper part of forearm, close to ulna, passing through the muscular mass arising from the internal humeral epicondyle, inter-muscular septum, and humeral ridge; bone uninjured; exit wound suppurated for some time. (Fig. 12.)

Symptoms of complete severance of Ulnar nerve present on admission.—Flexor carpi ulnaris, interossei, and adductor of thumb, completely paralysed; flexor profundus digitorum weakened; hypothenar muscles inefficient. Complete anæsthesia over the ulnar portion of the hand (palmar and dorsal aspects), also over the whole of the little finger, the whole dorsal aspect of the ring finger, and the ulnar half of its flexor aspect; also an indefinite area of anæsthesia on the ulnar, and ulnar-posterior, margin of the middle finger. "Trophic" disturbance, present on admission, became progressively more marked; blanching of the skin, tendency to ulceration, wasting of flexor carpi ulnaris, hypothenar eminence, and (later) thenar eminence; wasting of the interossei soon apparent in the longitudinal furrowing between the metacarpals.

Operation (4½ weeks after the injury).—Ulnar nerve exposed and defined, both below the point of damage and above the place where it perforates the flexor carpi ulnaris; a gap, fully 6 cm. in length, found to exist in the continuity of the nerve, the material filling up the space between the ends consisting of a very dense cicatricial tissue; approximation of the divided ends found impracticable; the intervening tissue therefore left in position, but freely split or "ribboned," then telescoped until the ends were within 2 cm. of each other, the longitudinal slits being thus widened; new nerve growth along these spaces being hoped for. (Figs. 12, A and B.) Wound sutured; aseptic course.

"Trophic" changes in skin and muscles early recovered from and motor function gradually but surely restored. Sensation showed no sign of return for about a fortnight, but was thereafter gradually recovered.

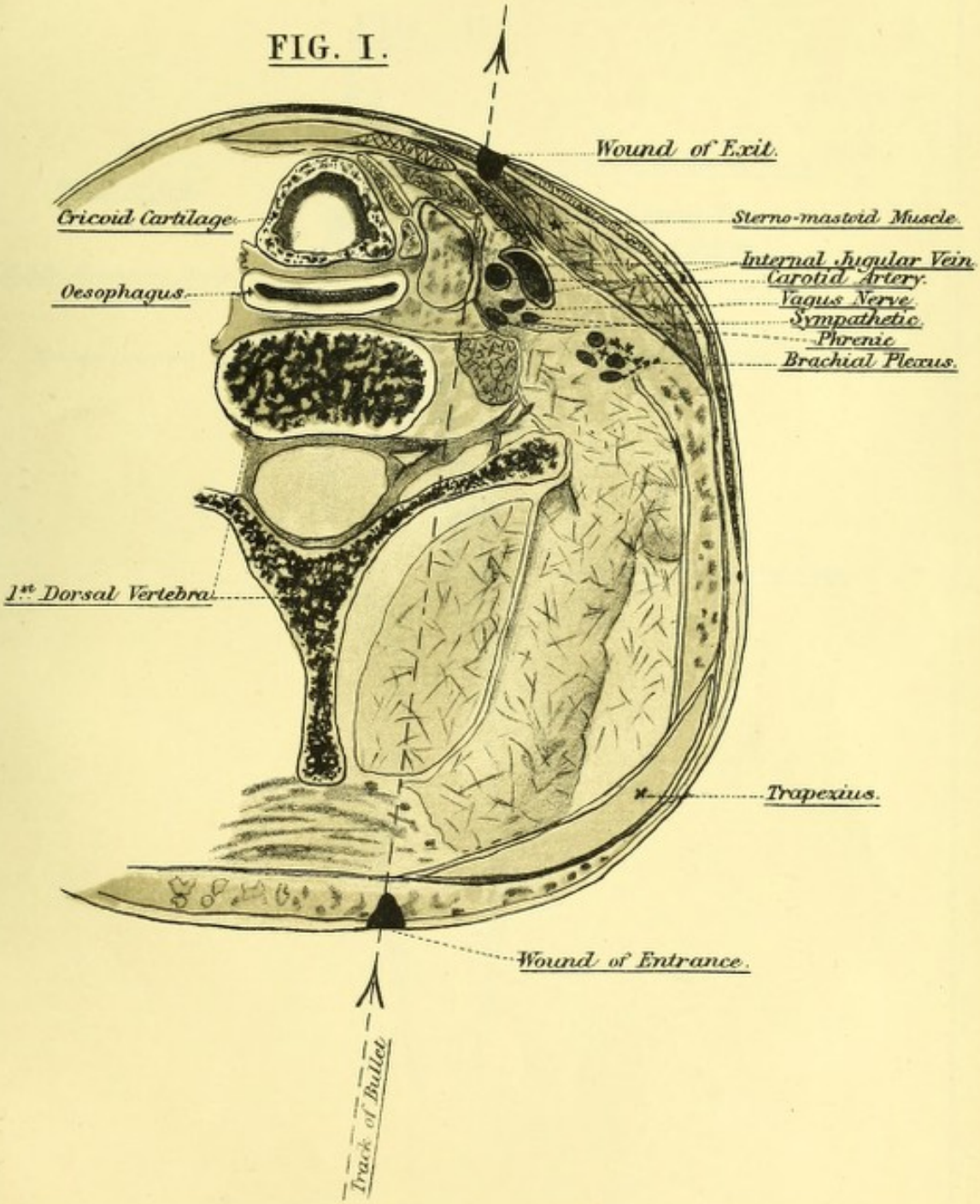
Note.—As regards the actual operative method adopted, several other procedures besides the one actually adopted were considered, such as nerve lengthening, and displacement of the nerve trunk to the anterior aspect of the internal humeral epicondyle. The expedient decided upon and carried out was suggested by the recollection of a somewhat similar plan adopted in the radical treatment of certain forms of spina bifida

CROSS SECTION OF THE NECK OBLIQUELY MADE SO AS TO PASS THROUGH THE 1ST DORSAL VERTEBRA BEHIND AND CRICOID CARTILAGE IN FRONT.

(Note:-The cricoid cartilage is higher in the neck than the 1st Dorsal vertebra, it corresponds really to the 6th cervical.)

D. Thomas.

FIG. I.



Note:- The arrow indicating the direction of the bullet track should pass forward in closer relation to the vessels than is here represented.

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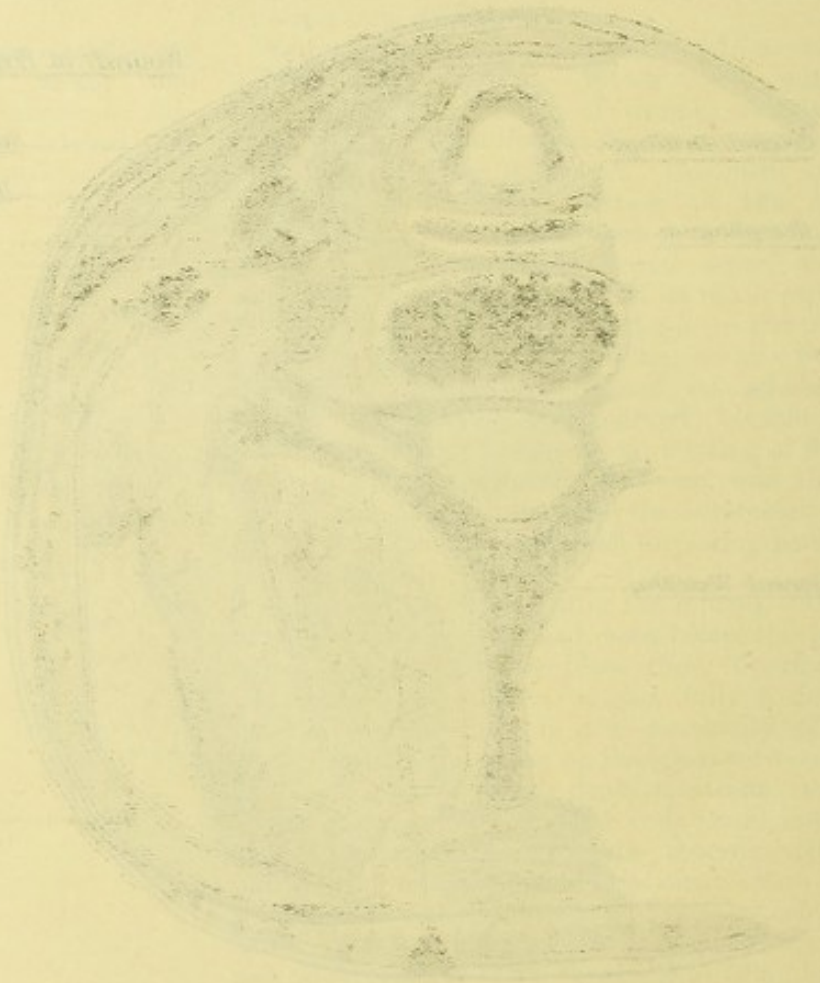
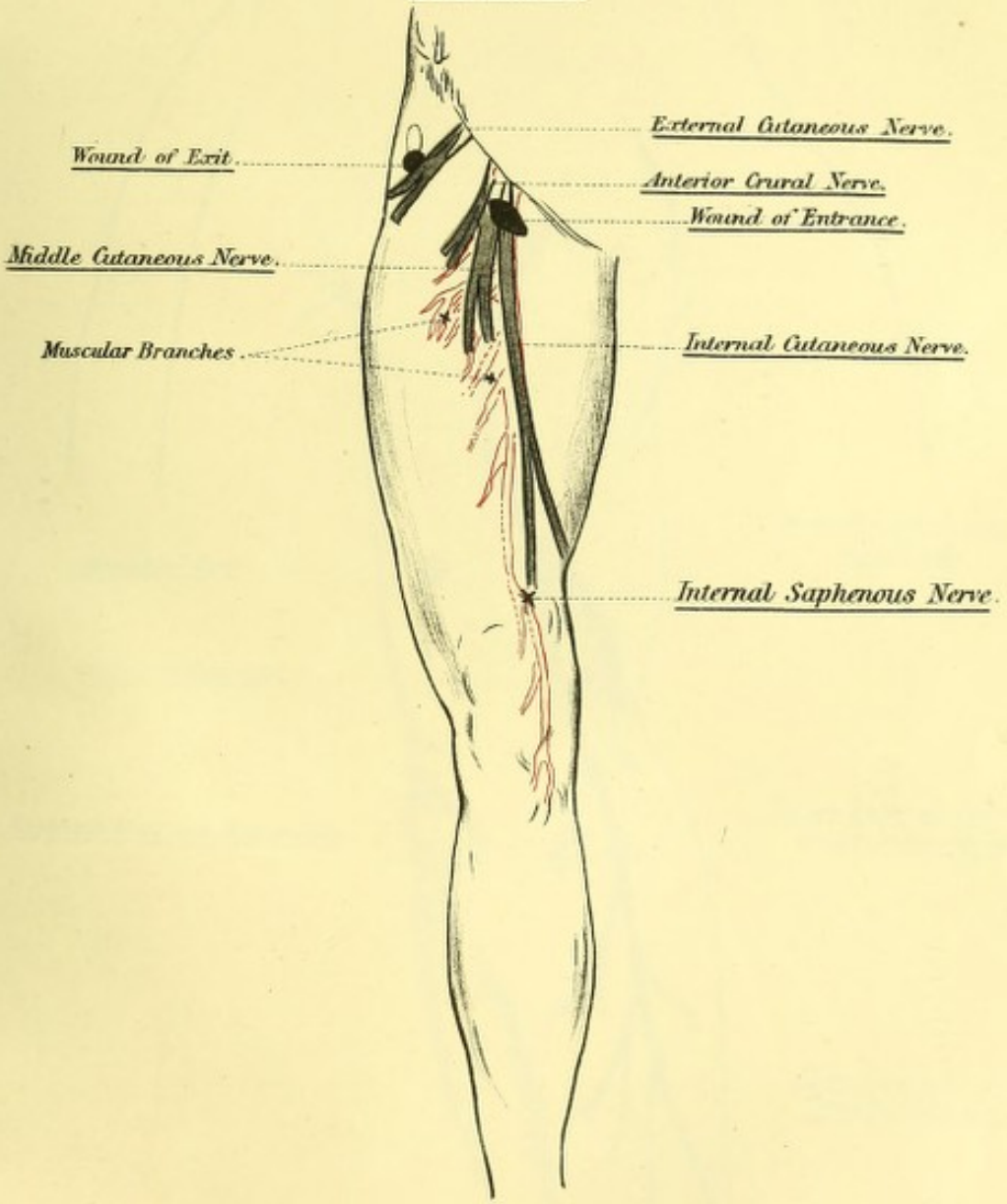


DIAGRAM TO SHOW RELATION OF BULLET TRACK, NOT ONLY TO THE AFFECTED CUTANEOUS BRANCHES, BUT TO THE DEEPER MUSCULAR AND CUTANEOUS BRANCHES SO CLOSELY RELATED TO THE OTHERS AT THE POINT INJURED.

A. S. Cheetham.

FIG. II.



The Muscular and Internal Saphenous nerve branches are coloured red.

5636 8.05

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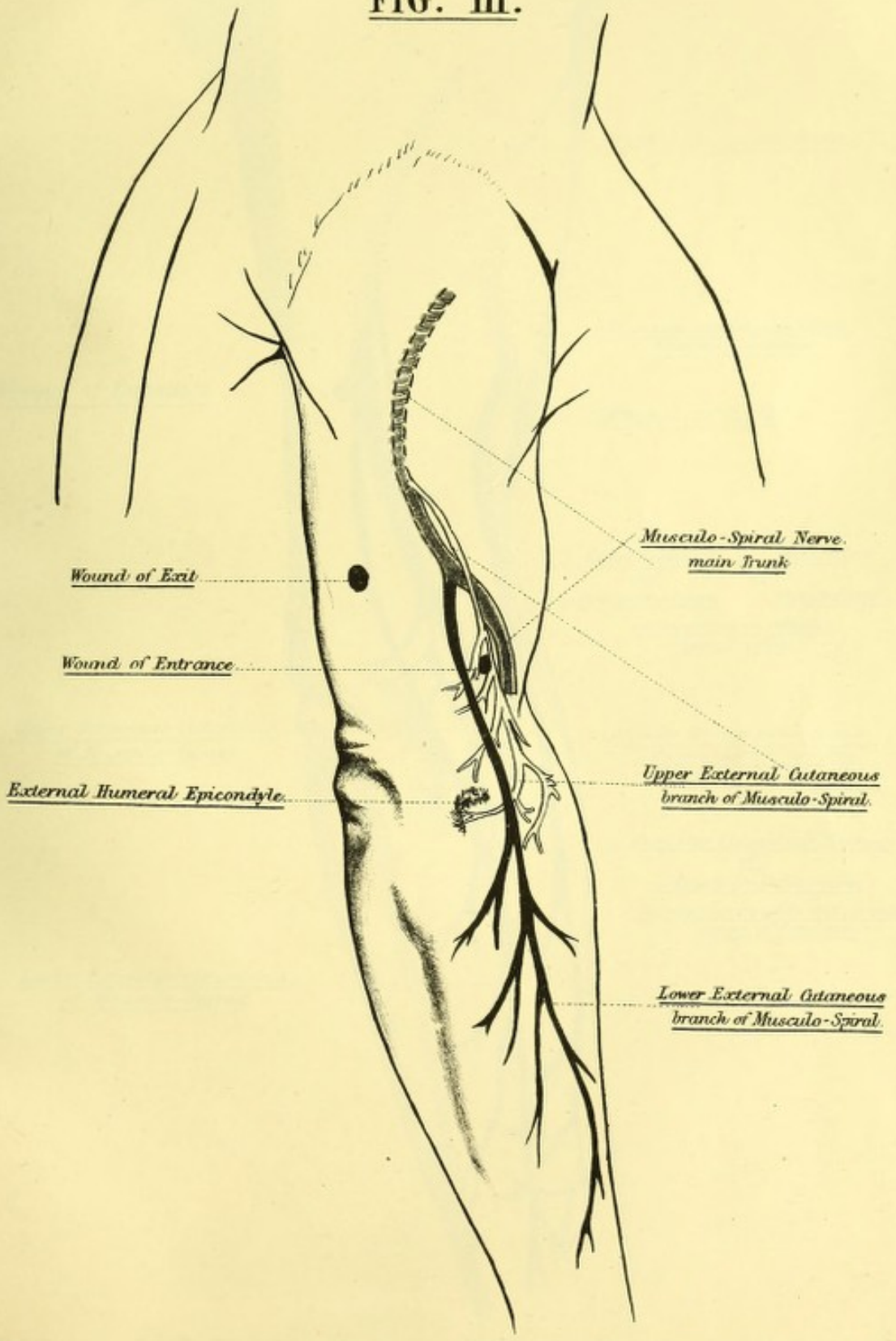
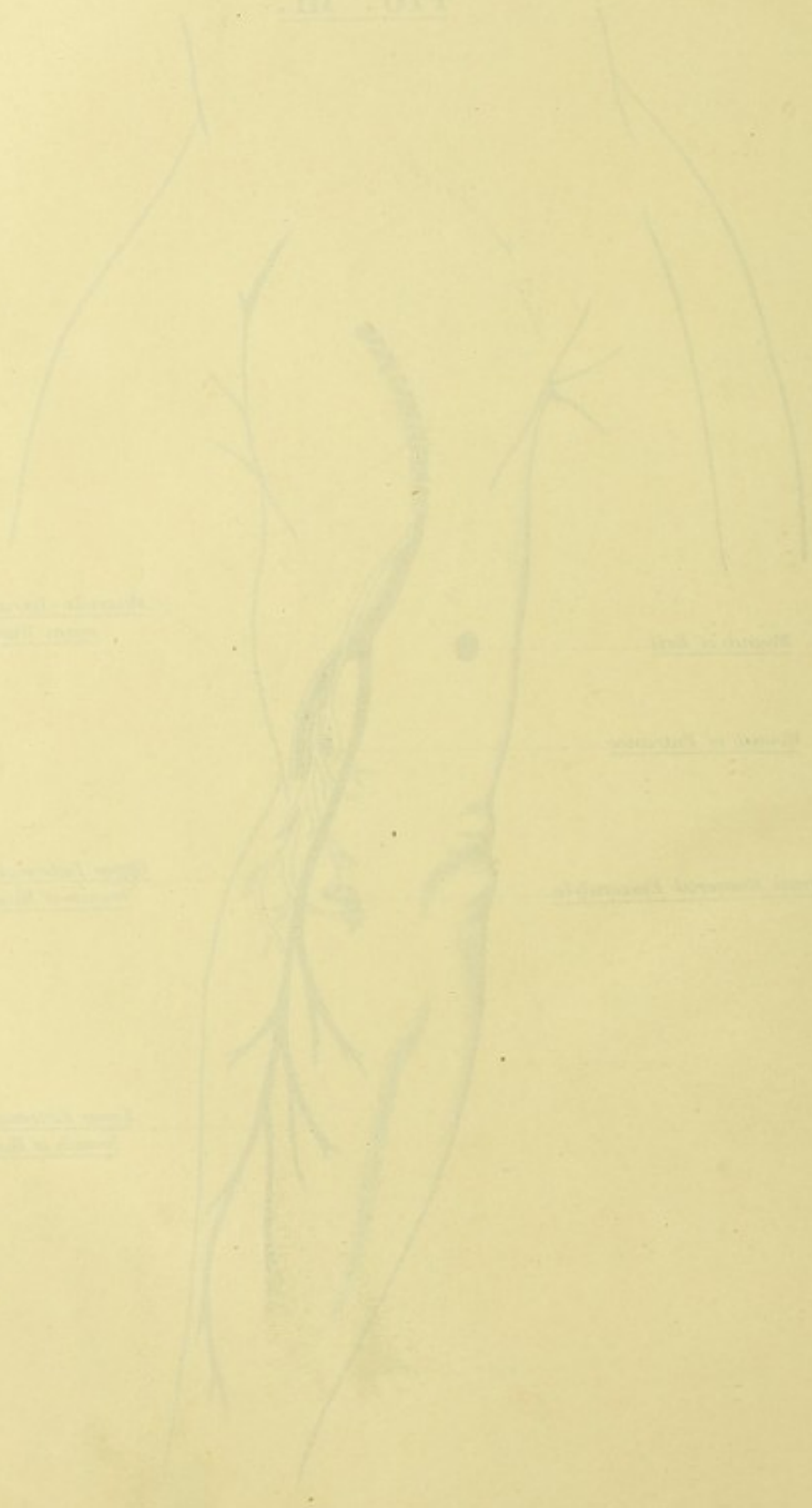
POSTERO EXTERNAL ASPECT OF ARM AND FOREARM, TO SHOW RELATIONS OF CUTANEOUS BRANCHES OF MUSCULO-SPIRAL NERVE TO THE BULLET TRACK.

Wm. Mc. Allister.

FIG. III.



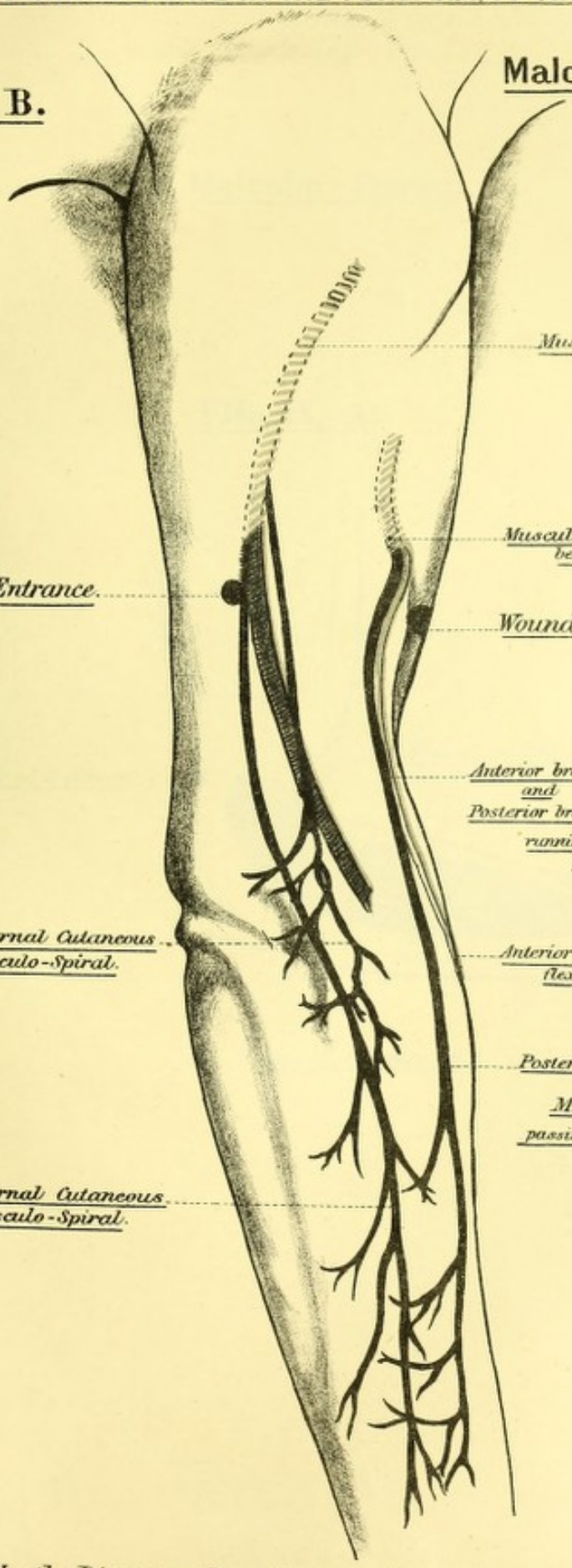
5636. 8. 05.



EXTERNAL ASPECT OF ARM AND FORE-ARM, TO SHOW RELATIONS OF THE CUTANEOUS BRANCHES OF MUSCULO SPIRAL NERVE, AND THE MUSCULO-CUTANEOUS NERVE IN THE FOREARM, TO THE BULLET TRACK.

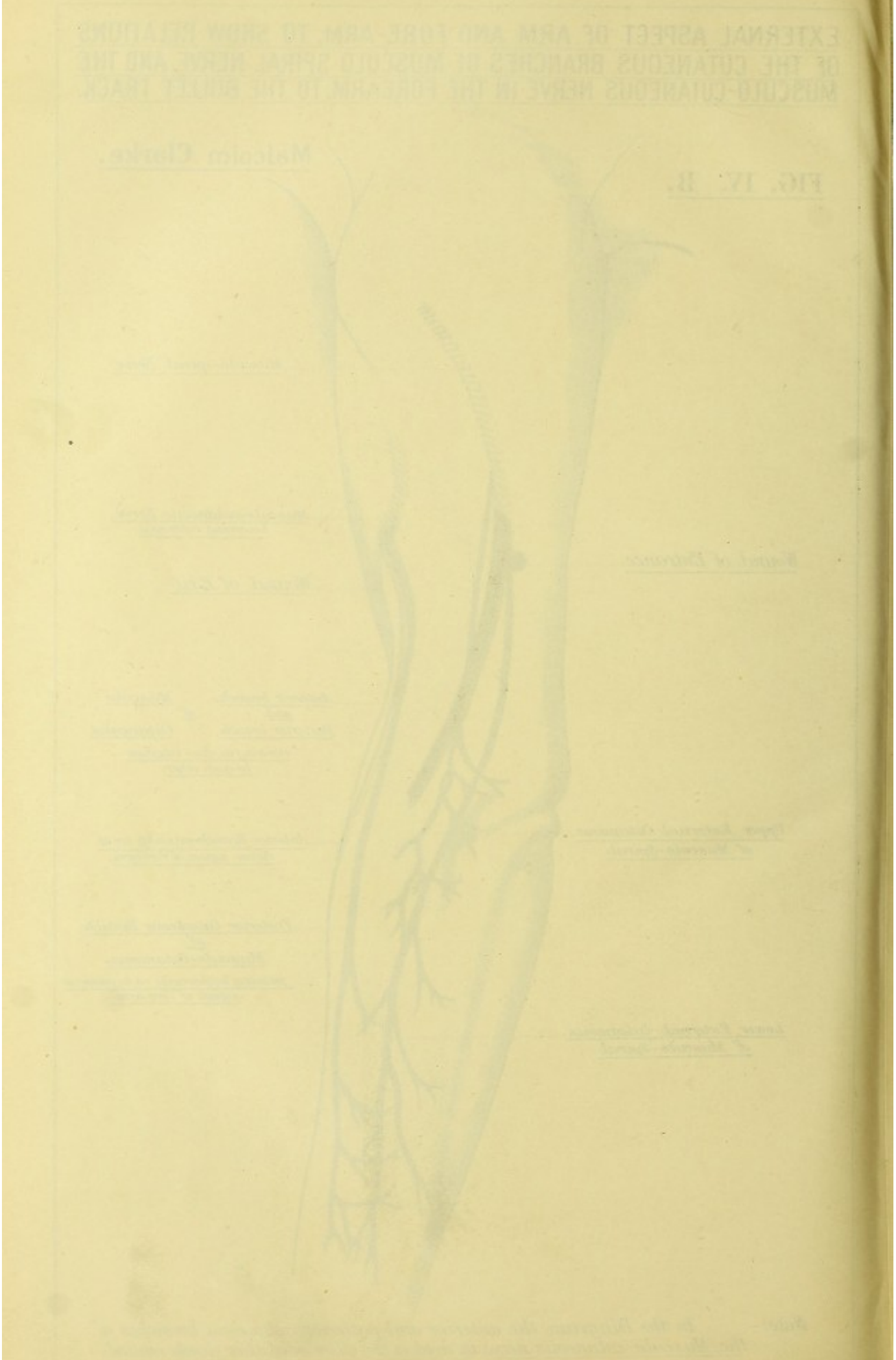
FIG. IV. B.

Malcolm Clarke.



Note:- *In the Diagram, the anterior and posterior cutaneous branches of the Musculo-cutaneous nerve in front of the elbow are rather closely related.*

3038. 8.05.



Malcolm Clarke.

FIG. IV. A.

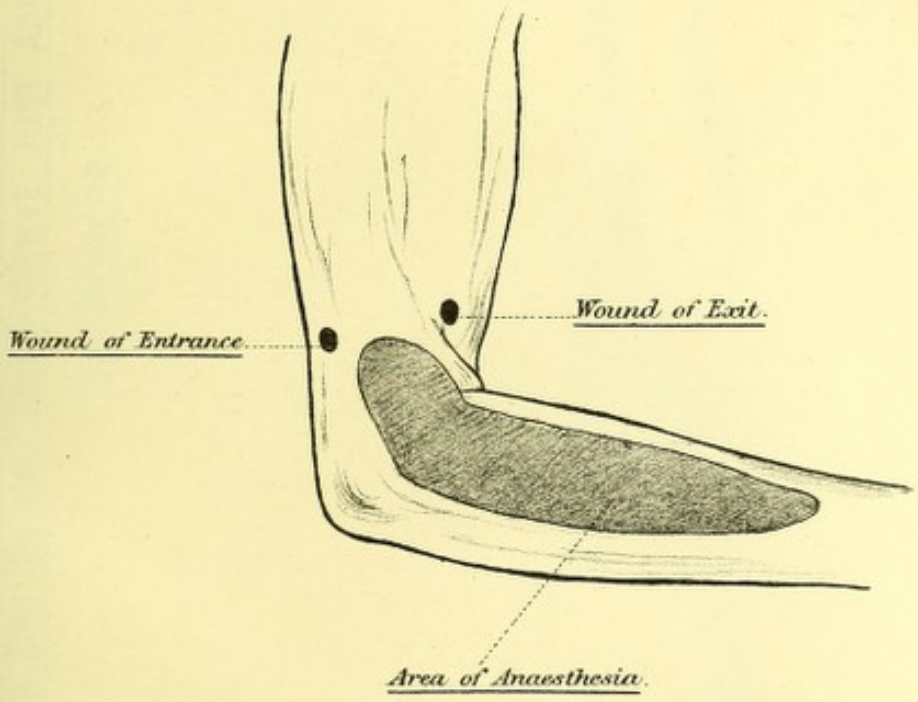


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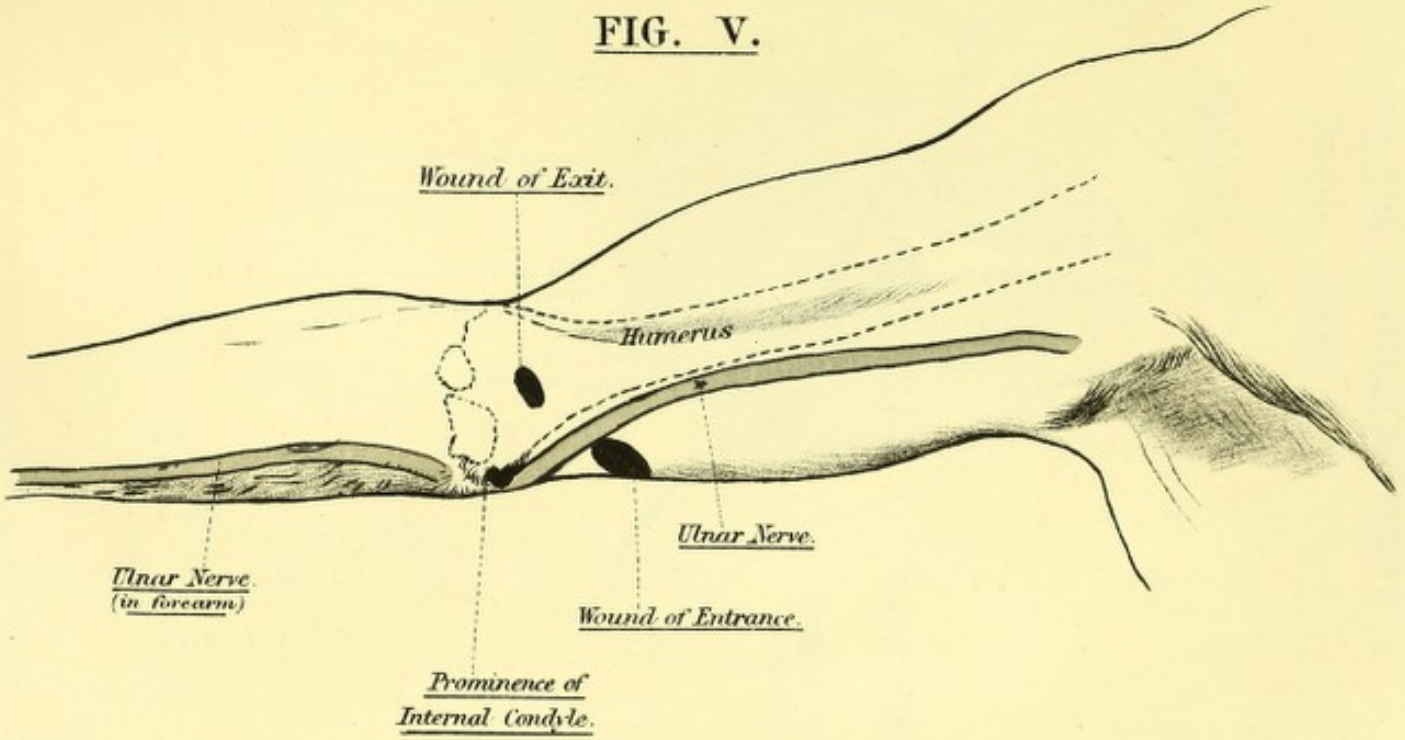
DIAGRAM TO SHOW THE RELATION OF THE WOUNDS OF ENTRANCE AND EXIT TO THE ULNAR NERVE JUST ABOVE ELBOW.

J. Osborne.

FIG. V.



5636. 8. 05

Miller & Graham Ltd. Litho. London.

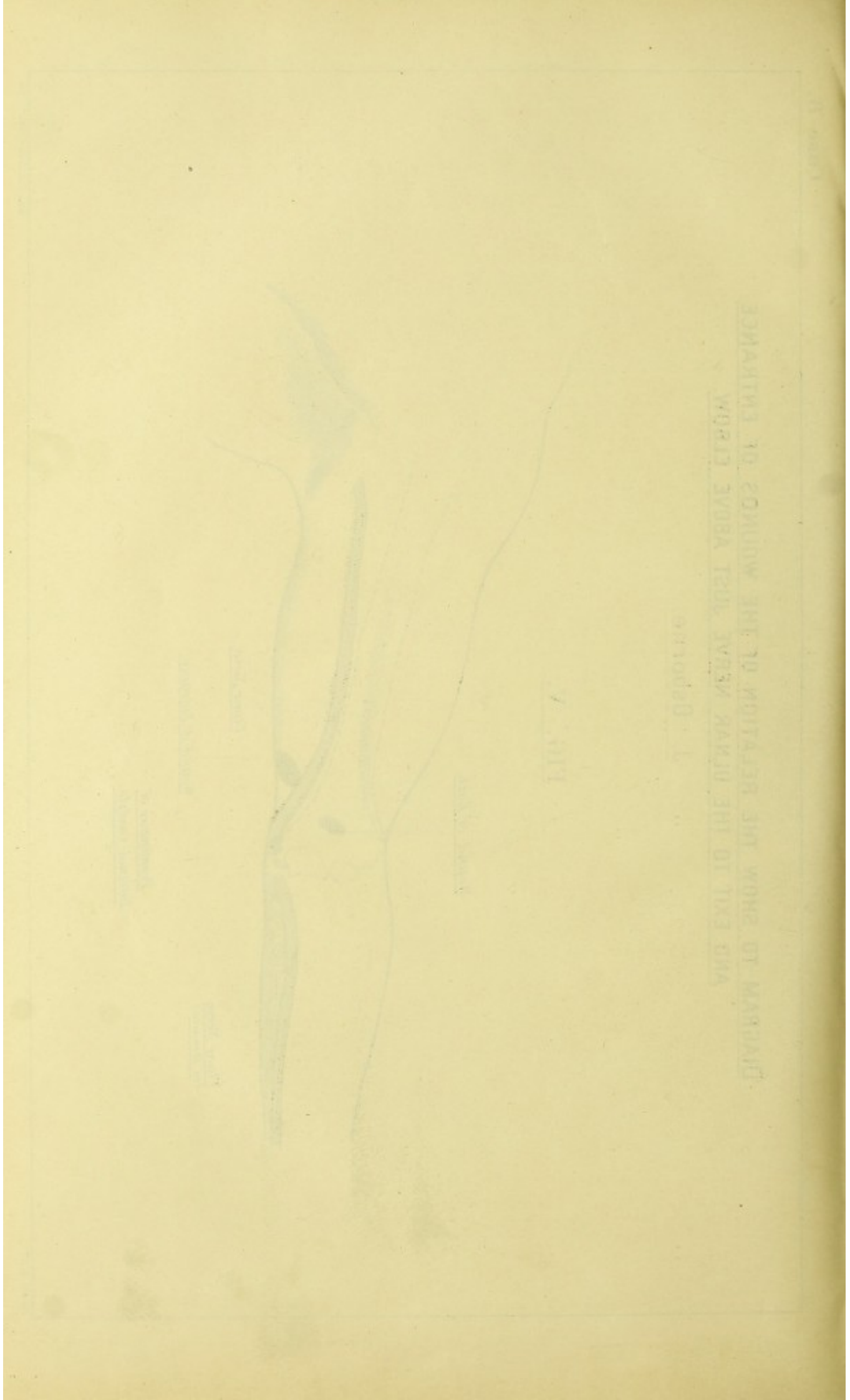
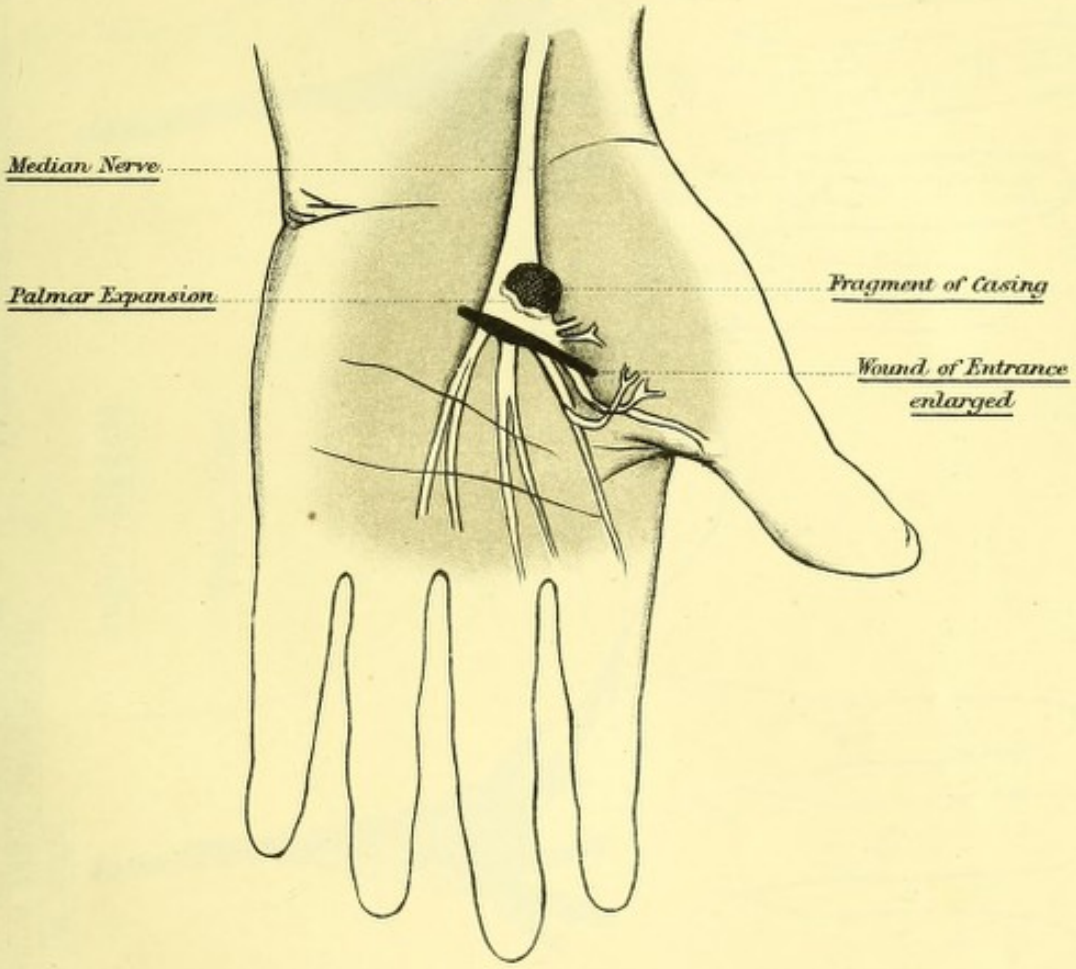


DIAGRAM TO SHOW RELATIONS OF THE EMBEDDED FRAGMENT OF CASING TO (1) THE ENTRANCE WOUND, (2) THE PALMAR EXPANSION OF MEDIAN NERVE AND THE SEVERAL BRANCHES TO INTRINSIC THUMB MUSCLES AND THE PARTICULAR DIGITS.

Angus Liggett.

FIG. VI. A.



Note:- On separate diagrams are shown (1) the position of the casing fragment with reference to the carpals and meta-carpals. (2) the relations of the incisions made at the two operations.

5636. 8. 05

THIS DIAGRAM SHOWS THE RELATION OF THE INCISION MADE AT THE 2ND OPERATION (FREEING OF THE NERVE EXPANSION) TO THE ORIGINAL WOUND (ENLARGED AT THE 1ST OPERATION), AND TO THE COURSE OF THE MEDIAN FROM ABOVE THE WRIST TO ITS DIVISION IN THE PALM.

THIS DIAGRAM SHOWS THE RELATION OF THE FRAGMENT OF CARTRIDGE CASING TO THE PROXIMAL EXTREMITIES OF THE METACARPALS OF THE FORE AND MID-FINGERS AND TO THE MEDIAN NERVE EXPANSION.

Angus Liggett.

FIG. VI. C.

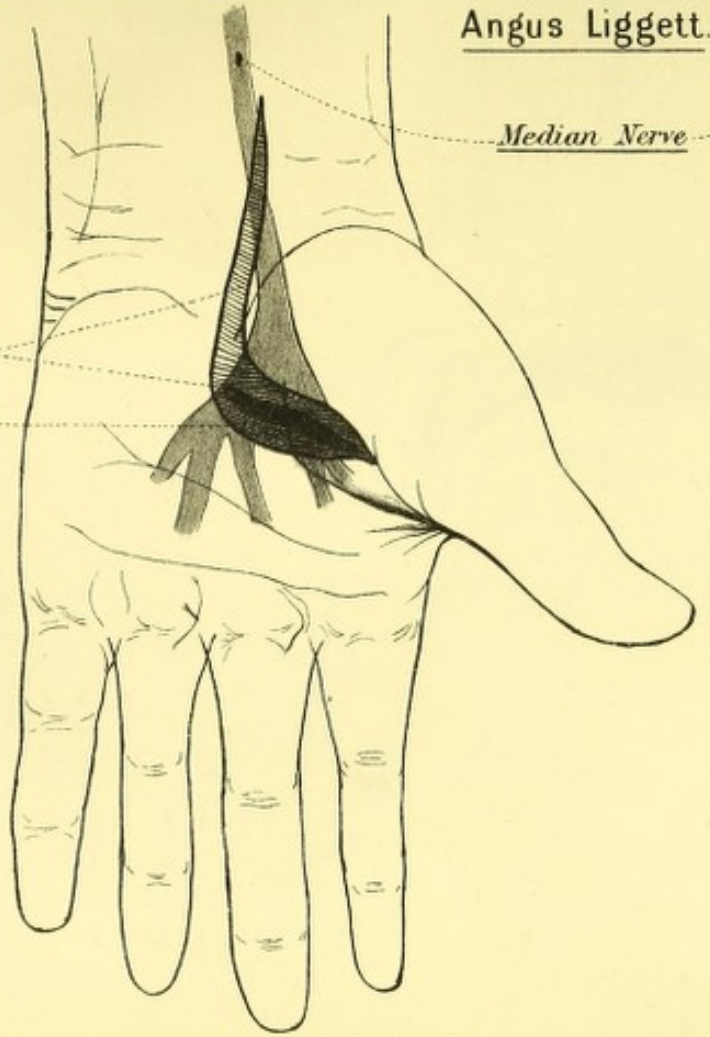
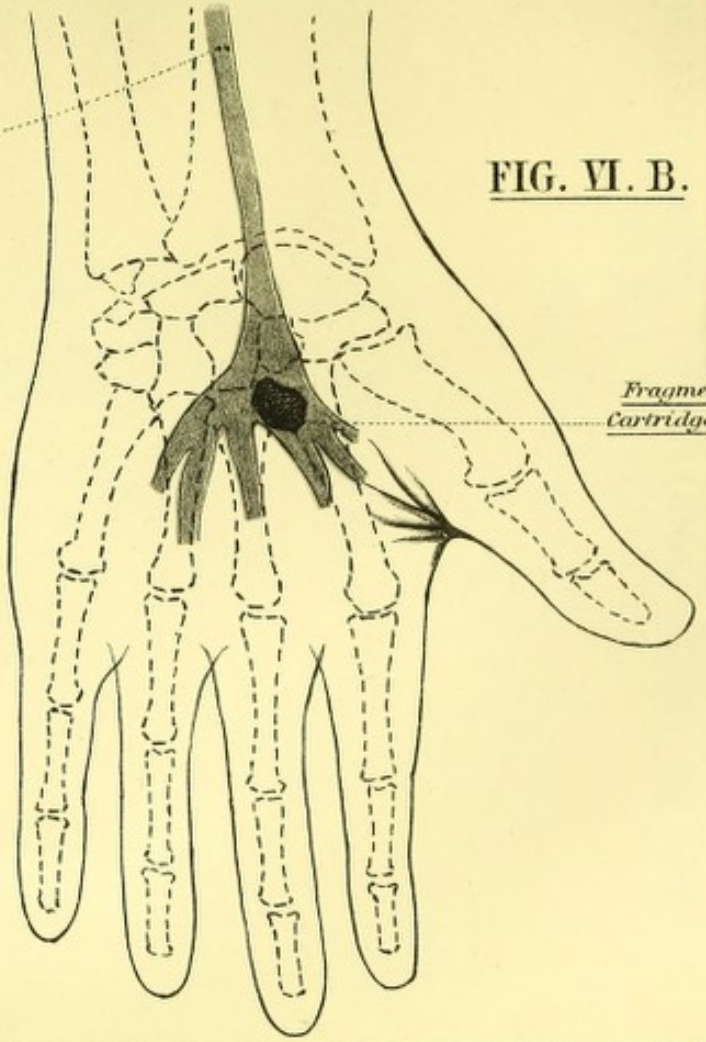


FIG. VI. B.



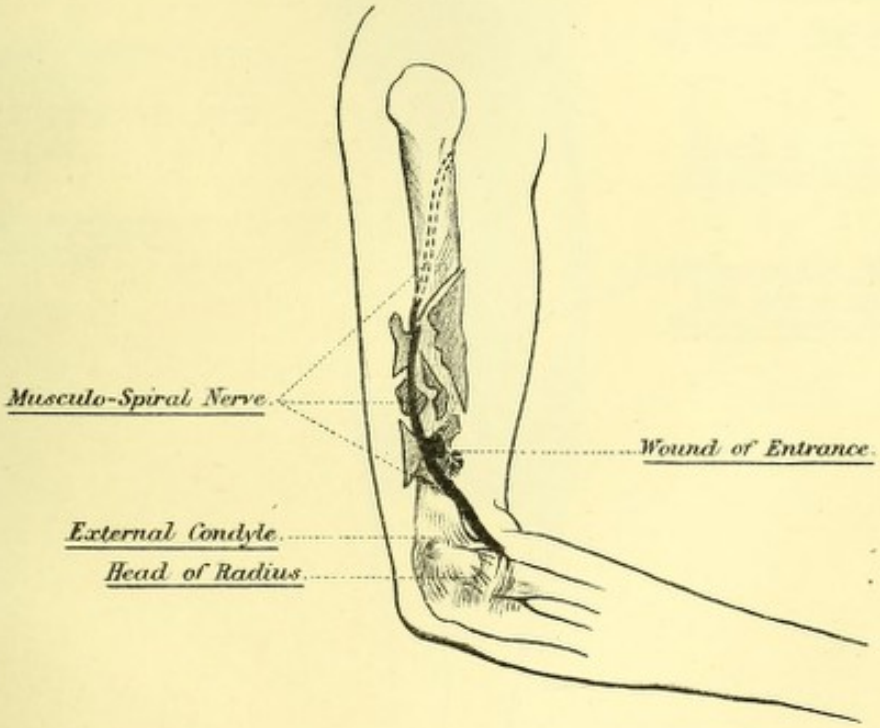
5636. 8. 05.

Waller & Graham 2nd. Litho. London.

EXTERNAL ASPECT OF RIGHT UPPER EXTREMITY TO SHOW RELATION OF ENTRANCE WOUND TO FRACTURED BONE AND MUSCULO-SPIRAL NERVE TRUNK. THE EXIT WOUND (ON INTERNAL ASPECT OF ARM) IS NOT REPRESENTED.

John G. Wagstaff.

FIG. VII.

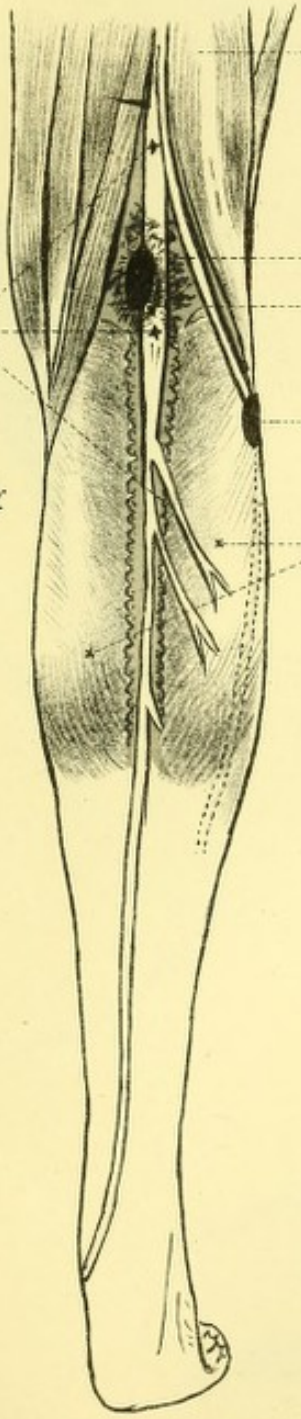


The Figure above represents pretty accurately the degree of comminution as ascertained by X rays.

5636 8.05.

James Marrey.

FIG. VIII. A.

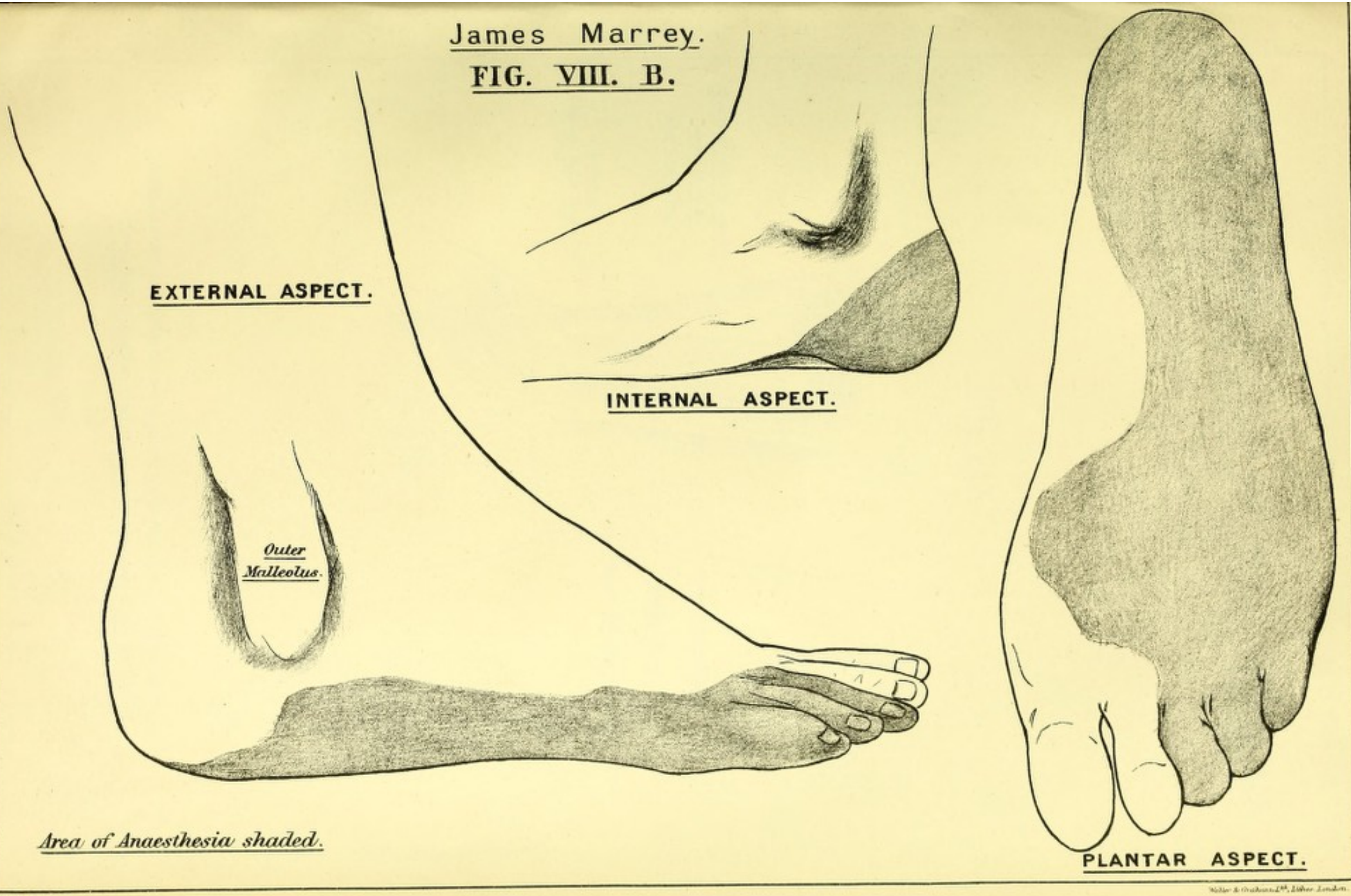


Note:- Wound of Entrance should in reality be placed over the thickened Internal Popliteal Nerve, but has been, in the diagram, displaced a little to display the button hole perforation of the nerve by the bullet.

5836. 8. 05.

James Marrey.

FIG. VIII. B.

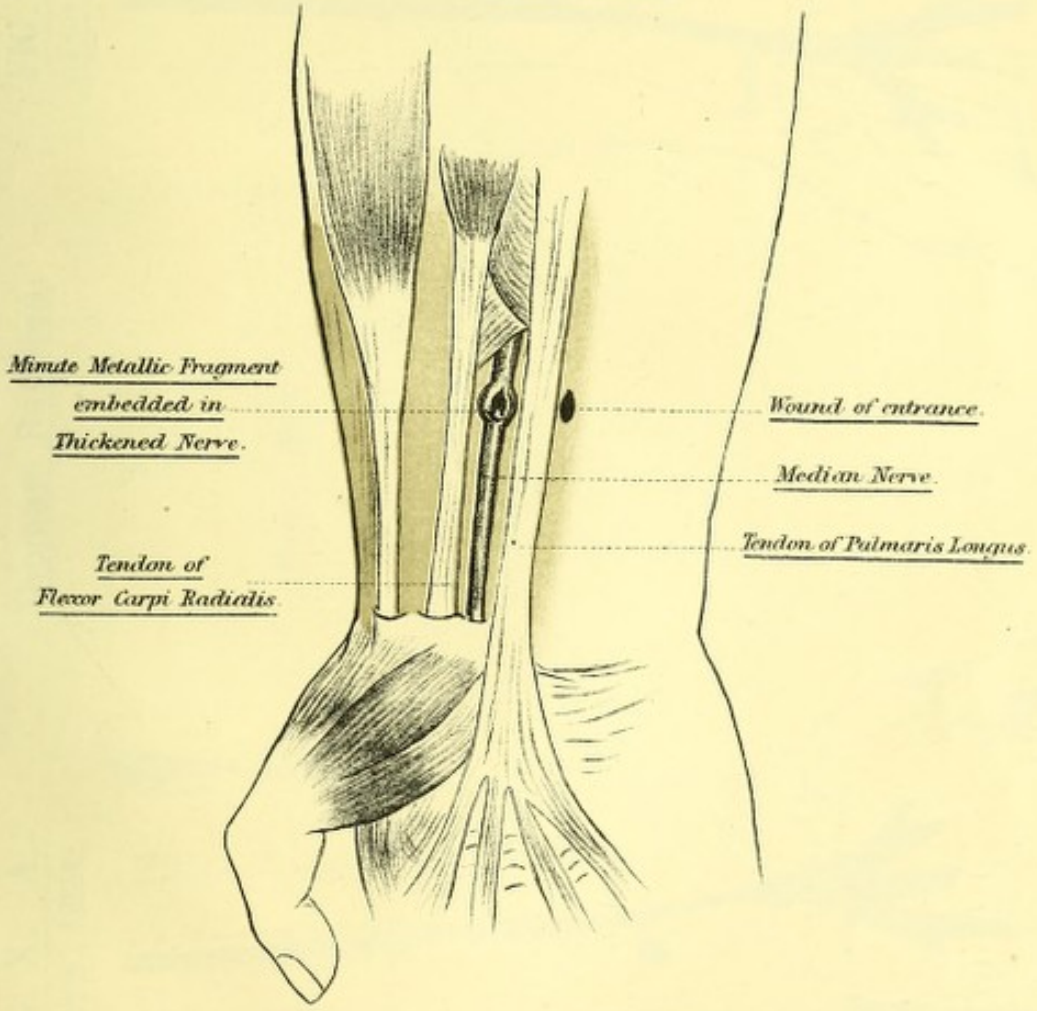


Area of Anaesthesia shaded.

DIAGRAM TO SHOW AFFECTED PART OF MEDIAN NERVE-WITH NEUROMATOUS THICKENING, AND EMBEDDED FRAGMENT.

John Crowley.

FIG. IX.



Note:-In order to display the nerve properly it has been displaced slightly to radial side, from under cover of Palmaris Longus Tendon.

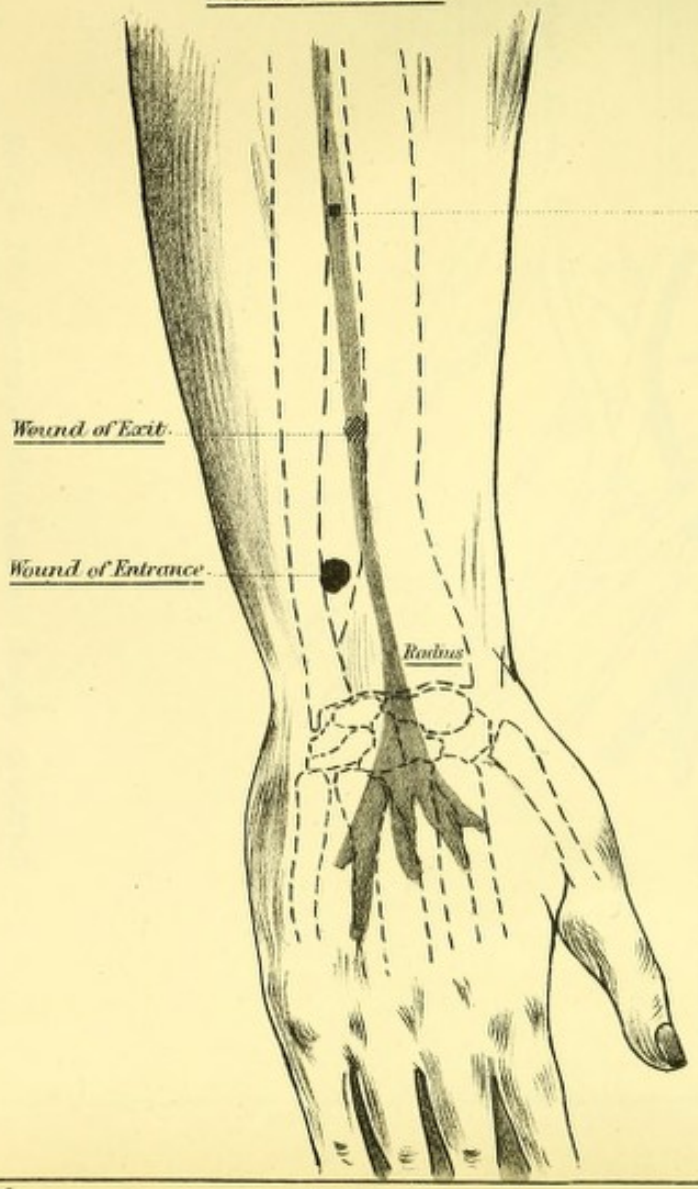
5636 8.05

DIAGRAMS SHOWING THE RELATIONS OF WOUNDS OF ENTRANCE AND EXIT TO THE MEDIAN NERVE AND BONES OF FOREARM.

Thomas Randles.

FIG. X. A.

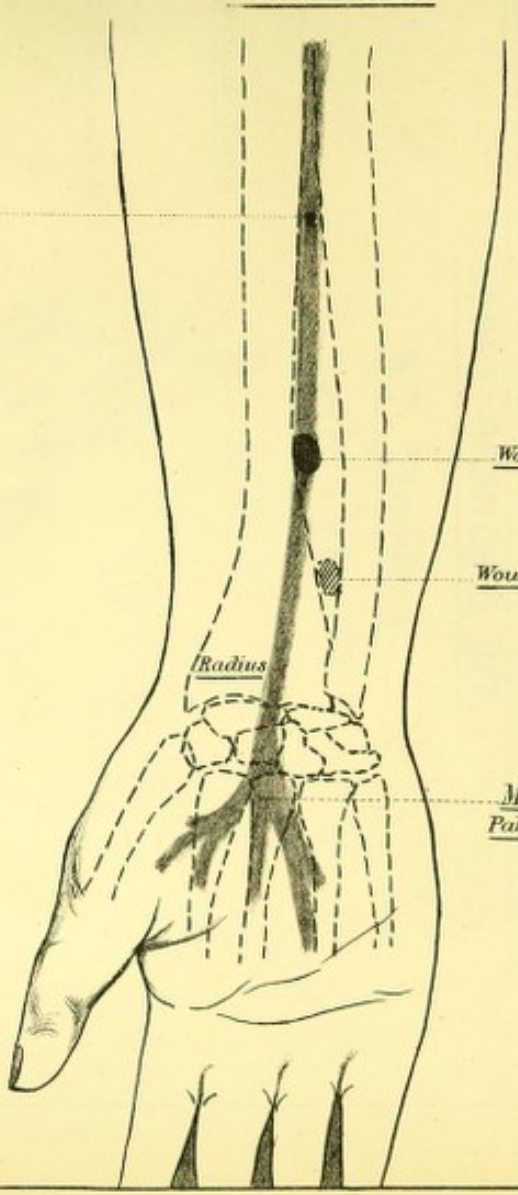
EXTENSOR ASPECT



Median Nerve

FIG. X B.

FLEXOR ASPECT



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Waller & Graham, Lith. London.

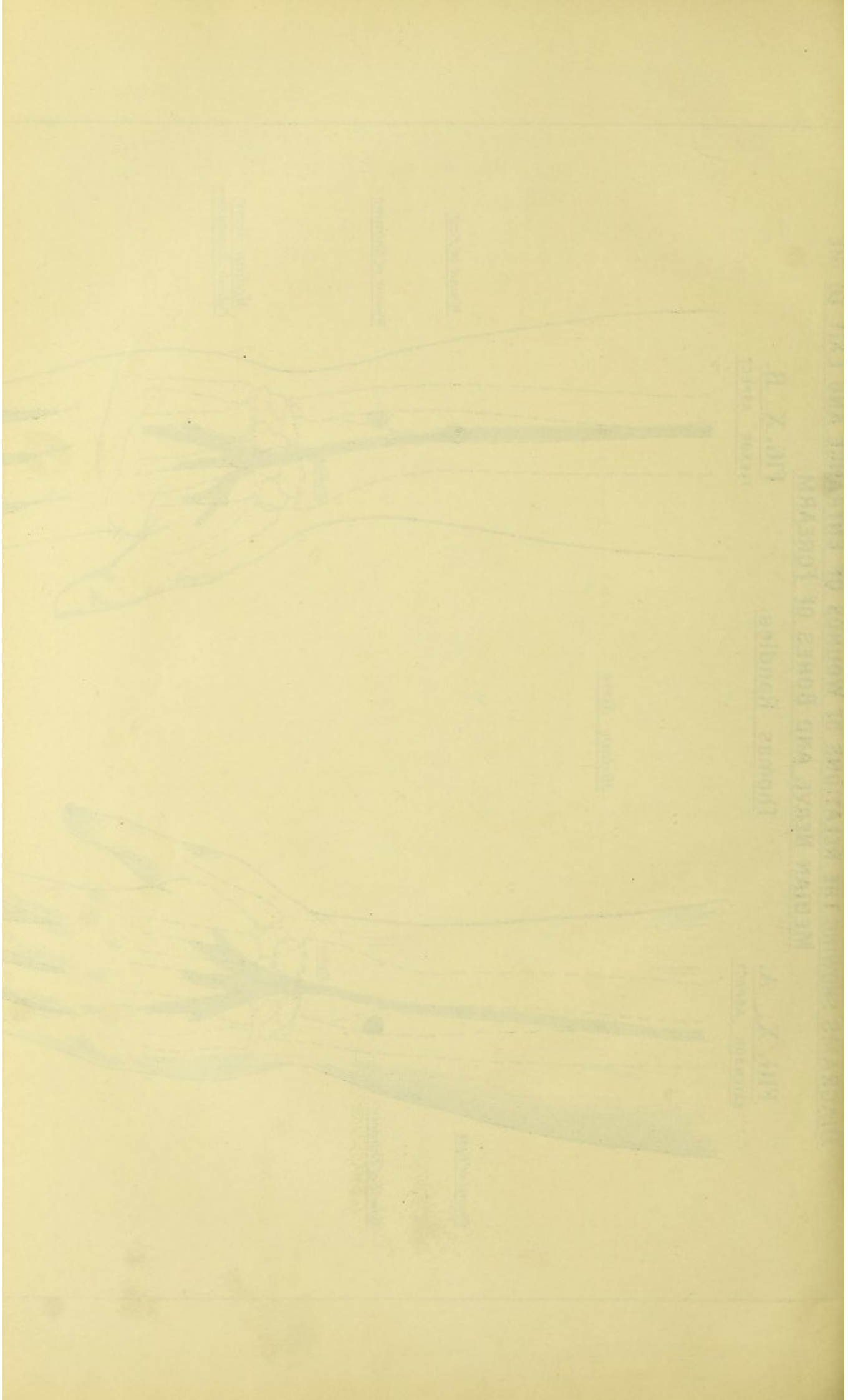
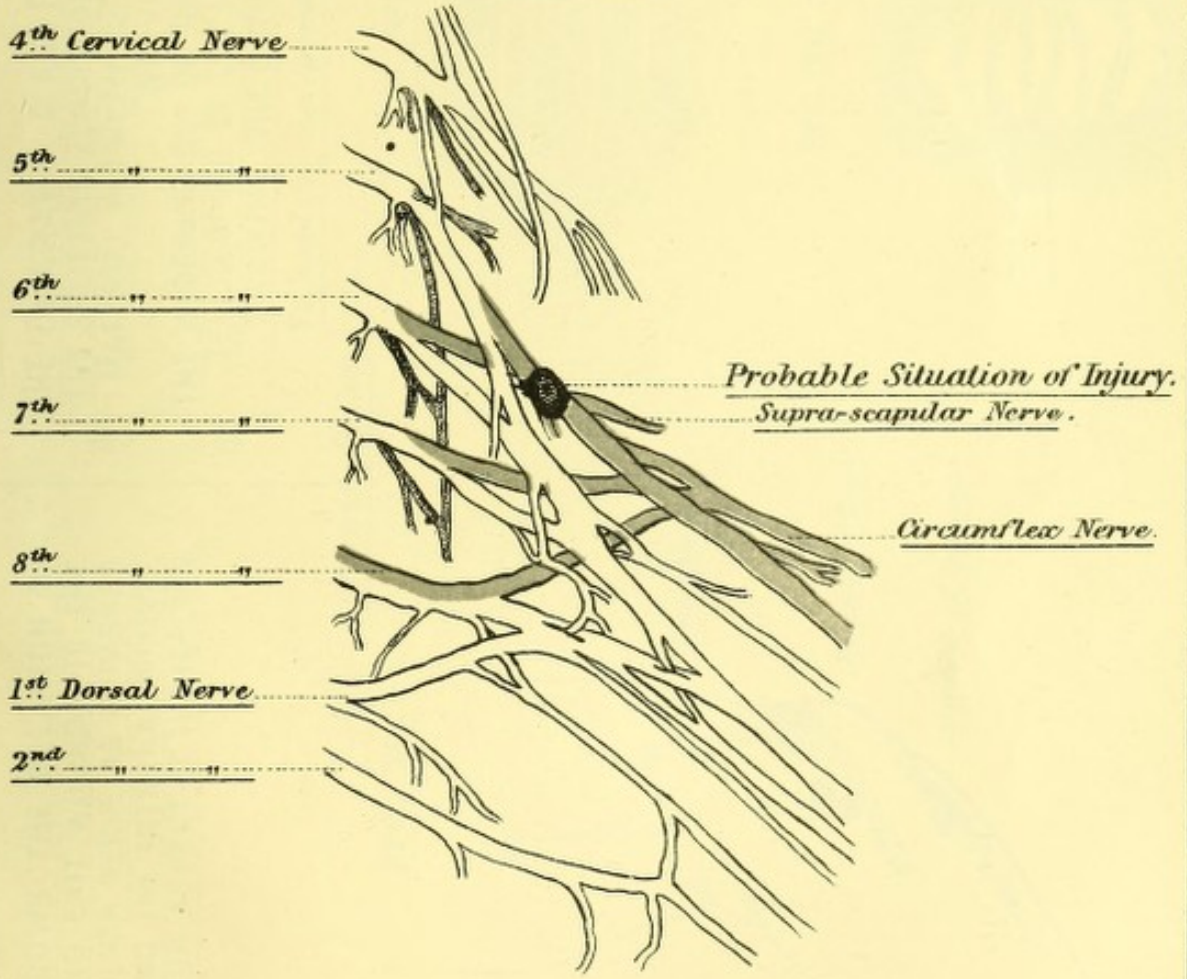


DIAGRAM TO SHOW THE RELATIONS OF THE CORDS OF THE BRACHIAL PLEXUS, AND THE PROBABLE SITE OF DAMAGE,—CORD FORMED FROM POSTERIOR BRANCHES OF ANTERIOR PRIMARY DIVISIONS OF THE 5TH AND 6TH CERVICAL NERVES JUST BEFORE SUPRA-SCAPULAR NERVE BRANCHES OFF.

Wm. Stoddern.

FIG. XI.



Note:— The posterior divisions are deeply coloured.

5636. 8.05.

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THIS DIAGRAM SHOWS THE RELATION OF THE ENTRANCE AND EXIT WOUNDS TO THE COURSE OF THE ULNAR NERVE AS IT PASSES ROUND FROM BEHIND THE INTERNAL CONDYLE TO REACH THE FLEXOR ASPECT OF THE FOREARM.

A THE DIAGRAMS A AND B. REPRESENT DIAGRAMMATICALLY THE SPLITTING LONGITUDINALLY OF THE INTERVENING MATERIAL BETWEEN THE ENDS OF THE DIVIDED ULNAR NERVE, — AND

B THE WIDENING OUT OF THE SLITS THUS MADE BY THE TELESCOPING OF THE INTERVENING MASS IN DRAWING THE SUTURE MODERATELY TIGHTLY.

To explain the operative procedure adopted.

Ambrose Pelkey.

FIG. XII.

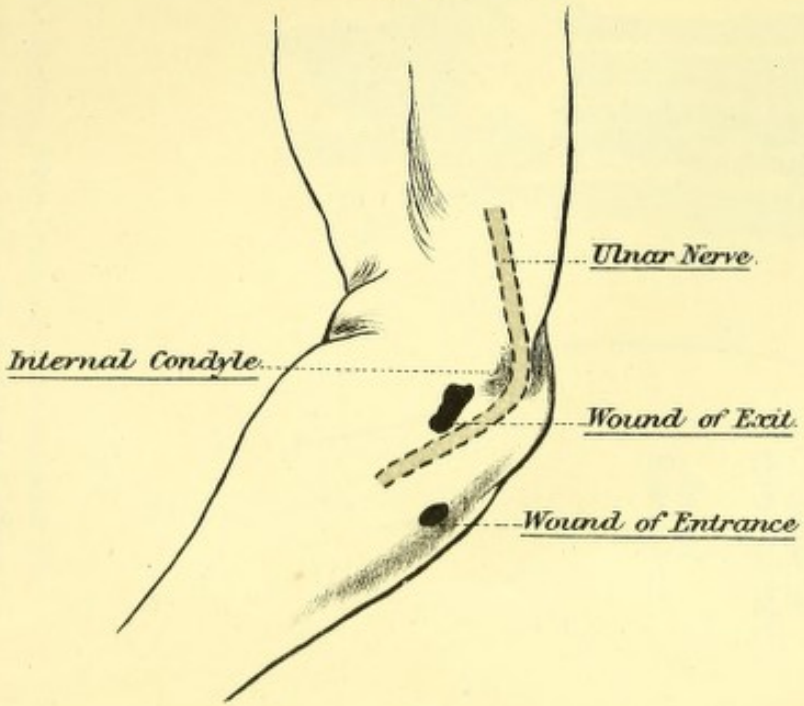


FIG. XII. A.

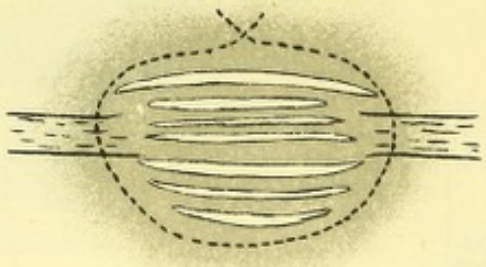
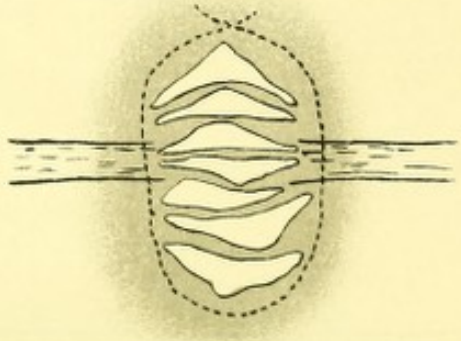


FIG. XII. B.



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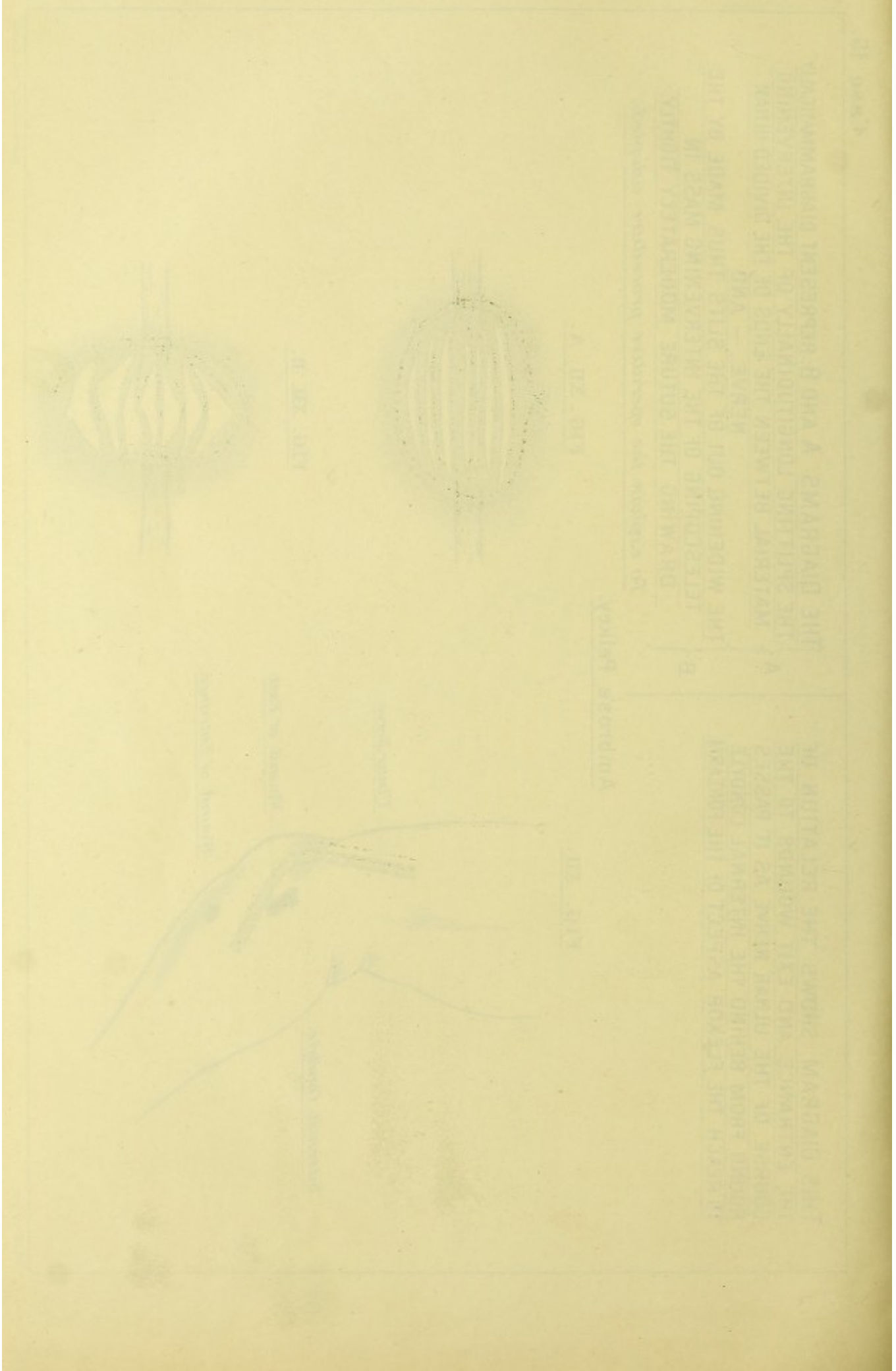
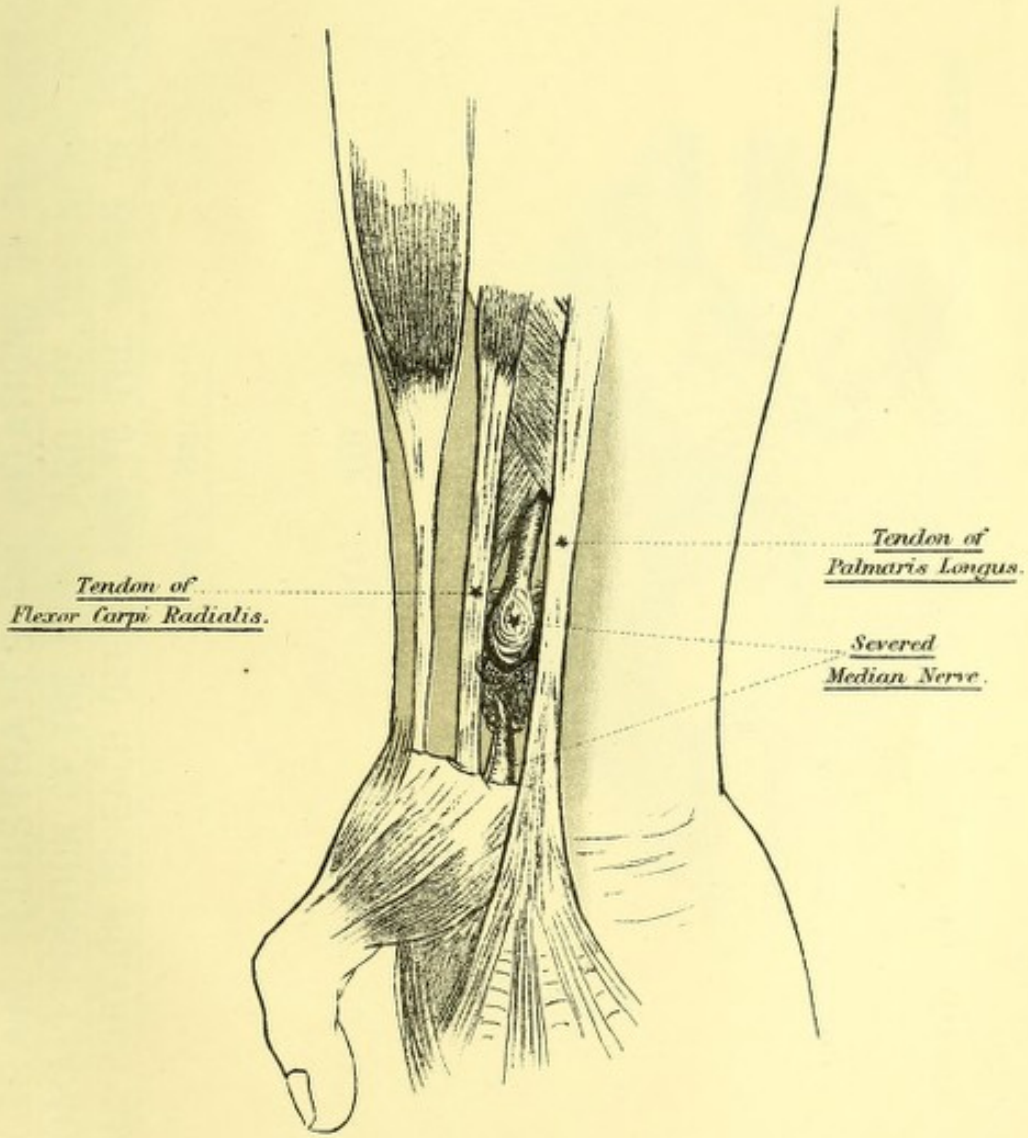


Jas. Barrett.

FIG. XIII. A.

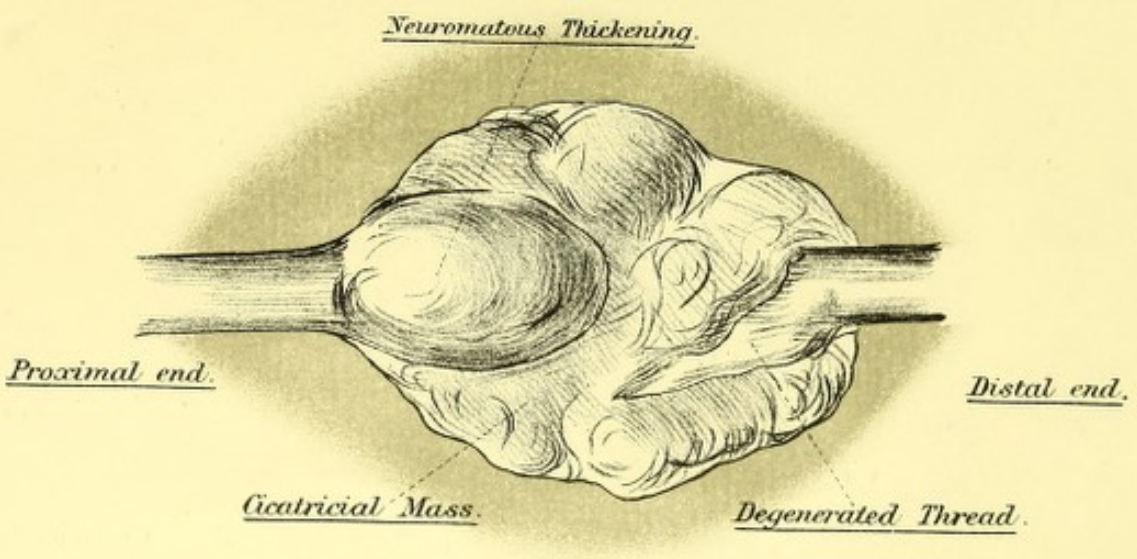


Note:-In the Diagram the Median Nerve is displaced from under the Palmaris Longus in order to display the condition of affairs as they were found; it is, therefore, too far to Radial side.

THIS DIAGRAM ILLUSTRATES THE RELATIONS OF THE BULBOUS THICKENING ON THE UPPER (PROXIMAL) PORTION OF THE NERVE AND THE DEGENERATED THREAD OF THE LOWER (DISTAL) PORTION TO EACH OTHER AND TO THE MASS OF CICATRICIAL TISSUE.

James Barrett.

FIG. XIII. B.



5636 8.05.

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(meningo-myelocele), a plan usually associated with the name of Nicoll, of Glasgow. (Figs. 12, A and B.)

CASE 16.

Laceration (complete severance) of right median nerve.

Bayonet stab.

Absolute loss of motor and sensory functions; profound "trophic" disturbance.

Operation 2½ months after original injury. Resection of "false neuroma" and scar tissue; gap 2·75 cm.; nerve suture (peri-neural).

Uninterrupted recovery of function; sensation fully restored within 24 hours.

Private Barrett.—Wounded on 17th May, 1900; bayonet stab.

Admitted to 3 General Hospital on 31st July, 1900.

Complete severance of right median nerve close above wrist; wound sutured at time of injury without the damage to the median being observed. Absolute loss of motor and sensory functions related to the peripheral distribution of the median; profound "trophic" disturbance—skin, muscles, nails, &c.

Operation (2½ months after original injury).—Ends of severed nerve trunk dissected free from cicatricial tissue; "false neuroma" on proximal end and atrophied upper portion of lower (distal) end freely cut away; resulting gap fully 2·75 cm. in length. (Figs. 13, A and B.) Ends then united by peri-neural sutures of catgut, and reunited trunk thrust under cover of tendon of flexor carpi radialis, so as to minimise risk of possible cicatricial connection with the scar in the skin. Limb fixed on splint, with wrist fully flexed, in order to relax median trunk; this gradually relaxed; aseptic course. Uninterrupted recovery.

Sensory function restored in 24 hours; motor function more gradually, but satisfactorily; "trophic" changes very rapidly corrected.

Note.—The man remained under observation for about six months, during which time the improvement was fully maintained.

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