Transverse fractures of the patella / by C.J. Manning.

TRANSVERSE FRACTURES

OF THE

PATELLA

BY

C. J. MANNING

LATE HOUSE SURGEON AT UNIVERSITY COLLEGE HOSPITAL.

LONDON:

H. K. LEWIS, 136 GOWER STREET, W.C.

1875.

LONDON:
PRINTED BY H. K. LEWIS GOWER STREET, W.C.

PREFACE.

THIS Essay was written while I was House Surgeon at University College Hospital, for the Liston Gold Medal in Clinical Surgery, and was successful.

I publish it, and hope that the Profession will give the apparatus herein described, a fair and impartial trial, with a view of ascertaining its practical value, which I, as a student of medicine have had but few opportunities of testing.

C. J. MANNING.

1875.

TRANSVERSE FRACTURES OF THE PATELLA.

In submitting to the consideration of the examiners the following pages, it is my first duty to state briefly to them the reasons which prompted my selecting Transverse Fracture of the Patella, as the subject of this Essay. Being limited in my choice by the published regulations of the College to matters of *original* research, and the short time which I have as yet been able to devote to the extensive range of professional study, having necessarily prevented the investigation of any subjects, which may have seemed likely to afford a sufficiently wide field for enquiry; I was compelled in choosing a subject, to select that one which was, as it were, accidentally thrown in my way during my house-surgeonship, and, which I have since had an opportunity of investigating by experiment, and dissection; and after very careful study I believe the views here stated to be correct in theory, and I trust that the treatment, which they compel

me to recommend may be found sound in practice.

My reasons for venturing to suggest a new method of treatment of these not uncommon accidents are these :—

In the first place it cannot be denied that there is room here for improvement, at least, if we may be permitted to judge from the results universally obtained, after resorting to the innumerable contrivances, which have been from time to time devised, with a view of securing that most rare occurrence—osseous union. The specimens from our museum may be taken as average samples of the results obtained after resorting to the usual plans of treatment.

In the second place, there are certain anatomical details with regard to the vascular supply of the patella, which after many careful dissections appear to throw considerable light on the subject, and which if my conclusions are correct, will in a great measure account for the imperfect union, which so often follows the transverse frracture of this bone.

I am particularly anxious that a case of transverse fracture of the patella, treated in the ordi-

nary way, should be considered nothing more nor less than a case of "ununited fracture."

It seems a matter of regret that these cases of transverse fracture should have been omitted in the statistics on "ununited fracture." That they have been so omitted by most writers, seems to be undeniable, if we turn for a moment to the statistics on "ununited fracture." Thus

Walker of Oxford found 6 or 8 cases of ununited fractures in 1000.

Lonsdale found 5 or 6 in 4000.

Norland found 1 during 19 years in the General Hospital in Massachusetts.

In the Pennsylvania Hospital, no case existed in 946.

Hamminck in all his experience in the Plymouth Hospital found 3.

Pierson found 1 in 367.

Liston only met with one case in all his practice.

Malgaigne *never* saw a case in his practice.*

Mr. Erichsen† says, "some bones are much

* Amstrong seems to have been the only authority who includes them, thus, he records 90 cases of "ununited fracture."

† P. 303, vol. i., 4th edit.

more liable than others to disunion of their fractures; according to the statistics collected by Norris, it would appear that the femur, the humerus, the bones of the leg, and of the forearm, and lastly, of the lower jaw, are those in which ununited fracture *most frequently* occur," so that here the patella is altogether left out, which we know is the commonest of all bones to remain ununited by osseous tissue after transverse fracture.

Mr. Erichsen, goes on to say, that "Hamilton states that in his experience the humerus is more commonly the seat of ununited fracture, than the femur," and my experience agrees with his, as if the question of frequency of non-union lay between the femur, and humerus, when in reality the patella is scarcely known to unite by bone.

This alienation tends to induce the student of surgery to regard this fracture in the light of a pathological puzzle, and leads him to believe that all hopes of obtaining osseous union are as idle tales, and the idea strikes him at last that the laws which govern the union of broken bones lose their force when applied to the patella. But it is indeed difficult to believe that nature, who

is neither capricious, nor changeable, should have without any apparent purpose so far outlawed a bone of such vast importance in our economy, and have withheld in this particular instance those reparative powers, with which she has so bounteously endowed all other bones, as to place the occurrence of osseous union beyond the pale of possibility.

Foremost then in the van of ununited fractures, I place transverse fractures of the *patella*, and although by doing so there is a risk of marring the statistics on these points, still there is nothing whatever to warrant the separation of these cases into a distinct group, and at any rate we shall be reminded that instances of ununited fracture are by no means so uncommon, as we should have otherwise been led to believe.

If the laws which govern the union of fractures be the same, the causes which prevent their repair are the same, and what these causes are, it will be my object to ascertain.

Although the causes which lead to the non-union of all fractures remain the same, some of them no doubt will exercise their influence with redoubled force in the cases under our imme-

diate consideration, owing to certain peculiarities of the bone, respecting its size, position, and anatomical connections, as I shall endeavour to point out.

Almost all surgeons who have written on "Ununited Fracture" have divided the causes into two distinct groups, namely—The Constitutional, and the Local.

Having briefly enumerated the so-called "constitutional" causes which are said by various writers to exercise a prohibitive influence on the union of broken bone; I shall with very few remarks, dismiss them from our consideration.

In the first place, because the views entertained by the recognised authorities are most conflicting and embarrassing; little indeed or nothing appears to have been accurately ascertained about many of them, either as regards their direct action, or remote consequences.

In the second place, because it is not to these that we have to attribute almost universal failure, which attends the treatment of these fractures; and therefore any close investigation of them here would be at once superfluous and tedious.

The constitutional causes enumerated by Holmes in his *System of Surgery* are—

1. Old age.
2. Pregnancy and lactation.
3. Syphilis.
4. Phthisis.
5. Fevers.
6. General cachexia.
7. Scurvy.

To these Billroth has added—

8. Bad nutrition.
9. Debility from repeated losses of blood.
10. Diseases of bone as osteomalachia, atrophy of the cortical substance, &c.
11. Paralysis.

The *local causes* which form a second and more important class demand our deliberate consideration, and with a view of dealing with them in detail, I have arranged them into three groups, thus—

I. *Separation of the fragments*, (from whatever cause arising.)

II. *Movement of the broken surfaces.*

III. *Impairment of nutrition*, especially any impediment to the circulation of the part.

I. The causes of separation of the fragments are these:

a. Portions of muscle, tendon, or bone, thrust between the fragments, effectually prevent union, as Berard has shown in a case of fractured clavicle, which had united by two bridges of bone enclosing the subclavius, which was found ossified.

Mr. Erichsen* mentions a case where union had not taken place in a fractured femur; because the upper fragment had perforated the vastus, which had become entangled between the broken ends.

Dupuytren also dissected a fracture and found non-union due to the same cause.

Notwithstanding these cases, it appears to me that they do not conclusively prove that a piece of muscle thrust between two fragments of bone can hinder osseous union from taking place. I should have thought that the muscle would have been absorbed in time enough to allow callus to be thrown out, or would have at once given way before the jagged end of broken bone.

* P. 303, vol. 1, 4th edit.

In Berard's case union had taken place, nay, more than this, nature had done her best since the muscle itself was ossified.

With the two remaining cases we have no history of the amount of damage done to the soft parts, so it is impossible to surmise how much was due to the mechanical difficulties caused by an interposed muscle *per se*, or how much was due to the vital depression and shock, the inevitable results of severe injuries, which in themselves undoubtedly are powerful agents in stopping reparation, and arresting nutrition. At all events the injuries were sufficiently severe, for either the limbs were amputated, or the patients died, since dissection revealed the state of things in both cases.

b. Loss of substance, where circumstances prevent the apposition of the broken surfaces, is said to prevent union taking place. Thus, Sir Astley Cooper has reported three cases, where there has been fracture of the tibia with loss of substance, the fibula remaining perfect, and so preventing the tibial fragments from being brought into apposition.

Experiments on animals have according to

some authors given like results. But animals are so restless under treatment, that it is very difficult, indeed, almost impossible to say, whether the separation of the fragments, or the movement of the creature, had the greater share in preventing union.

Doubtless much will depend on the amount of loss of substance; but certain it is that good results may be obtained after a considerable loss has been sustained, provided the soft parts are otherwise sound, and the other conditions be present, which are necessary for the union of a broken bone. Namely *absolute rest*, *no impediment* to the circulation, and a tolerably *healthy* constitution. The following cases in which union occurred will illustrate the amount of loss, which may be sustained with the prospect of a good result.

Delamotte removed a splinter of tibia, a hand's breadth in length, 60 days after the accident.*

Gooch removed 5 inches.

Phillips removed 5 inches.

Morris 2 inches of tibia in a child of 12 years.*

Surgeons have doubted the veracity of these

* See Malgaigne's work, p. 127, 1859.

statements; but they appear perfectly within the bounds of possibility, if we recollect the results we obtain after the removal of large masses of carious and necrosed bone, and if we compare them with the results of the experiments, in Syme's paper on the *Formation of new Bone*, (read before the Royal Society of Edinburgh, March 6th, 1837, which is published in the 14th volume of their "Transactions,") where he removed large portions of the radius in dogs leaving as much of the periosteum as possible, and when the loss was repaired almost perfectly in a few weeks.

If, as I have said, the soft parts are sound, by which I include the periosteum, and if the splinter or splinters be carefully dissected out, leaving that membrane as entire as possible, I see no reason to doubt the reports of these cases mentioned above.

c. The contraction of the muscles in connection with the broken bone is not infrequently a powerful agent in causing separation of the fragments. Familiar instances of this are commonly seen where the lower fragment is displaced inwards, by the latissimus dorsi, teres major, and pectoralis major, when the humerus is fractured

through the surgical neck, or when the upper fragment is forcibly abducted by the deltoid, when the fracture is just below the insertion of that muscle, or again, when the lower fragment is drawn up by the powerful contraction of the triceps, when the fracture is near the condyles, or when the same muscle, in fracture of the olecranon drags it up the arm ; the same thing is seen when the radius is fractured above the pronator quadratus, which draws the lower fragment close to the ulna, while the upper is being separated from it by the action of the biceps.

In the lower limb the same occurs, when in fracture of the femur, just below the trochanters, the upper fragment is tilted forwards by the combined action of the psoas and iliacus, being inverted and drawn outwards by the external rotator, and glutei muscles ; the lower fragment is at the same time drawn up by the biceps, semi-membranosus, semi-tendinosus, and rectus.

When the fracture occurs just above the condyles, the lower fragment is drawn back by the gastrocnemius, soleus, and plantaris, while the limb is shortened by the contraction of the muscles of the thigh.

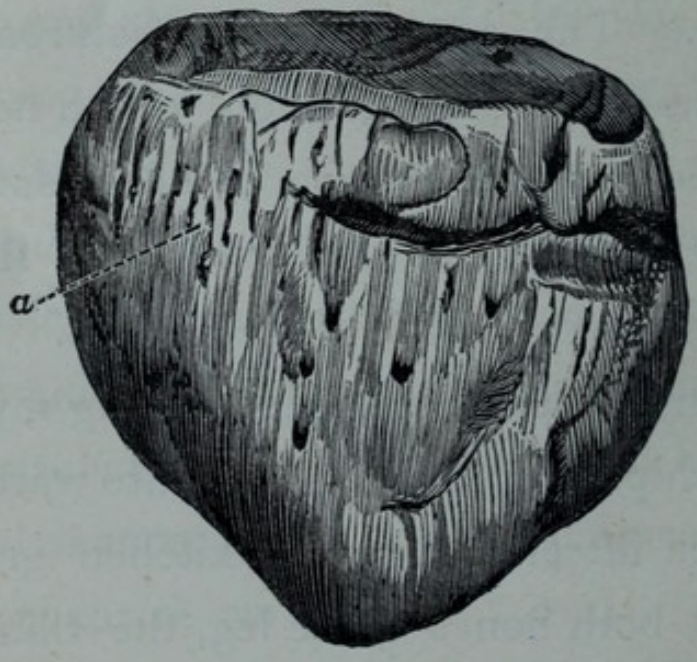
Again, in oblique fracture of the shaft of the tibia,

when the obliquity is from above, down, and forwards, the lower fragment is drawn up, and back by the muscles of the calf, while the upper fragment projects forwards; but in no instance have we a better example of the displacement of the fragments due to muscular contraction, than in transverse fracture of the patella, for when the fibrous aponeurosis over the face of the bone is completely divided, the violent action of the quadriceps extensor, which causes the fracture in many instances, is sufficient to drag the superior fragment up the thigh to a distance of two or three inches, or even more.

Independently of their mechanical bulk, collections of fluid, whether of blood, serum, or pus, often prove formidable obstacles to the union of fractures. The constitutional disturbance set up by the fierce inflammation, which not infrequently accompanies them, is often sufficiently severe to threaten not only the loss of the limb, but occasionally the life of the patient. I myself have seen a case of this kind during my house-surgeonship. I admitted a man into ward 2, who had fallen fifteen feet on to a kitchen grate, and fractured both bones of the leg, the tibia nearly in the middle, and the fibula a few inches nearer

the foot; there was considerable bruising and discoloration of the surrounding tissues in a day or two; the accident was done by direct violence. Soon a large hæmatoma made its appearance, and after many weeks it took an inflammatory action and suppurated; the abscess thus formed was opened under antiseptics, and it could then be seen that the fragments were as separate as on the day of the accident.

But there are instances on record, where fractures have united notwithstanding extensive suppuration. There are two specimens in the Pathological Museum of the Royal College of Surgeons of great interest; No. 543 is the patella of a sailor aged 24, which has been fractured transversely. It is represented below.



The fragments are remarkably close, and osseous union has taken place along the line of fracture on the right side of the bone, marked *a*. He died seven weeks after the accident, of profuse suppuration of the joint. The other is No. 545. A knee-joint, in which ankylosis has occurred, as the result of inflammation, and caries. In the catalogue it is suggested that the patella had been *fractured* transversely; but I cannot help thinking that it underwent fatty degeneration, and became softened with the femur and bones of the leg, and as it was weakened by the disease which invaded the joint, gave way under the influence of the muscular contraction of the quadriceps extensor. If this accident happened early in the disease, before the patient became exhausted by the profuse suppuration, which soon told on his constitution sufficiently to render those muscles weak, and inefficient, it is easy then to believe that they were unable, when the whole constitution was shattered, to drag the superior fragment up the thigh, and as the inflammation became chronic, the patella shared in the general ankylosis, which welded together the bones in connection with the joint. Here then are two instances where

the union of the fragments has taken place notwithstanding suppuration, which in one instance, took the life of the patient, and in the other occasioned amputation of the limb.

Accumulations of fluid, which commonly are found in the synovial pouches about joints, can by their mechanical bulk cause separation of the fragments, and prevent the union of the broken surfaces, and we often see the remarkable influence of an effusion of this kind in the cases of transverse fractures of the patella. Here not only does the collection of fluid do harm, which tends, by the distension of the synovial sac, to separate the fragments; but many surgeons prefer to leave the treatment of the case until this effusion has subsided; and a delay is thus often caused for several weeks, when no chance of obtaining osseous union remains.

These effusions, in cases of transverse fracture of the patella, make their appearance in a remarkably short time after the accident. Their contents have been proved to be a large amount of blood mixed with the synovial fluid of the joint; by the experiments of Sir Astley Cooper made by dividing the patella transversely in rab-

bits, and dissecting the knee-joints afterwards, when he found the fragments separated by a blood-clot which filled the joint.

M. Cloquet reports the case of an old man who sustained a transverse fracture of the patella by direct violence, and died on the 8th day after the accident. On dissection he found the joint enormously distended with blood and synovia, the former having evidently escaped from the broken surfaces.*

Independently of any serous effusion, due to inflammatory action of the synovial pouch, there can be little doubt, from the remarkable suddeness with which the joint fills, in the cases under our consideration, that the collection of fluid is chiefly composed of blood.

While apparently perfect in theory, unfortunately it has been proved in practice, that some of the surgical appliances used in the treatment of these cases are found to cause separation of the fragments, by "tilting" them forwards, so as to separate their anterior edges.

Others, it is to be feared, indirectly cause separation of the broken surfaces by the irritation

* See Malgaigne, p. 608, 1859.

they produce, which, sets up, or increases the spasmodic contractions of the muscles acting on the upper fragment. I will refer to these in the section on "treatment."

II. Whatever causes are assigned as obstacles to the union of broken bone; unquestionably non union too often proceeds from the fragments not being maintained in a state of sufficient rest during the process of repair.

Movement of the fragments may be the result of these spasmodic twitchings of the muscles, which are due either to irritation set up by the jagged edges of the broken bone in the surrounding tissues, which are soft and sensitive, or to the undue pressure of a tight bandage, or a splint that pinches, or not unfrequently to a characteristic nervous irritability so peculiar to the temperament of some patients, as I have observed occasionally in the wards of the hospital.

But even after we have been fortunate enough to obtain a healthy deposit of callus, it sometimes happens that the fractured surfaces may become disunited, and a false joint may be the result.

This may happen in the lower limb from allowing the patient to get out of bed too soon, or from some accident to the injured limb before the callus has become firm and strong.

I have always felt great anxiety about the patient whose leg has been put up in starch, and suspended from his neck by means of a stirup, and allowed to get about on crutches before firm union has taken place. They are often clumsy with their crutches, and the slightest slip on a smooth floor, may undo the work of weeks. For these reasons it appears that no advantage is to be gained from allowing a patient out of bed before union has taken place. Since there is a risk of an accident, which might prolong the treatment, and perhaps result in an ununited fracture.

In the upper limb the humerus is most commonly the seat of ununited fracture, and this is most probably due to the short splints which are used, and to the patients being allowed to go about during the process of reparation. Mr. Syme in his "*Observations in Clinical Surgery*" has written a very able and interesting paper on ununited fracture of the humerus, and shows that

by keeping the limb absolutely at rest, osseous union invariably was the result, which while movement was allowed did not take place.

III. Impaired nutrition, specially when due to impeded circulation in the immediate vicinity of the bone, is a most important cause of ununited fracture. It is scarcely necessary to say that the processes of repair cannot possibly go on when the supply of blood is cut off from a broken bone.

Brodie* in a series of experiments has shown that when the circulation is obstructed, either by pressure upon, or ligature of the main artery above a fracture; that the fracture remains ununited, or at any rate the union is greatly prolonged. Pressure on the vessels has been proved, beyond the possibility of doubt, to prevent or retard union, by the experiments of Delahaye, Duhamel, and Troja.

Hence it is, that the various immovable apparatus, which have been in vogue from time to time amongst some of the French surgeons, were found either to altogether prevent, or at any rate greatly retard the formation of healthy callus.

Even in fractures of the femur, a bone abun-

* See *Med. Gaz.*, vol. xiv.

dantly padded by muscles on all sides, bony union may be prevented by the simple application of a very firm bandage evenly applied from heel to buttock. Formerly, surgeons used to wonder why this was, but all feelings of surprise vanish, if we recollect for a moment how little blood remains in a limb after the application of the preliminary bandage, in the so-called "bloodless operations" of the present day. Independently of resorting to any surgical artifice to prove how important the blood supply is for osseous union to be the result in treating a fracture, unfortunately we have two instances, when we consider intra-capsular fracture of the femur, and fracture through the anatomical neck of the humerus. In the former case, the vascular connections maintained through the ligamentum teres, are sufficient to rescue from death the head of the bone, but are not enough to meet the requirements of repair. Whilst in the latter instance the head of the bone becomes atrophied, and not unfrequently dies. Mr. Curling believes that the eccentric atrophy which occasionally occurs after fractures, depends on some impediment to the arterial circulation through the nutrient vessels. It appears to me, however,

that the bones may suffer atrophy together with the muscles, when confined in splints, not from the impeded circulation, so much as from the impared nutrition, and low vitality, which are caused by long confinement in one position, and want of exercise during the treatment of some tedious fractures, when they become remarkably wasted from want of use. At any rate *his* evidence is not conclusive on this point.

Being deeply impressed that it is of the greatest importance that the vascular supply ought on no account to be impeded during the treatment of fractures, and at the same time being anxious to know the exact arrangement of those vessels supplying the patella, so that one might be enabled to avoid undue pressure on them in treating these cases; and also to ascertain the amount of blood supplied to the bone, whether that is sufficient for the purposes of repair, or whether as in cases mentioned above, bony union was impossible, from the insufficient supply of blood to the part, I was led to dissect thirteen knee-joints, and I feel assured that the blood supply is abundant, and I find the arrangement of the vessels is as follows:—

The patella receives its supply of blood from

the superior, and inferior external articular arteries, and anterior tibial recurrent on the outer side, and from the anastomotica magna, which receives a few small twigs of the internal inferior articular on the inner side. But it is not to the vessels that I wish to attract attention so much as to their *arrangement*. I have found in every dissection, that the upper part of the bone is supplied by an arch formed by the anastomosis of the superior external articular, and the anastomotic which runs along the *superior margin* of the patella, and parallel with it; this arch is *anterior* to the bone and the tendon of the rectus. The lower part of the patella is supplied by an arch formed by the anastomosis of one of the terminal branches of the anastomotic on the inner side, and the inferior external articular on the outer, sometimes the anterior tibial recurrent sends a branch to anastomose with the latter vessel, before forming this arch, which passes across the joint *behind* the lower margin of the bone. A few branches of the above named arteries send a twig or two in front of the bone, but these are very small, when compared with the arch along the superior border. In addition to these, there is a very small branch

of the external circumflex which joins the superior arch, about its middle.

For the sake of convenience, I have divided the vessels into two sets, superficial, and deep, not because there is a well-marked boundary line between them, but those which I call *superficial* are easily dissected on the anterior surface of the bone, and must be cut away in dissecting those lying under them, which I describe as *deep*, and which lie along the edges of the bone behind it at its lower margin.

The superficial vessels enter the bone on its anterior aspect, through the numerous foramina and are easily seen in a dried specimen. These

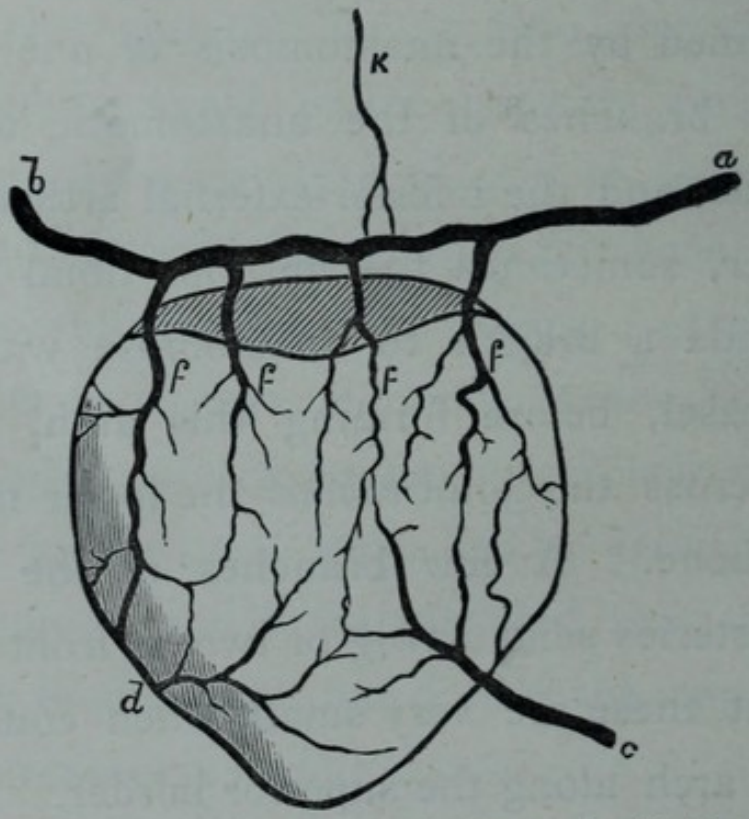


FIG. I.—Diagram showing the superficial vessels which supply the Patella.

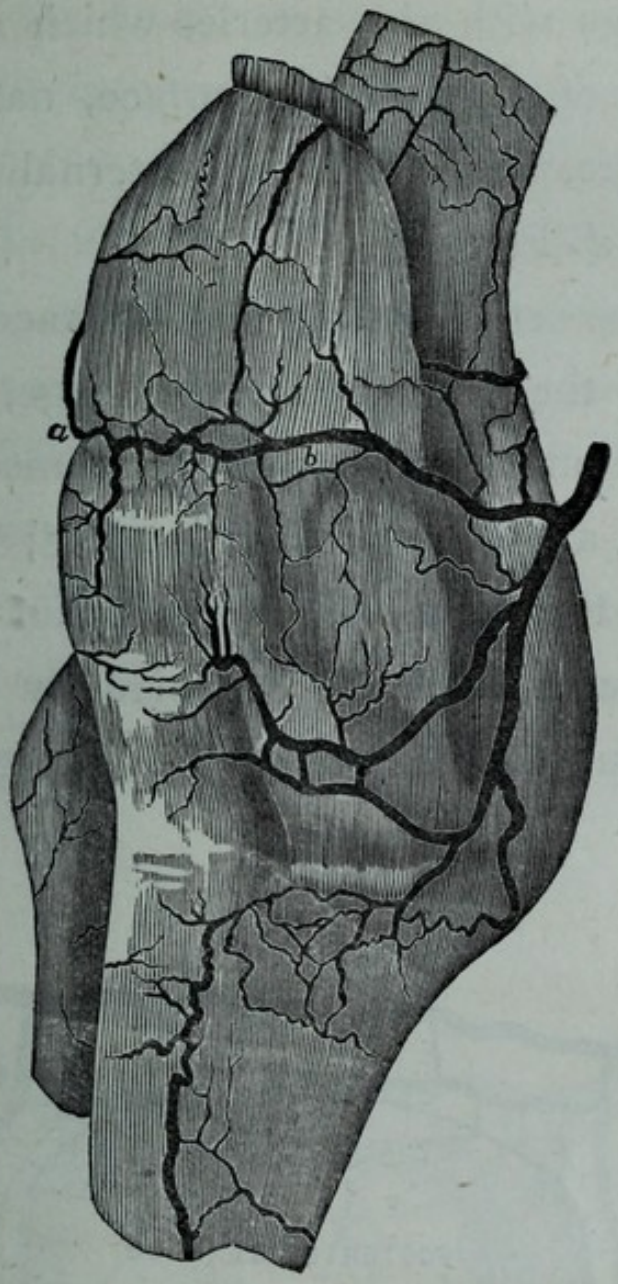


FIG. II.—Drawing of vessels which supply the patella, from one of my dissections.

vessels are given off from the superficial arch *a.b.* Fig. I. formed by the anastomotic and external superior artery. They are four or five in number and are marked *f*, and descend vertically, and may be traced into the foramina before named. They unite as may be seen by

small twigs with the arteries which supply the lower part of the anterior surface, namely, the anastomotic, and inferior external articular, marked *c. d.* Fig. III.

The deep set of vessels may be traced into the borders of the bone at their very edge, round its whole circumference, but they are most numerous above, along its superior border; and some penetrate the bone, on its posterior aspect, in the triangular space not occupied by a smooth articular surface marked H, in the diagram here

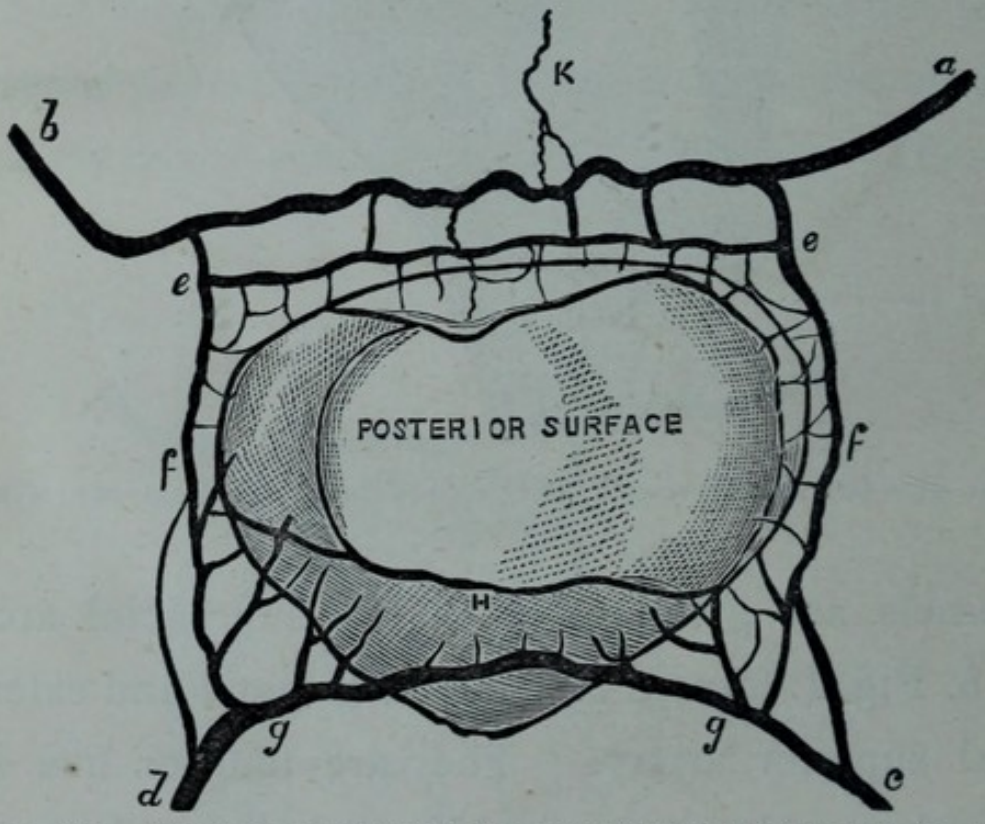


FIG. III.—Diagram showing the deep vessels and inferior arch (*c. d.*) on the posterior aspect of the patella.

represented (Fig. III.). Along the lateral bor-

ders of the bone, a series of *very fine* loops may be dissected out which spring from a branch marked *f. f.* and connects the arch *a. b.* with the arch *c. d.*, and beneath the superficial superior arch *a. b.*, a small branch *e. e.* is given off, which sends a series of loops into the upper edge of the bone. The loops at the sides from the branches *f. f.* are very small and insignificant.

I believe it to be of the utmost clinical importance to clearly understand the arrangement of these vessels, for a glance at this diagram will

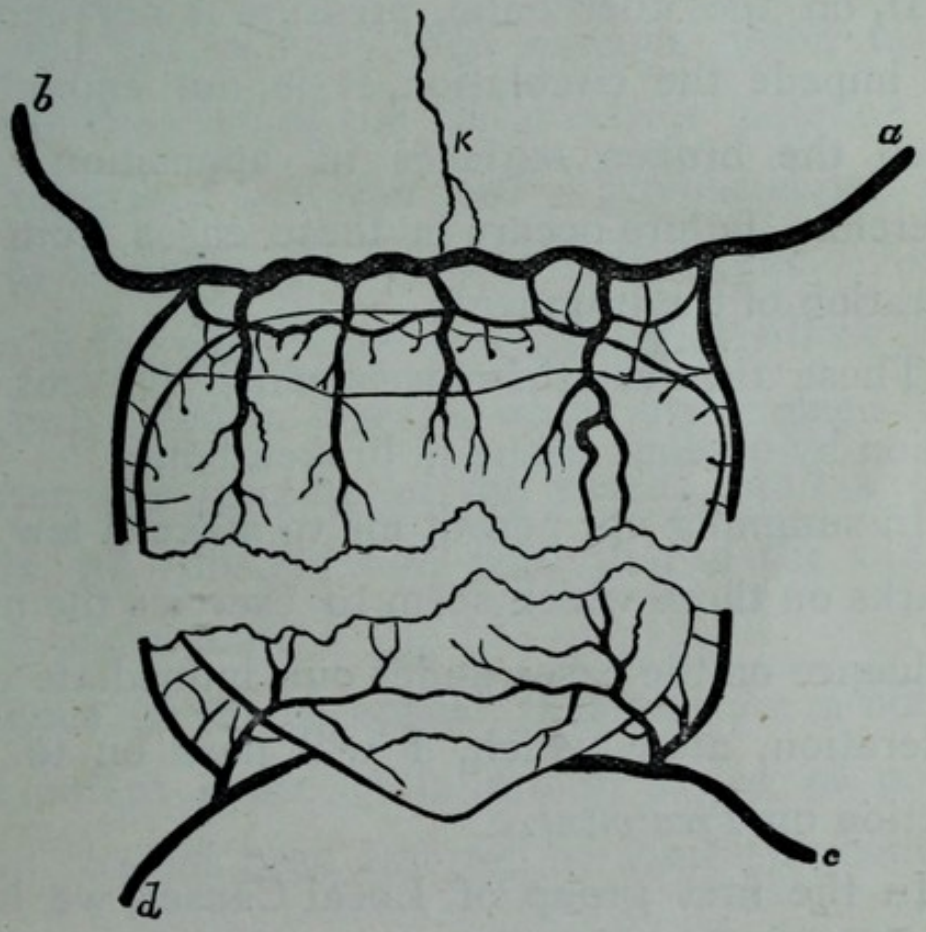


FIG. IV.

show that the upper fragment is entirely dependent for its blood supply, when the fracture is complete, and the fibrous investment torn across, on the arteries *a. b.* Now, in nine-tenths of the treatment usually recommended for these injuries, the pressure is applied directly on this arch, and I maintain that if it is sufficient to retain the fragments in apposition, the circulation to this fragment is either materially impeded, or altogether stoped, and therefore failure of union occurs from a deficient blood supply.

If, on the other hand, pressure is not enough to impede the circulation, it is not enough to keep the broken surfaces in apposition, and therefore failure occurs in these cases from separation of the fragments.

These then are the causes which prevent the union by osseous tissue in broken bones.

In summing up, permit me to make a few remarks on those which seem to exercise the most influence on the cases under our immediate consideration, after which, I will pass on to the section on *Treatment*.

In the first group of Local Causes, we have seen that it is difficult to say how much depends

on the mechanical obstruction *per se*, of portions of muscles, tendons, or bone, and how much depends on the shock to the system, and injury of soft parts in the immediate neighbourhood of the fracture.

With regard to the effusion of blood or pus, we know that there must be an effusion of blood into *every* knee-joint, which sustains the injury of a fractured patella; because the torn vessels on the face of the bone pour their blood into the synovial pouch, and the irritation set up in the synovial pouch causes an increased secretion of synovia; but we have seen osseous union take place in the case of the sailor whose patella* I have described, and who died of profuse suppuration in the joint accompanied with hectic. And again in the case of the man (No. 545) whose leg was amputated for disease, which first caused the spontaneous fracture of the patella, and afterwards, its consolidation with that of the other bones of the joint.

Hence it would appear that effusion is not a very potent cause of failure in cases of non-union; as has been asserted by some surgeons.

* No. 543 in Pathological Collection in Royal College of Surgeons.

Then there is loss of substance, this does not occur in the cases we are considering, so I pass on to—

Movement of the broken surfaces. Without a doubt this is the most common cause of ununited fracture. Wherever movement of the fragments is allowed, there osseous union cannot take place. First and foremost, the patella is the most common seat of fibrous union. Then the olecranon, then the humerus for the reasons given above, then femur, &c.

In the section on treatment, I shall have to refer to *movement* of the fragments.

Lastly, we have seen how necessary the blood supply is for the production of osseous tissue. We have seen how the head of the humerus atrophies and dies, when separated through the anatomical neck, and how the head of the femur has through the vascular supply afforded by the branches in the ligamentum teres sufficient blood to prevent necrosis, but not enough for the processes of repair.

We have seen too, how the immovable appliances of the French retard, or altogether prevent union, possibly by the impediment they offer to the circulation.

Treatment.

The small size of the fragments, their mobility, and proximity to an extensive synovial sac, and to the largest joint of the body, the powerful influence exerted by the extensor muscles, the exposed position of the blood vessels, and the ease with which they may be compressed, all enhance the dangers and difficulties attending the treatment of these cases. Accurate knowledge on these points is necessary to assist us in establishing correct principles, which may guide us in treating them successfully.

The separation of the fragments is due, as we have shown, to the contraction of the muscles, which draw the superior fragment up the thigh; the tilting is due to the application of certain surgical contrivances, and to the distension of the synovial sac.

The rational indications for the successful treatment of the separation of the broken surfaces are these:—

1st. *Efficiently* control the muscles which cause the displacement, and fix the knee; this

will be the means of overcoming the two first causes of non union. Namely, *separation* of fragments and *movement*.

2nd. We have shown that the patella receives the greater part of its blood from the vessels springing from the arch which courses along its superior border, and that the vessels supplying the lower part of the bone spring from a corresponding arch, but this is *behind* the lower border of the bone, imbedded in a protective cushion of fat. The following experiment will prove, I think, that any pressure exerted on the superior margin will impede the circulation to the fragments, but specially affects the supply of blood to the upper fragments. I opened the femoral arteries in the *post-mortem* room, an inch or two below Poupart's ligament; on the right limb I sub-cutaneously divided the patella transversely with a fine saw, and a friend of mine put up the limb in the *ordinary* way for transverse patella fracture, a back splint, a compress above and below, and figure of eight the method in fact known as *Wood's*. An assistant then injected both femorals using *as much force as was possible*. I removed the knee joints the next day and found on dissec-

tion that there was scarcely any injection where the bandages had been applied, here and there *a trace*, there was none effused into the synovial sac, and just where the bandage pressed over the inner condyle, the anastomotic burst, and there was what would have been in life a hæmatoma the size of a pigeon's egg. The parts beyond the figure of 8 were beautifully injected, all the small vessels of the toes were quite full. The vessels supplying the other patella were well injected. I again performed the same experiment on another body, and although there was no rupture of the vessels, there was a vast difference in the amount of injection in the two joints. In both instances the utmost force was used in working the syringe—in the first instance enough to burst one of the vessels, and still a very small quantity of injection reached the bandaged patella. In the 2nd case the result was similar. The 2nd principle then, teaches us to *avoid undue* pressure on the fragments themselves, since it impedes the circulation, irritates the synovial sac by pressing the jagged surfaces against it, and causing them not infrequently to tilt forwards.

It is important to ascertain the circumstances

which attend those cases in which osseous union has been produced. There is no. 543 mentioned above,—the sailor who died of profuse suppuration and hectic, the consequences of the accident.

He died of an asthenic fever, which speedily saps the patient's strength, and robs him of all vital energy; the muscles share the general emaciation, and their contractile force is reduced to a minimum. There was little tendency in the extensors to draw away the upper fragment, and there was enough mischief about the joint to keep the surgeon's hand from interfering with the circulation of the bone, by the application of any apparatus. Then there is no. 545 in the same collection, where the patella has shared in the general anchylosis which followed *profuse* suppuration of the joint, and was sufficiently severe to warrant amputation of the limb; the conditions therefore were nearly similar. Then there is the case of the *aged* patient, who died in the Hotel Dieu in 1831 under Dupuytren's care.* Here, in addition to the asthenia of age, inflammation of the joint set in, which led to the patient's death. Here

* P. 224, 1847.

again no bandages were used, or we may be sure they were looselyapplied; Dupuytren had a great horror of tight bandaging.

Let us turn for a moment to the treatment adopted by Sir Astley Cooper, and Dupuytren, with the results they obtained in cases of *longitudinal* or vertical fracture.

Surgeons are agreed, that osseous union more commonly takes place in longitudinal patella fractures, and this happens they say, because the fragments are so easily retained in apposition. But if my views be correct with regard to the arrangement of the vessels, if pressure be made on them, osseous union would be impossible, however close the fragments may be, and so it is. Sir Astley Cooper had an opportunity of examining some cases of longitudinal fracture sometime after the injuries, and he found the bond of union, not osseous but ligamentous. Accordingly he writes*—"this circumstance surprised me, because I saw no reason why the patella should not be united by bone when fractured perpendicularly."

But how did he treat these cases? He tells us

* At p. 232, in the new edition of his work, 1842.

at p. 233, "In the longitudinal or perpendicular fracture of the patella, the best treatment consists in extending the leg, and in using local depletion, and evaporating lotions; when inflammation has subsided a *roller* should be applied, and then *a laced knee cap with a strap and buckle around the knee, above and below the patella*, and a *pad on each side*, to bring its parts as nearly as possible into contact." Thus while he was making every effort to approximate the fragments, he was at the same time unconsciously doing his best to impede the circulation. But if pressure prevents osseous union in longitudinal fractures, those cases ought to unite by bone where none is exerted: and in the cases treated by Dupuytren, and examined at the autopsy some time afterwards, osseous union had taken place. At page 228 in his work on *Diseases and Injuries of Bones*, he says: "Vertical fractures of the patella require *no treatment* beyond the simple extention of the leg on the thigh, and a few weeks of absolute repose. The employment of any form of apparatus is entirely superfluous."

In fact he uses no constricting bands above and below the patella, he offers no impediment

to the circulation, and accordingly we find him reporting cases where osseous union has indisputably taken place. Notwithstanding these cases, some surgeons have denied that osseous union ever does take place. Pilrac offered one hundred louis to any one who would bring him a patella entirely united by bone; and some eminent surgeons have asserted that by macerating those specimens where it is said to have been produced, the fragments readily become separated. But the specimens we have, are all cases where the callus is only a few weeks old, and they certainly seem as firmly knit as fractures in other situations would be, which have existed for the same length of time. In every case where Malgaigne has seen osseous union, he has observed that there has always been at least one splinter broken off from one of the fragments. I think this can be explained in the following way: Let us take a case we have in our Museum as an example, I have sketched it here, Fig. V: osseous union seems to have taken place along the posterior edges of the broken surfaces. Now in this case the fibrous investment probably was not cleanly divided across the entire width of the bone.

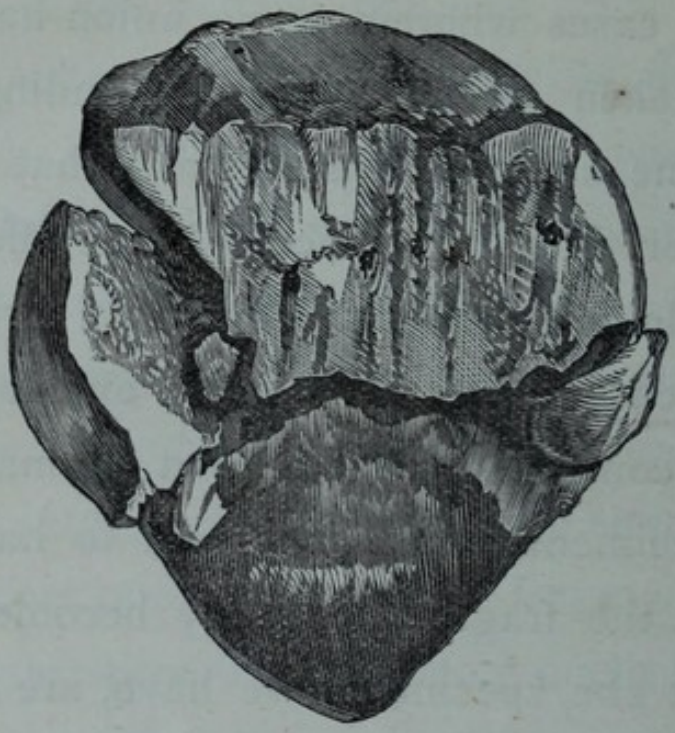


FIG. V.

The separation of the fragments was but slight, and if the ordinary bandages were applied, that pressing on the upper edge of the bone would have the effect of stopping the circulation through the arch marked *a.b.* The inferior arch protected in a cushion of fat and lying behind the patella is not so easily interfered with, the circulation would go on, through the branches marked *c.d.* and *e.e.*, and from the imperfect separation would supply the upper fragment in the manner indicated in Fig. III.

A great number of surgical appliances have

been invented for treating transverse fractures. Many of them are remarkable for the ingenuity of their design, and the complexity of their arrangement. I will not describe these at length, but will refer the examiners to the drawings of the more important, which have been copied from various works on the subject. The first point which strikes one in looking at them, is that there is *only one attempt* made at controlling the muscles of the thigh which cause the displacement, and consists of the application of an ordinary roller up the thigh. Now every Surgeon knows that a roller becomes loose and inefficient in 24 hours, but even if it kept its hold for a longer period, the pressure exerted is in the direction A. B., when the extensor muscles contract in the direction C. D., so that the tube of calico formed by the bandage

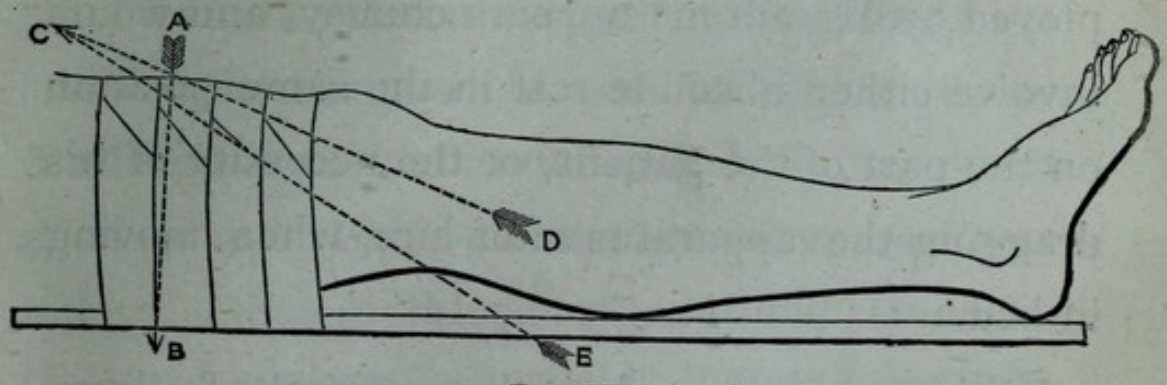


FIG. VI.

can do but little in controlling their contractility; the arrow C.E. shows the direction in which extension is made in my splint. All the appliances which have hitherto been contrived, have taken their purchase on the external prominences of the bone for maintaining the fragments in apposition, and for overcoming the action of the quadriceps extensor. But as Malgaigne has pointed out, these do not afford sufficient purchase, because the insertion of the extensor tendon is not *behind* the edge of the patella, but rather in front of it; the same holds good with regard to the Ligamentum Patellæ.

Every inventor has only produced a different method of doing the *same* thing, viz., of approximating the fragments by exerting pressure on the upper, and lower margins of the bone. Such appears to be the principle in the contrivances of Cooper, Wood, and Dorsey. The method employed by Hamilton* appears clumsy, and would involve either absolute rest in the same position on the part of the patient, or the necessity of his dragging the apparatus after him, when moving in bed.

Without any regard to the patient's feelings,

* Edition in 1871, p. 439. Fig. 100.

or to the complications likely to arise in applying their apparatus, Messrs. Malgaigne, Valette, and Fontan, have apparently had but one object in view, *i.e.*, the apposition of the fragments.

It would be out of place here, and indiscreet, to criticise the treatment of surgeons of the greatest skill, and experience. Many of the appliances die a natural death, and others are condemned by their inventors. Malgaigne invented his "Hooks" so as to avoid the tilting of the fragments, which he found always existed in his experiments on the dead subject, whenever pressure backwards was exerted on them. I have repeated these, and the tilting is easily produced to the extent of an inch, between the anterior edges of the broken bone, by very slight pressure backwards. But as the inventor confesses, these "hooks" do not retain their hold, either they tear through the fibrous investment covering the patella on its anterior surface, or they slough out, and English surgeons have found they set up too much inflammation at the seat of fracture to be applied with safety. These are never used now-a-days, although there is generally a set among the instruments of a hospital. But, practically,

they are a dead letter. It is curious to observe that those appliances, which most thoroughly impede the circulation, namely, those made by being moulded accurately to the shape of the bone, and which would exert their pressure, not only above and below, but around its entire circumference, have been the first to become obsolete, and are never used; so we have long ceased to hear of such instruments as "the Ring of Purman," or the "petit chapeau pileolus of Meibomius."

After all the elaborate efforts which have been made from time to time, each in its turn has given way for some new invention, or soon has been forgotten, and fallen into disuse. Surgeons of great skill have given up the idea of facing the difficulties of these cases. Sir William Blizard for instance, used to believe that it was sufficient to attend carefully to the position of the limb, and to the local treatment of the inflammation. "Bandages," said he, "are not only useless, but pernicious;" and I believe Sir James Paget follows his example, and trusts entirely to rest in bed, the position of the limb, and avoids the application of any mechanical contrivance.

Notwithstanding the examples set by such distinguished surgeons, I cannot help thinking that we might hope for better results, if we could devise some apparatus, without being heavy, clumsy, or inconvenient to the patient, on the following principles :—

I. On no account attempt to retain the upper fragment in apposition, by the direct application of any bandages, straps, or constricting bands whatever, since they are only effectual in impeding the circulation.

II. Control the muscles of the thigh by any means which will exercise persistent extension on them and efficiently overcome their contractility.

III. Keep the limb at rest, with the heal raised, the knee extended, and the thigh slightly flexed.

The apparatus which I wish to recommend consists of a straight wooden back splint, a little wider than the knee-joint, long enough to reach from the sole of the foot to the gluteal fold, and provided at its lower end with a foot-piece.

At the junction of the lower and middle thirds is a transverse slit, one inch and a half long, cut

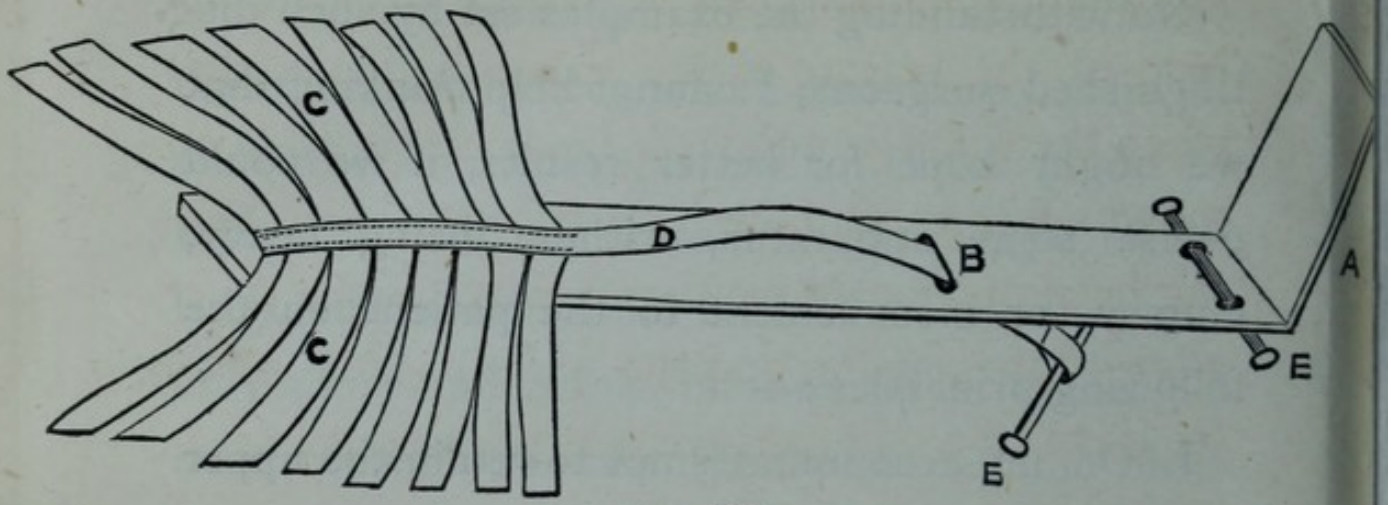


FIG. VII.

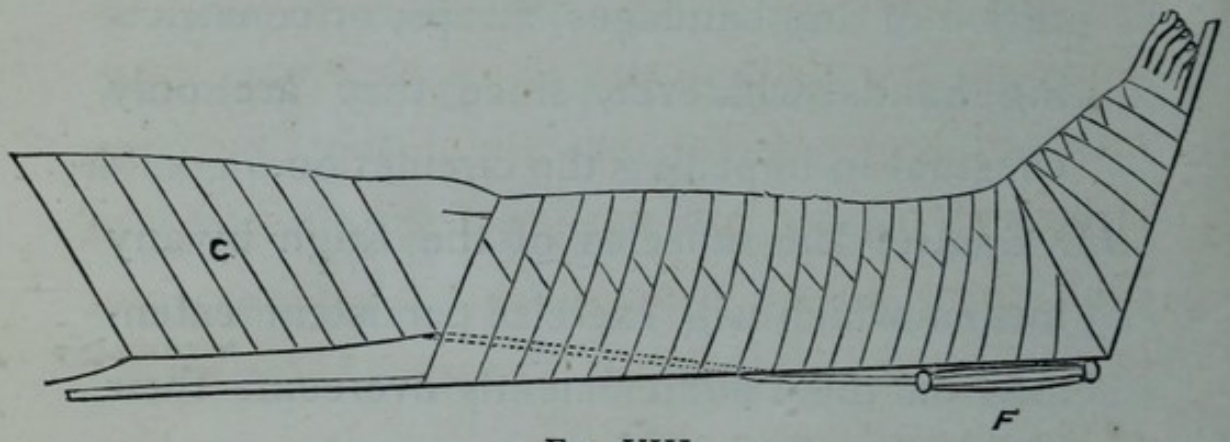


FIG. VIII.

obliquely from above, downwards (B). Some strips of stout strapping, about two inches wide and long enough to encircle the thigh, and overlap a few inches, are stitched to a band of strong calico (D), a little narrower than the slit in the splint. The free end of this band is passed through the slit, so that the strips of plaster lie on the upper surface of the splint. A piece of wood of the comparative length and shape at (E), is secured to the splint by means of a strip of bandage passed through two holes at its lower

end; and a similar piece of wood is stitched in a loop at the bottom of the calico band, so that when the splint is adjusted, these pieces of wood may be five or six inches apart. The foot having been previously bandaged as far as the lower edge of the patella, and the splint padded so as to leave the slit uncovered, the strapping is heated by means of a bottle of hot water, (which is more convenient than a strapping tin), and while an assistant draws down the upper fragment by grasping the muscles of the thigh, the straps of plaster are carried firmly round the limb from above, downwards, extending from just below the gluteal fold to within three inches of the upper border of the patella. It is important that the band of calico should be kept in the middle line behind; the upper part of the thigh is then secured to the splint by a few turns of a roller. Lastly, as many elastic rings, (those known as "office bands" answer the purpose very well), as will serve to approximate the fragments without causing too much pain to the patient, are passed over the projecting ends of the pieces of wood, as at F., on each side of the splint, so as to exercise sufficient traction on the muscles retracting the upper fragment.

In adopting this plan of treatment, I believe its advantages are these :—

That while no pressure is exerted at the seat of injury, and all tilting of the fragments is avoided, the muscles are nevertheless effectually controlled, and the circulation to the upper fragment is in no way impeded. The strapping unlike a bandage, has no tendency to slip or become loose, and grasps the extensor muscles in the same manner as the hands of an assistant; while the elastic bands are so arranged, as to exert persistent traction in a direction best calculated to overcome the contractile force of the muscles, instead of at right angles to it, as I pointed out a few pages back. Moreover, as the apparatus does not press upon the synovial pouch, it can be applied immediately, as there is now no reason why we should wait for the subsidence of the effusion. Lastly, there being no constriction of the vessels supplying the upper fragment, a sufficient quantity of blood circulates through it, to favour the formation of healthy callus, and the occurrence of osseous union.

A friend of mine lately returned from Vienna, tells me that Professor Billroth has been treating ununited fractures of the long bones by firm-

ly bandaging the limb from the below upwards, stopping an inch or two short of the seat of fracture, and by applying another bandage beginning an inch or two above the seat of fracture, which is left without any constriction. In this way he succeeds in getting an increased effusion of plastic material from the œdema, which result is sufficient to produce a firm union of the broken ends. For the same reasons there might be some advantage in the apparatus I have described, since there is a constriction both below and above the seat of fracture, but not over it.

My task is done, and I take this opportunity of submitting with deference to the notice of the examiners, the conclusions which my dissections have compelled me to arrive at, and the treatment which they force me to recommend, in the hope that those who are interested in the subject, will give it their dispassionate consideration, and as far as circumstances admit, will allow it a fair and impartial trial, inasmuch as those opportunities so necessary for testing its real worth, and practical value, while I serve the allotted time as a student of medicine, are altogether denied me.