W. ARBUTHNOT LANE, M.S.

Cleft Palate and Adenoids.

Treatment of Simple Fractures by Operation.

Diseases of Joints.

Operative Treatment of Cancer.

Acquired Deformities.

Antrectomy. Hernia, etc.

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ANTRECTOMY. HERNIA, ETC.

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PREFACE TO THE SECOND EDITION.

Encouraged by the demand for the first edition of my lectures, I have ventured to prepare a second issue. I have taken the opportunity of supplementing a few of my original statements where I think detail has been somewhat sacrificed for brevity.

W. ARBUTHNOT LANE.

21, Cavendish Square, W.;
March, 1900.

CONTENTS.

CLEFT PALATE.

Gentlemen,—I propose to take as the subject of this lecture the conditions of imperfect development of the septum between the mouth and naso-pharynx, comprised under the term cleft palate.

In order to place their treatment on a scientific basis, I will first call your attention to the physiology of the nose, which practically means to a consideration of the mechanical factors that determine the form of the nasal cavities and of the upper part of the pharynx, described together as the "naso-pharynx." We shall then be in a position to formulate general principles on which our methods of treatment may be most advantageously based.

The chief function of the naso-pharynx is to transmit air into the lungs, in order that the sensitive surface of its mucous covering may become affected by substances contained in it. In other words, this part of the body is constructed essentially for the purpose of smell, and in the several groups of animals the degree of its development varies with the importance of the sense of smell to them.

The upper portion of the nasal cavities is used for the ramifications of the olfactory nerve, and the current of air is distributed especially over this area by the act of sniffing. During the normal process of respiration the mouth is kept shut, the upper lip covering the upper incisor teeth entirely, and projecting below them. The breathing air passes chiefly through the lower meatus, while there is hardly any current in the upper part of the space. It is therefore obvious that anything interfering sufficiently with the calibre of the lower part of the nasal cavities impairs their capacity of transmitting air to an extent to make it necessary to keep the mouth open while breathing. When this is done, air enters so freely in through

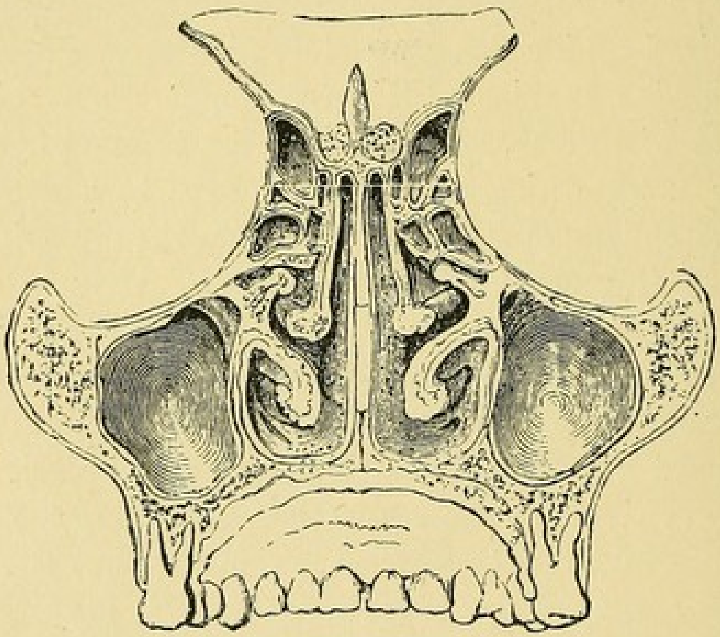


Fig. 1 represents a vertical transverse section through the nasal cavities and adjacent structures.

the larger and more direct channel formed by the mouth, that it ceases to pass through the nose either during inspiration or expiration, the most important function of the part is lost, and the forces which act upon it normally and develop it are in abeyance. Even after air has ceased to pass through the nose in inspiration, it does so during the expiratory process of vocalisation, though in a diminishing degree. Therefore the so-called nasal intonation does not develop as early as one would imagine in association with much loss of nasal inspiration. You see at once from an examination of Fig. 1, which represents a vertical transverse section through the nasal cavities and surrounding structures in the normal subject, that the calibre of the lower part of the nasal cavities, or of their respiratory section, if I may so describe it, is enormously encroached upon by any ascent of the hard palate above the normal

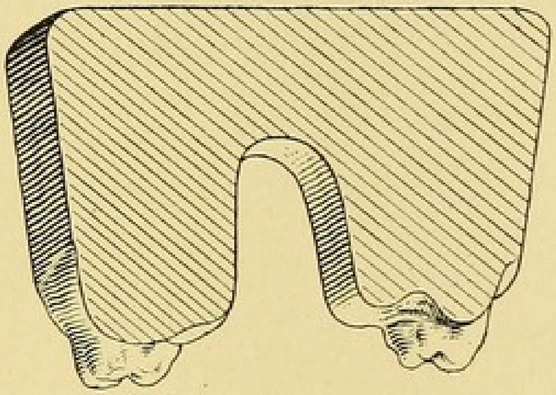


Fig. 2 represents a transverse vertical section of the palate and alveolus, life size, of an adult with an imperfectly-developed naso-pharynx. The model was made by Mr. Edgar Ashby.

level, and that the air-transmitting capacity of the naso-pharynx varies inversely as the height of the palate. Also that the calibre of the entire nasal space is very much affected by the slightest variation in the interval between the septum and the structures forming the outer wall of the space.

You all know how exceedingly common are such cases of imperfect development of the nasal cavity of which Fig. 2 is an excellent example. It has probably often struck you that if we exclude diseases of the nose, ear, larynx, and even lungs, which are directly or indirectly consequent upon some imperfect development of the naso-pharynx, a not unimportant section of their consideration and treatment would have to be deleted from works on these subjects.

It behoves us, therefore, to consider very carefully the factors which are responsible for such imperfect development, in order that we may save our patients from innumerable complications, some of which may not at first sight seem to depend directly upon it.

I believe that such undeveloped conditions result solely from the fact that for some reason or another the mechanical factors that affect the development of the naso-pharynx are in abeyance, and that in consequence this space does not enlarge as it should.

Of course, we must bear in mind that some children inherit a degree of development which is less than the normal. An interesting and ready means is afforded, by the study of such imperfectly developed conditions, of determining how quickly an acquired deformity in the parent may arise in the offspring. Personally I believe that the transmission of this particular condition is very direct and rapid.

The absence of this developmental factor is brought about by an infection of the mucous membrane of the nose, of which the most common type is a cold in the head. The inflammatory swelling of the mucous membrane and the presence of mucus interfere sufficiently with the entry of air during inspiration to make it necessary to breathe through the mouth. This at once deprives the naso pharynx of the presence of the mechanical factor upon which it is dependent for its growth, namely, the pressure of the air upon its walls ; and in consequence it ceases to increase in size. The interval between the septum and the outer wall of the space remains unchanged, and the septum between the mouth and nose does not descend, the arch of the palate remaining abnormally high.

The infective process in the mucous membrane of the nose sets up a corresponding one in the lymphatic mass in the pharynx spoken of as the pharyngeal tonsil, and later in the lymphatic glands in the neck, which receive part of their supply from these structures. The pharyngeal tonsils are also frequently affected, and the larynx, trachea, and bronchi may be also attacked.

The enlargement of the pharyngeal lymphatic tissue interferes with the normal functions of the middle ear, with consequences you are well aware of ; while tubercular organisms readily find a suitable nidus in the inflamed cervical lymphatic glands, and produce more or less disastrous results.

To the condition of nasal obstruction the term "adenoids" has been applied. It has become a household word, and is deservedly regarded by parents generally with very considerable dread.

Unfortunately for their patients, surgeons under the influence of the suggestion of Wilhelm Meyer have considered that the secondary infection of the so-called pharyngeal tonsil is the primary cause of the obstruction of the naso-pharynx, and they have hoped to cure their patients by cutting away a varying proportion of this substance. It is quite apparent that the removal of this lymphatic tissue cannot alone restore to the nose the mechanical factor which is the active agent in its development; though associated with forcible ventilation of the space, such a procedure may occasionally be of service. The children who have not got the vigour and energy to get rid of the primary nasal infection

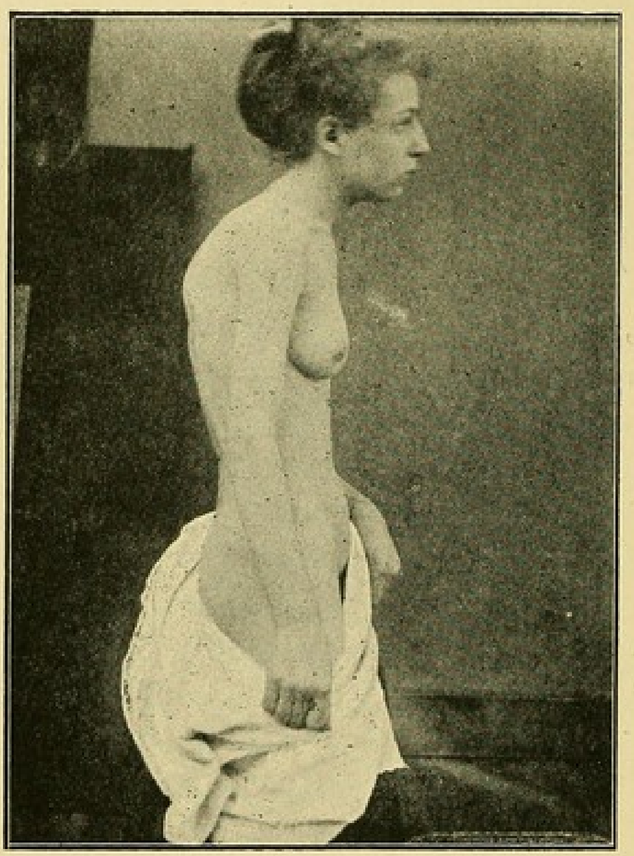


Fig. 3 shows a typical example of the fixation of the symmetrical posture of rest of the trunk.

or cold in the head by forcibly expelling the mucus, and drawing air through the space, are very much alike in certain particulars. They are of low vitality, having little energy to expend, assuming habitually attitudes of rest, and avoiding those of activity. The amount of air they change during respiration is very small, and results almost, if not entirely, from the action of the diaphragm, the chest being retained in the position of rest or of expiration. If a tape be passed round the chest at the level of the nipple it will be found to vary to a minute extent, if at all, during natural respiration. Fig. 3 shows such a condition fixed as the "symmetrical resting posture of the trunk," or, as it is often described, "dorsal excurvation." The assumption of the "asymmetrical resting posture" results after a time in its fixation, to which the popular but singularly unmeaning and unscientific terms "lateral curvature" and "scoliosis" are usually applied.

The "fixation of the resting position of the foot and knee" produces the deformities spoken of as "flat-foot" and "knock-knee."

Such children being supplied with a minimum amount of oxygen, and overloaded with pulmonary and other foul products, have no energy to expend in spontaneously and forcibly ventilating the naso-pharynx, but at once fall back on the more ready mode of obtaining air through the open mouth, with the results with which we are all too familiar.

It is curious that medical men devote so little attention to the manner in which people perform the function of respiration, since it is by far the most important of any to the well-being of the individual. By means of it alone are the tissues of the body supplied with oxygen; and in proportion as the supply provided is good or bad, so are the functions of the several tissues and organs performed in a satisfactory or unsatisfactory manner.

The attention of the profession has been fixed, and medical men have educated their patients to fix theirs largely upon the rate at which the products of digestion pass along the intestinal tract, and it is generally assumed that there should be a daily evacuation. I hardly ever find that any attention has been bestowed upon the manner and character of the respiratory process, though it is of infinitely greater importance to the patient; indeed, constipation frequently and readily results as a natural sequence both directly and indirectly from imperfect oxygenation.

Too often one finds that the patient who performs no thoracic respiration whatever has the spine fixed in a position of extension by a steel support, or by some form of brace; while at other times exercises are ordered which rapidly exhaust the imperfect capital of oxygen without adding to it appreciably.

This all results from an imperfect knowledge of the mechanics of the respiratory process, and especially of the important part which the spinal column takes in it.

The physiologist has misled the profession chiefly by his attempts at illustrating the respiratory process by means of a mechanism in which the spinal column is represented as a rigid immoveable rod. As is too often the case, the generally received teaching is absolutely false, since the variations in the spinal column are much more conspicuous than those of the rest of the wall of the thorax.

I would, therefore, urge that the mode in which the organism is supplied with oxygen should receive at least as much attention as the rate at which the sewage products are evacuated from the body. If this is done, and done well, adenoids, the several varieties of resting deformities, and many other conditions directly and indirectly dependent upon imperfect aëration will disappear.

I do not propose to consider the subject of post-nasal adenoids, as they are called, beyond stating that operative procedures are, in my opinion and experience, quite unnecessary, and that systematic ventilation of the lungs and naso-pharynx furnishes us with a means not only of applying to the naso-pharynx such force as is exerted by air being driven forcibly through it, but by oxygenating the blood more fully, and removing more thoroughly its carbonic acid, &c., the several structures of the body are better nourished, and perform their functions in a normal manner.

The primary infection is removed in this manner, and as a natural sequence the enlargement of the lymphatic glands, which is consequent upon it, disappears.

The whole of the cavity of the naso-pharynx increases in size, the palate descends, the alveolar arches of the upper and lower jaws increase in breadth, and the malar bones become more prominent owing to the greater development of the antral cavity in the inferior maxilla.

As to how this is best done must vary largely with the intelligence of parents, their perseverance, and the time and means they have at their disposal.

In out-patient practice, in which from the circumstances of the parents it can rarely be carried out in the same effectual manner that is possible in private practice, where the patient is under the immediate control of the medical attendant, and his instructions are strictly enforced, I give the mother a printed form containing the following words: "Put the child on its back three times a day for half an hour at a time, and make it breathe in and out as deeply as possible through the nose, the mouth being kept shut," and endeavour to interest them in its application.

Among the better class of mothers, such as the wives of policemen and mechanics, you will frequently obtain results as good as those in private practice; but the poorer portion of the community have not the time, nor will they often devote their energy to follow these instructions.

The surgeon can readily determine whether his treatment is carried out efficiently or not by making the parents keep a diary in which they must enter the differences between the measurements of the chest in extreme inspiration and extreme expiration. These daily observations will keep him informed of the degree of progress his patient is making.

Should this variation not show a steady increase in amount he can rest assured that his instructions are not being carried out properly.

Well, gentlemen, I hope I have proved to your satisfaction that the pressure exerted by air, as it is driven backwards and forwards through the constricted channel bounded laterally by the upper jaws, is the only mechanical factor which determines the form of the naso-pharynx, and of the structures which are to a large extent dependent upon it for their perfect development.

Now returning to cleft palate, which forms the subject of this paper, you recognise that while the nasal cavities are in communication with the mouth, the mechanical factor upon which they depend for their development is in abeyance, and therefore they do not develop. In consequence the sides of the alveolar arch become approximated, as do the edges of the cleft, and the portions of the roof on either side of the cleft become more vertical and extensive. I will call your attention particularly to this, since you will find that many surgeons use as an argument in favour of delaying the operation that the changes in the roof of the mouth which I have indicated take place in time, and render surgical interference more simple. In other words, the less developed the nose, the more easy the operation for the closure of a deficiency in its floor.

Since the calibre of the nasal cavities bears an inverse proportion to the height of the palate, and as the lower part of the nasal fossæ is that through which air is chiefly transmitted, this is especially encroached upon by any abnormal increase in the height of the palate. Being aware of the mechanics of the naso-pharynx, you will recognise the immense importance of separating the mouth from the nose as early in life as possible, so that the pressure exerted by the air as it passes through the former can be brought to bear upon the walls of the space, and the nasal cavities and the adjacent bones shall be influenced by normal developmental factors.

In order to recall to your minds the practice followed by surgeons of the present day, I will quote a few lines on the treatment of cleft palate from Treves' 'System of Surgery,' which is, I think, the most recent English text-book. "In the infant the cleft is by almost all surgeons rightly deemed inoperable. In the child, after the age of two years, the chief importance of the malformation is the defect of speech which is occasioned. It is well, therefore, to be prepared for the fact that the closure of the cleft in no way remedies the defect of articulation. Of prime importance is the question, at what age should the operation be performed? It may, I think, be laid down that whilst it is never wise to operate on a child under three years of age, the time of election is from this age up to six years." These definite statements, which are picked out from the text, we may regard as representing generally accepted views, and as open to our criticism. The author does not appear to adduce any argument in support of the first statement, viz. that surgeons are acting *wisely* in avoiding operations in infants; therefore we may satisfy ourselves by merely asserting that in our opinion this statement is not borne out by our experience, but that the reverse is true. The second statement is, I fancy, partly correct. Some patients will, however, complain more of the discomfort they experience through food getting into the nose, than from the consciousness of the fact that their voice differs from the normal. The chief disadvantage of the deformity depends upon whether you regard it from the point of view of physical discomfort to the sufferers, or of depreciation of them in the opinion of their fellow-creatures, since the peculiar intonation, *per se*, causes no discomfort, and is often not recognised by the speaker.

Now as to the statement that "it is well further to be prepared for the fact that the closure of the cleft in no way remedies the defective articulation," this I am prepared to deny if the operation is performed during the period of growth. The reason that the patient's intonation is peculiar, or, as it is usually called, nasal, is that the outgoing air does not pass through the nose, and when the cleft is closed at the usual time, there is in the extremely undeveloped nose very little space through which air can be transmitted, and as far as I am aware no effort is made by surgeons to develop this space after operation. This is probably due to the fact that they had not considered the mechanics of this channel. If, however, the space is systematically and forcibly ventilated the calibre of the naso-pharynx is increased, and a considerable proportion of air passes through it, so that the so-called nasal character of the voice is diminished very greatly. Still assuming this statement and the preceding to be absolutely correct, in what light are we to regard the next? "Of primary importance is the question, at what age should the operation be performed? It may, I think, be laid down that whilst it is never wise to operate upon the child under three years of age, the time of election is from this age up to six years." If we allow the second and third statements to be true, as they are approximately so, it is difficult for the ordinary mind to grasp the logical sequence of the conclusion deduced from them. No, gentlemen, the treatment of cleft palate, like the greater part of surgery, has been a matter of creed and tradition, and has not been arrived at in any reasonable manner. In order to treat these cases as efficiently as possible no time whatever should be lost in restoring to the nose its normal physiology, or in other words in giving back to it the mechanical factor which alone determines its development and that of the other structures dependent on it to a considerable extent for their normal form.

We will pass on to consider the following questions, viz.:

1. What is the best age for operation?

2. What is the best method of performing the operation?

3. How and when can any complication such as harelip be met to the greatest advantage?

1. *Age.*—I find the best age for operative interference is during the fourth or fifth week, providing there is no special indication to the contrary, by which I mean bronchitis, diarrhœa, and the results of bad feeding generally. Under such circumstances it is necessary to postpone the operation till the condition of the child is satisfactory.

The advantages of operating at this early period are—

(*a*) The child bears the operation very well.

(*b*) It experiences but slight subsequent discomfort, and will take food with satisfaction within an hour or two of the operation.

(*c*) The amount of hæmorrhage is very slight, and is readily controlled.

2. *Method of operating.*—Though the details of the operation must vary considerably in a small proportion of the cases, in a large number I endeavour to raise a flap of mucous membrane and periosteum from one side, and to fasten it securely beneath the separated margin of the opposite side. This is to a certain extent a modification of a mode of treatment by flaps introduced by Mr. Davies-Colley some years ago.

The measures I usually adopt can be best illustrated by diagrams. Fig. 4 represents a cleft running through the whole of the hard and soft palate. A flap which is attached to the margin of the cleft is turned up from the bone of the hard palate, and is

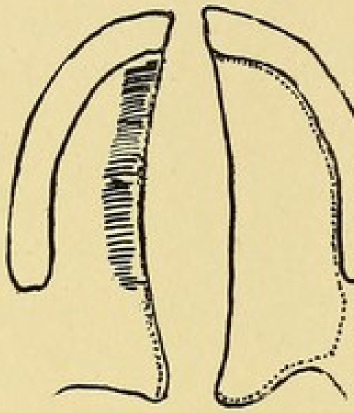


Fig. 4 represents a complete cleft of the palate. The dotted lines indicate the incisions, and the shaded area the portion of muco-periosteum elevated from the subjacent bone.

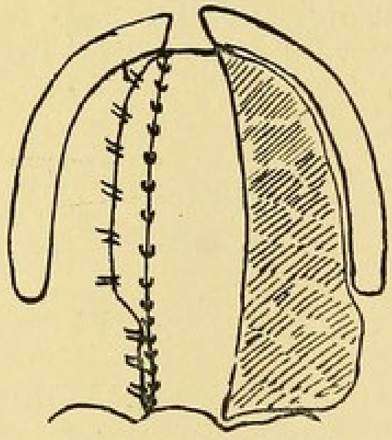


Fig. 5 represents the flap fixed in position by a double row of sutures.

dissected off the soft palate. Its extent must vary with the area to be closed. There is practically no limit to the amount of flap that can be obtained, since the whole of the muco-periosteum covering the under and outer surfaces of the edentulous alveolus may be included in it, and this is sufficient to fill any gap in the hard palate however large. Great care must be taken not to tear away this flap from the margin of the cleft in the hard palate. The latter part of the operation can be done very well with the form of knives shown in Fig. 8 or by means of a very sharp

Fig. 6 shows in vertical transverse section the line of incision along the margin of the flap.

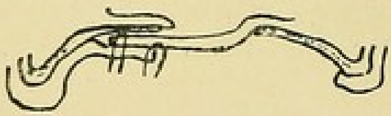


Fig. 7 shows the flap raised and fixed in position. It is a transverse section through Fig. 4.

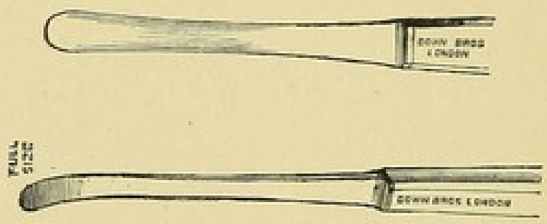


Fig. 8 represents straight and curved knives used for splitting the soft palate.

pointed scissors. In doing this the descending palatine vessels are exposed as they emerge in a loose periosteal sheath from a single foramen. These can be cut long, and any hæmorrhage readily controlled by a ligature or by torsion. At this early period of life the vessels are very small, and the amount of blood lost is always trifling. On no occasion have I ever felt the slightest anxiety on that account. This was certainly not my experience when operating on children over three years of age. Indeed, it was in a case of cleft palate, apparently moribund from loss of blood, that I first applied the method of intra-venous injection of saline solution which has since been the means of saving so many lives, not only from hæmorrhage but also from exhaustion, as in cases of intestinal obstruction, &c. The case was described in the 'Lancet' September 12th 1891, under the heading of "A Surgical Tribute to the late Dr. Wooldridge." An incision is then made along the

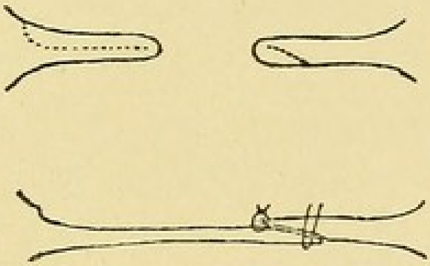


Fig. 9 shows manner of treating soft palate.

opposite free margin of the cleft in the hard palate, and the muco-periosteum is raised from the bone for about a quarter of an inch. The soft palate on the same side is pulled forward, being held in forceps, or a thread may be passed through its extremity. It is split in the same manner indicated in Fig. 9, none of it being removed. Lately I have frequently cut a flap from the posterior aspect, increasing still further the areas of the opposing raw surfaces. This is done in order to offer a large raw surface which can be brought into accurate apposition with the reflected flap. The reflected flap is first introduced beneath the separated edge of the muco-periosteum of the hard palate, and its margin pinned at intervals by sutures. Then the margin of the flap of the soft palate is similarly attached to the outer limit of the raw surface on the back of the op-

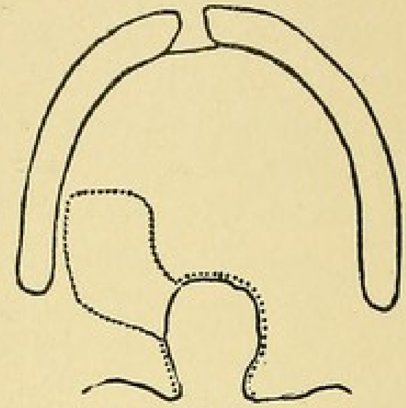


Fig. 10.—A mode of treating residual cleft in soft palate.

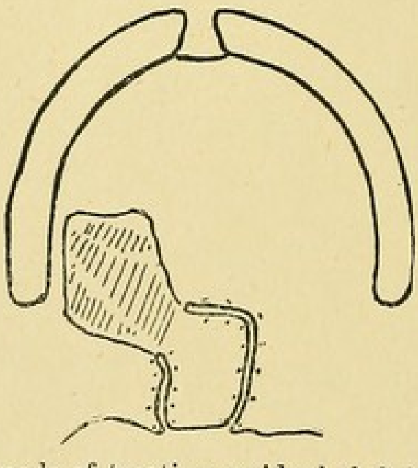


Fig. 11.—A mode of treating residual cleft in soft palate.

posite margin by means of separate sutures. The free part of the elevated border is attached securely to the raw surface of the reflected flap by means of separate or several continued sutures. In this manner two large raw surfaces well supplied with blood-vessels are retained immoveably in accurate apposition, and are placed under the most favourable circumstances for immediate union. In many cases, especially in clefts limited to the soft palate, I find that the old method of freshening of the edges of the divided palate, tension being removed from the line of suture by vertical incisions, gives excellent results. This is clearly of no use when the cleft is horseshoe-shaped. It is very unusual for any portion of the flap covering in the cleft in the hard palate to give way, but occasionally the margins of the soft palate

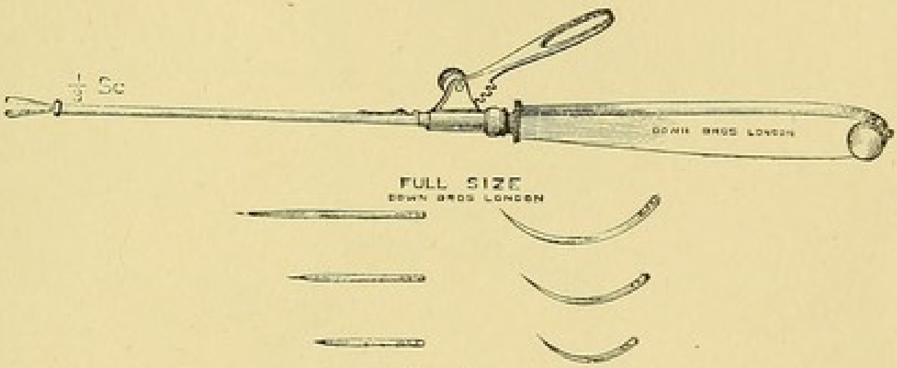


Fig. 12.

may come apart. To remedy this, after an interval of two or three weeks a flap should be taken from the side of the hard and soft palate opposite to that utilised on the first occasion, and be retained by the same method in the cleft (Fig. 10). By this means the sutured surfaces are exposed to a minimum of strain. To render this method of operating in the young infant possible, it was necessary to devise an instrument for the purpose, since those in common use at the time were inefficient. The needle-holder and needle shown in Fig. 12 meet all possible requirements. The needles are made straight and full curved, and vary in size from three-eighths of an inch upwards. For pinning the flap the straight needles are best suited, while the curved ones are more serviceable in the later stages of the operation. The

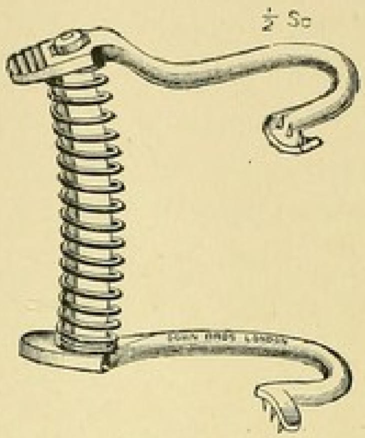


Fig. 13.

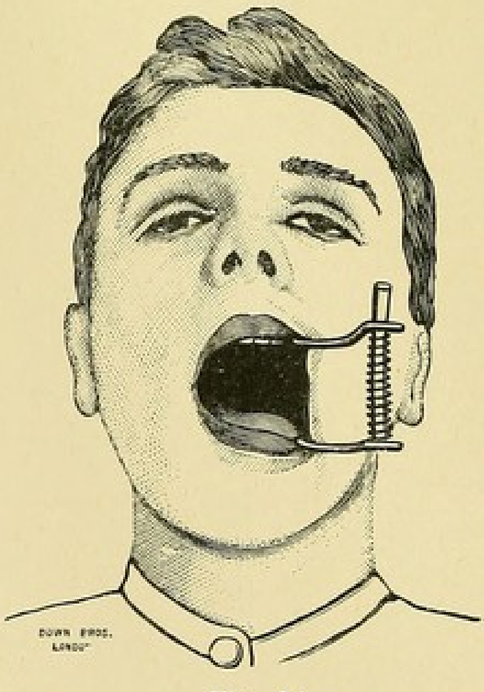


Fig. 14.

sutures used are of the finest silk, and employed dry to facilitate threading. The gag I employ is one made for me by Messrs. Down Bros. some time ago. It is perfectly self-retaining, owing to the presence of small sharp teeth which bite into the gum behind the molars. It is depicted in Fig. 13, and in position in Fig. 14. It is well to be provided with several sizes of this gag. The gag most generally used is too powerful for the infant only four weeks old. Messrs.

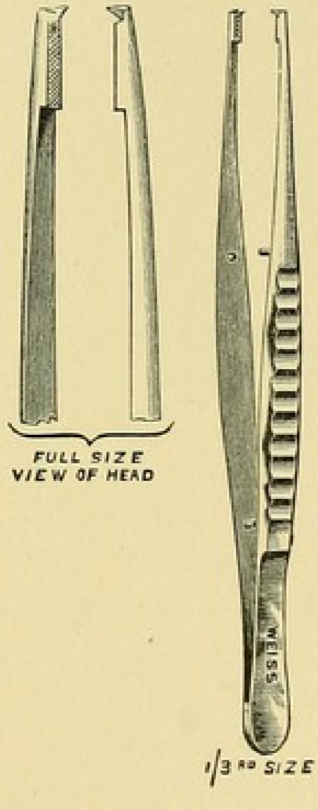


Fig. 15.

Weiss made me a very useful pair of forceps which have terminal teeth, and approximating serrated plates (Fig. 15). By means of the teeth the flap can be held, and with the plates the operator can grasp the needle firmly and readily, and draw it through the flap when necessary. As a rule, the needle is taken up and drawn through the flap by the needle-holder.

Many children with cleft palates are also afflicted with harelip. The latter is, of course, left untouched till the fissure in the palate has been closed, since it affords a larger aperture, and renders the cleft more get-at-able and the operation consequently very much easier to perform than it would be if the harelip was treated in the first instance. When there is no cleft in the lip and the narrow orifice is a difficulty, I do not hesitate where necessary to split the lip, restoring its continuity accurately after the operation on the palate has been completed.

I do not pretend to obtain the same results in the treatment of harelip as are apparently got by some surgeons, if one can place any reliance whatever upon the diagrams they use to illustrate their methods of procedure. These, I fancy, are purely imaginary, since they appear to be able to restore the imperfectly developed lip to its normal form, and to its relationship to the lower lip. My experience is that, excepting in slight cases, the upper lip always remains smaller than normal, and disproportionate in size to the lower. In some few cases I have obviated the relative loss by filling in this gap by a flap obtained from the lower lip, with which it remains continuous till it has united firmly to the upper. I would point out to you the advantage of passing all the sutures through the lip from within outwards, since by so doing you can bring the margins of the cleft into firm and accurate apposition, and are enabled to control the hæmorrhage without scarring the skin surface, as is frequently done when the sutures pass through the skin in the usual manner. Besides, they can be left in much longer, as their presence causes no discomfort, and retains the raw surfaces in accurate apposition. The scarring of the lip was a more marked feature when the old-fashioned harelip pins were employed.

There is a form of cleft palate combined with double harelip, in which the premaxilla is attached

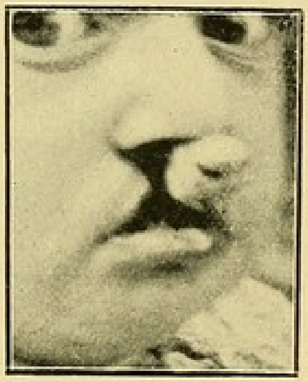


Fig. 16.

to the under surface of the septum of the nose immediately behind its tip (Fig. 16). In such cases I have found the most satisfactory procedure is to close one of the fissures in the lip in order to supply the premaxilla with blood-vessels from a source other than the septum. When this has been effected the premaxilla can be cut away from the septum, the mucous membrane covering it, and the corresponding surfaces of the jaw removed, and the bone being trimmed and replaced can be wired securely in position. The remaining fissure in the lip can then be closed, but by leaving it open till this period you obtain more room to work in, and you are able to carry out the details of the operation on the septum, &c , with greater facility and accuracy.

ACQUIRED DEFORMITIES.

Gentlemen,—I would urge on you very strongly when you are studying clinically the several surgical conditions with which you must render yourselves familiar, not to be satisfied with accepting the usual text-book statements of their causation, unless, on applying to them the test of your sound common sense, you find that they are perfectly intelligible and rational.

You may, I think, conclude that any explanation of the causation of a condition that, after thoughtful consideration, appears confused, complicated, and verbose, is probably false.

When a writer has in his own mind no definite idea of the cause of a morbid condition, he often takes great pains to render his description of it as unintelligible and vague as possible, or he smothers the reader with a number of views held by various authors, each usually utterly at variance with the other.

General laws are, as a rule, very simple, readily intelligible and capable of proof, and the importance of a principle is generally directly proportional in degree to its simplicity.

I would, therefore, advise you to avoid assimilating in an unchanged form the accumulation of what passes for knowledge unless you have first digested it, absorbing the reasonable, and excreting anything which cannot bear the closest criticism.

I intend in this lecture to attempt to explain the anatomy and the causation of the several acquired deformities which are painfully familiar to us in the out-patient room, and which too frequently derive very little benefit from our treatment of them, for the reason that we are unable to place our patients under such circumstances as would bring about their recovery.

The deformities I allude to are knock-knee, flat-foot, lateral curvature, and dorsal excurvation. These I will call for convenience "resting" deformities, the reason for which I will show later.

It is obvious that if you are unfamiliar with the anatomy, physiology, and causation of these conditions, you are not in a good position to treat them. You are still more unfortunately placed if the idea you have of the mode of their production, &c., is absolutely false. There is, perhaps, no branch of surgery about which so many various theories of causation have been evolved, and about which so much obscurity and ignorance exist even in the best standard works on surgery.

One is very liable to imagine, from a knowledge of anatomy as taught by the text-books, that the construction of the human body does not allow of much variation. A little careful study will, however, show you that not only do the forms of the bones of the human adult skeleton vary with such movements as are performed habitually, and with such routine attitudes as are assumed by the vigorous individual, but also do the details of the structure and the functions of the several joints.

If an individual is habitually engaged in performing a certain movement or sequence of movements of activity, the form of the skeleton varies from the normal in a degree which is proportionate to the length of the period during which the movement has been performed, and to the amount of energy expended in the act. During a single performance of the attitude of activity there are present numerous tendencies for the bones and joints to undergo changes in form. Their constant repetition enables the tendencies to become actualities. The earliest variation from the normal consists in the fixation of the physiological attitude which is naturally assumed during the performance of such a movement of activity, while the later changes are exaggerations of the same attitude due to changes in the bones and in the intervening soft structures. In other words, *the peculiar character of the anatomy of the labourer is, first, the fixation, and subsequently the exaggeration of a normal physiological attitude of activity.*

A workman who for a large number of years has followed the same laborious occupation, possesses an anatomy which is unmistakably characteristic of that occupation, and which in many cases differs from what we are accustomed to regard as the normal anatomy of the human subject, infinitely more than the latter differs from that of the ape.

The variations exist not only in the separate bones and joints, but in the arrangement of these bones.

Compare, for instance, the clavicle and scapula of the shoemaker with those of the sailor and deal porter, and the least observant will at once recognise the very great difference in the form of the several bones. A little consideration of the peculiar physiology of each occupation will show you the factors that have produced the characteristic form of each bone. They are chiefly ossification of muscles along the lines of habitual traction, and the alteration in form which results from the habitual transmission of considerable force in certain directions (see Figs. 17 and 18).

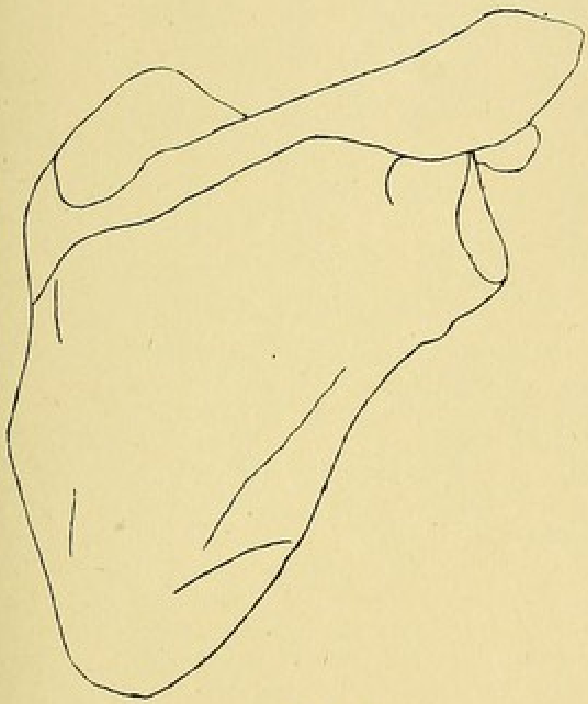


Fig. 17.

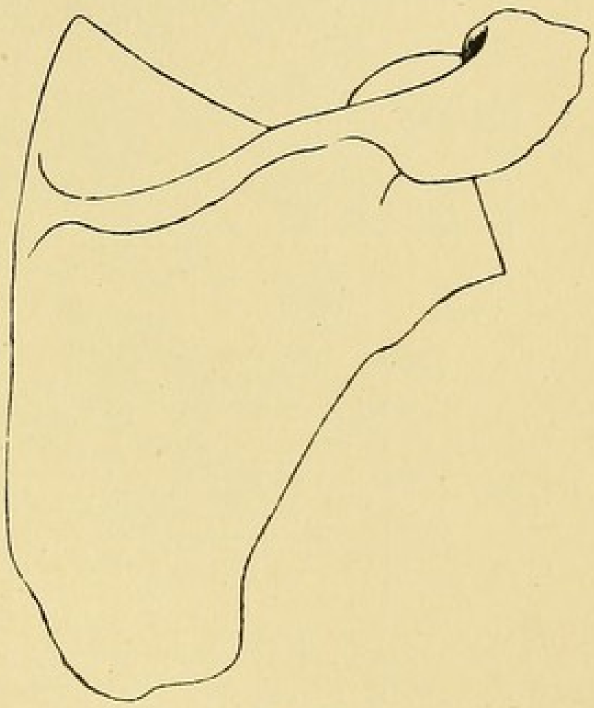


Fig. 18.

Figs. 17 and 18 represent respectively the scapulæ of a shoemaker and of a deal porter, who carried his load habitually on the right shoulder. The latter shows the result of strain exerted chiefly on the trapezius and levator anguli scapulæ, and the former the very great breadth of the acromion process, which develops in consequence of the strain on the back of the deltoid, and the eversion of the margins of the supra-spinous fossa from that sustained by the supraspinatus muscle. The strain on the infraspinatus and teres major muscles, and upon the rhomboids during the process of pulling the threads has left a very definite impress upon the bone.

A very good instance of the effect of pressure on bone, which you observe in the shoemaker, is the remarkable deformity of the sternum, which results from the constant pressure exerted by the mode in which the boot is fixed between the chest and thigh. The depression which is formed in front of the chest by this alteration in the form of the sternum is very considerable and striking.

The result of excessive pressure is also shown very well in Fig. 19.

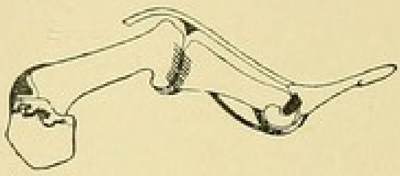


Fig. 19 represents the thumb of the same shoemaker, and shows the remarkable alteration in the normal anatomy of this part of the body, which develops in consequence of the strain sustained by it in the pursuit of this particular occupation. The forcible apposition of the thumb to the index finger in holding and pulling on the thread produces the forward displacement of the base of the first phalanx, with a corresponding alteration in the shape of the head of the latter, and in the strength and attachment of the anterior and lateral ligaments, together with the formation of a fringe in the angular interval existing between the bones posteriorly. Similarly in the carpo-metacarpal joint the anterior part of the base of the metacarpal bone has cut deeply into the trapezium, the opposing surfaces being highly polished, while a fibro-cartilage has developed in the angular interval posteriorly being attached by its base to the enormously hypertrophied posterior ligament. The forcible over-extension of the terminal phalanx has brought about a very great increase in the size of the anterior ligament, and the formation of a very powerful oblique band of fibres in the sheath to prevent the very considerable tendency to the displacement of the flexor tendon which exists. There are many other changes which cannot be represented diagrammatically, but which are full of interest and instruction to the surgeon.

The body of the same labourer illustrates in a wonderful manner a function which the organism possesses, perhaps even more curious than the selfish-control which I have shown * is exerted upon the bone-forming department in favour of the brain. I refer to its capacity to form a perfectly new mechanical arrangement, or to produce a modification in an already existing one where it is

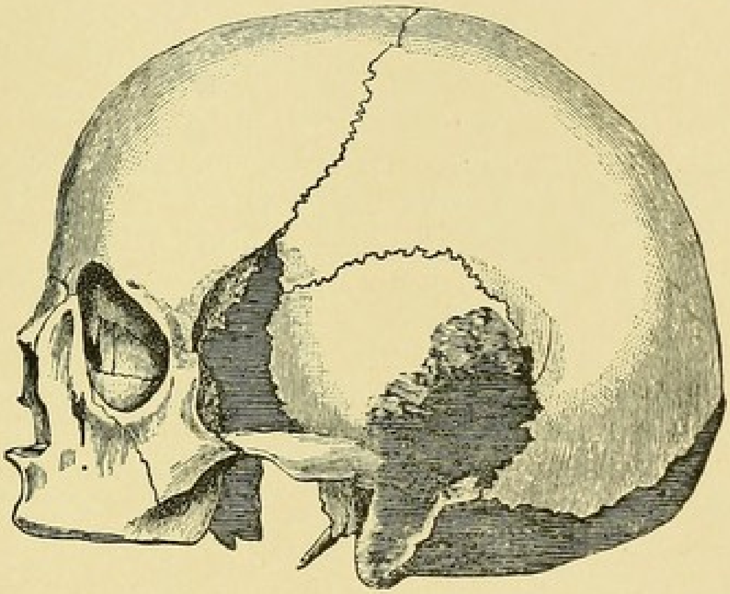


Fig. 20 represents the skull. The shaded parts indicating the areas in which the softening process was most advanced.

obviously of great advantage to possess it. The sweated shoemaker, as he sits daily for twelve—and probably a larger number of hours sewing, holds

* "Cases of mollities ossium, rheumatic arthritis and Charcot's disease" ('Trans. Path. Soc.,' 1884).

"The factors which determine the hypertrophy of the skull in mollities ossium, rickets, and ostitis deformans" ('Lancet,' April 28th, 1888).

In the paper in the 'Trans. Path. Soc.' I endeavoured to disprove the view of the pathology of mollities put forward by Rindfleish, who regarded the fibrillation as part of a degenerative process, whereas it appeared to me to be reparative and analogous to changes in rickets and osteitis deformans. I was fortunate in obtaining a body the subject of early mollities (see Fig. 20).

his head in a sloping position, so that it is tilted obliquely to one side. It would obviously be of the greatest service to him in that it would relieve him very considerably of muscular strain in fixing his skull during the abrupt and powerful movements he

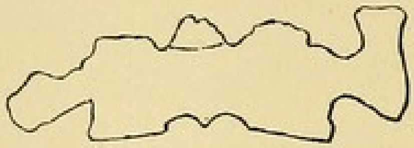


Fig. 21 represents the anterior surface of the atlas with a prolongation upwards from its anterior arch, also the large quadrilateral column of bone which stood upon the upper surface of the left lateral mass.

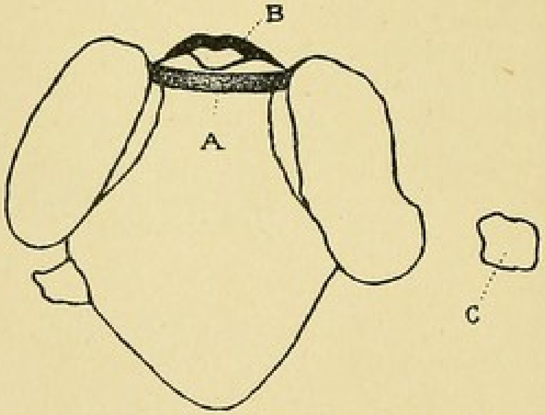


Fig. 22 represents the foramen magnum and condyles of the occipital bone. *B*, the groove that received the sharp free upper margin of the articular facet upon the atlas; *A*, the transverse ligament which lay behind the upward prolongation of the odontoid process; *C*. the facet on the jugular process of the occipital bone, which articulated with the column of bone growing from the lateral mass of the atlas. Note also the change in the form of the condyles of this bone.

is constantly performing if he had projecting up from the upper surface of the lateral mass of the atlas, on the side to which his skull is tilted, a pillar of bone which articulated with the jugular process of the occipital bone, and formed with it a secure joint through which much of the superjacent weight could be transmitted. This is exactly what takes place, and these diagrams illustrate the condition of the atlas and of the occipital bone, &c.

This represents a new formation quite independent of any pre-existing joint, and therefore serves my purpose in demonstrating this function very clearly to you. Yet though this exists independently of any

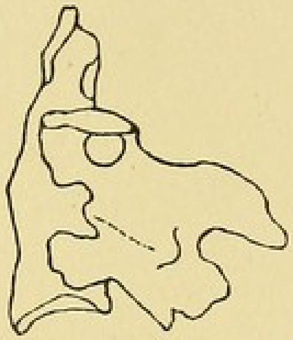


Fig. 23 represents the axis and third cervical vertebra, the prolongation upwards of the odontoid process with its articular facet, the formation of a layer of bone connecting the arches of the axis and third cervical vertebra, and the position of the ankylosed articulation of the articular processes. The cause of the destruction of the intervening soft parts, and the union of the vertebræ to one another in this as in other laborious pursuits, is fully explained in the original paper. I have frequently seen this condition exhibited as cured tubercular disease of the spine by surgeons, and congenital union of bone by anatomists.

joint, if you examine the various changes that take place in the several joints in the labourer, and in the subject whose mechanics have been altered by disease of bone or joints, or by fracture of a bone or bones, you will find the same law in evidence everywhere.

If you wish to pursue the subject further, you will find the anatomy and physiology of the shoemaker fully described in the 'Journal of Anatomy and Physiology,' July, 1888.

We take advantage of these laws very largely in surgery. Occasionally the temporo-maxillary articulation becomes ankylosed in consequence of some septic infection, either from its becoming involved in some adjacent inflammatory process, or because of its infection through the circulation as part of a pyæmic process. In such cases the articular and interarti-

Fig. 24 represents the result of this operation on a boy aged nine, in 1892. The jaw was fused to the temporal bone, no evidence of the original joint being visible.

cular cartilages are destroyed, and the condyle of the jaw becomes united by bone to, and is practically continuous with, the temporal bone. The jaws are fixed on one another in the position in which they are normally closed, so that the molars and bicuspids come into accurate apposition, while the incisors of the lower jaw project into the roof of the mouth considerably behind those of the upper jaw. The patient is therefore only able to swallow food of a fluid consistence. If ankylosis takes place early in life the portion of the jaw represented by the condyle and neck becomes very broad and thick, and also shorter than its fellow. The jaw not performing its normal function does not develop in the same pro-

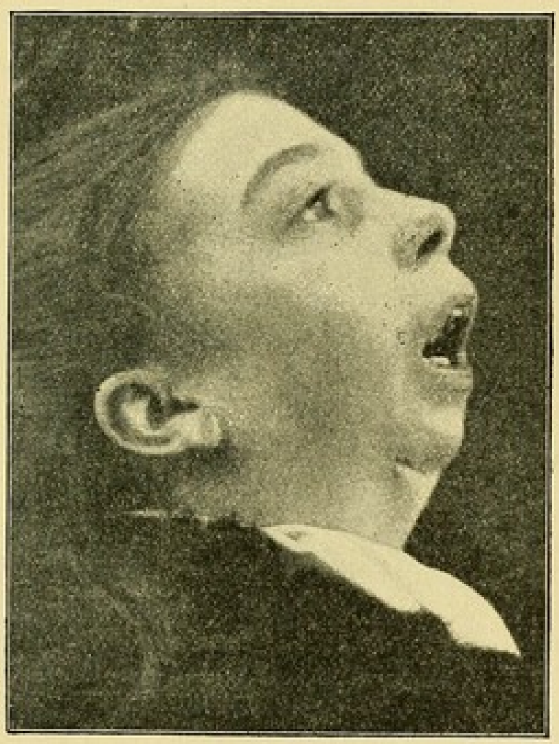


Fig. 25 shows the condition of a girl aged twelve, operated on in 1893. The joint was destroyed when she was eighteen months old, and at the operation all trace of it had disappeared completely.

portion as the rest of the bones of the face, so that the chin loses altogether its normal prominence. The lower incisor teeth, missing the habitual pressure exerted by the upper incisors in biting the food, become abnormally long, and project into the mucous membrane of the roof of the mouth, so interfering still further with the introduction of food. This difficulty is even more exaggerated by the overgrowth of the upper incisors from the same causes.

The treatment of such a condition consists in cutting down upon the temporal bone, and upon that portion of the jaw which is continuous with it, and then removing a piece of bone from the junction sufficiently large to enable the mouth to be opened.

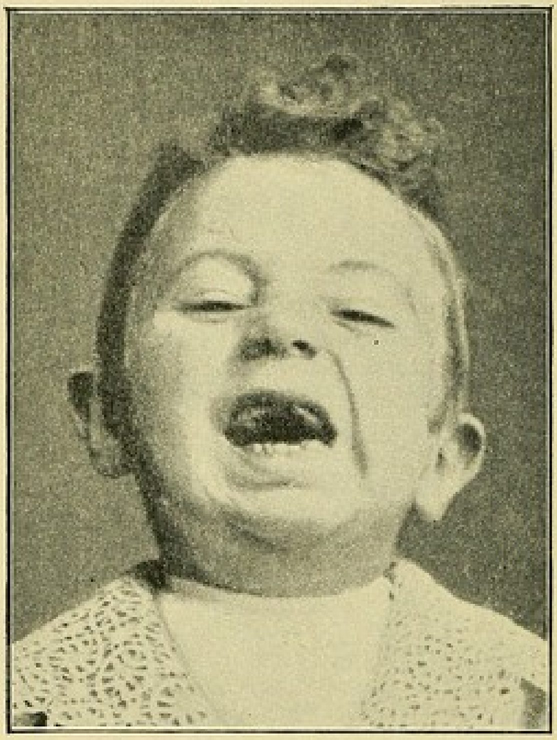


Fig. 26 illustrates a boy aged four, operated on in 1894. The joint had been disorganised three years before.

Within a few days of the operation the child is encouraged to bite and chew, and by the mutual friction of the bones upon one another they alter in form, become covered by articular cartilage, and a synovial membrane is developed. In this manner a perfectly new joint is evolved, and it performs the function of the normal temporo-maxillary articulation more or less perfectly. See Figs. 24, 25, 26, 27, and 28.

It is *very much more difficult* to obtain a good result in adult life than it is in childhood.

Let us pass on to examine the spine of the coal-trimmer, whose anatomy and physiology is described in the same journal, April, 1887.* You will find

Fig. 27 is a girl aged ten, operated on in 1895. The joint was destroyed when the child was seven years old.

that in consequence of the forcible rotation of the thorax upon the pelvis in throwing coal to places at a distance, the neural arch of the fourth lumbar vertebra is completely divided, and an arthrodial joint is formed between the bodies of the fourth and

* "A remarkable example of the manner in which pressure-changes in the skeleton may reveal the labour history of the individual."

fifth vertebræ, the fibro-cartilage which originally existed there having been more or less completely divided.

One of the innumerable points of interest in the skeleton of the coal-trimmer in whom movement between the head of the first rib and the vertebræ

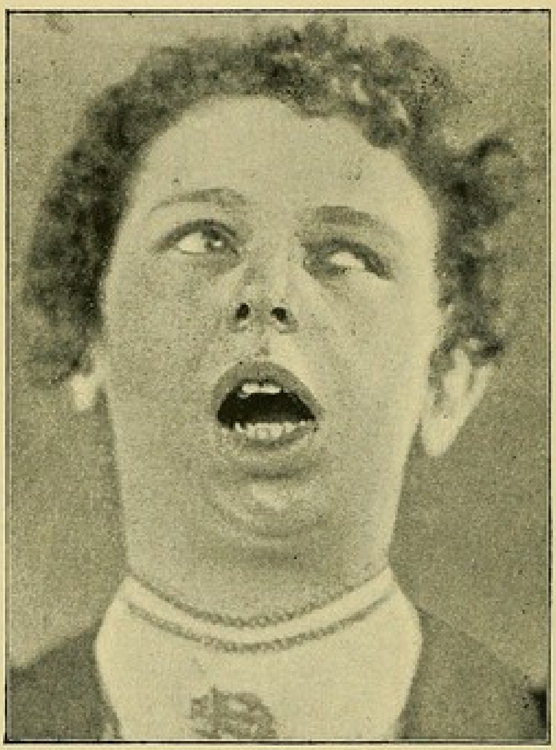


Fig. 28 is an adult whose joint had been disorganised in infancy. The operation was performed in November, 1895, and the photograph represents her condition in April, 1896.

is limited in direction is that the articulation between these bones is strengthened by prominent bony processes which project outwards from the adjoining margins of the bodies of the seventh cervical and first dorsal vertebræ. This is shown in Fig. 31.

Again, observe the spinal column of this drayman, and see the large single lateral curve, with changes

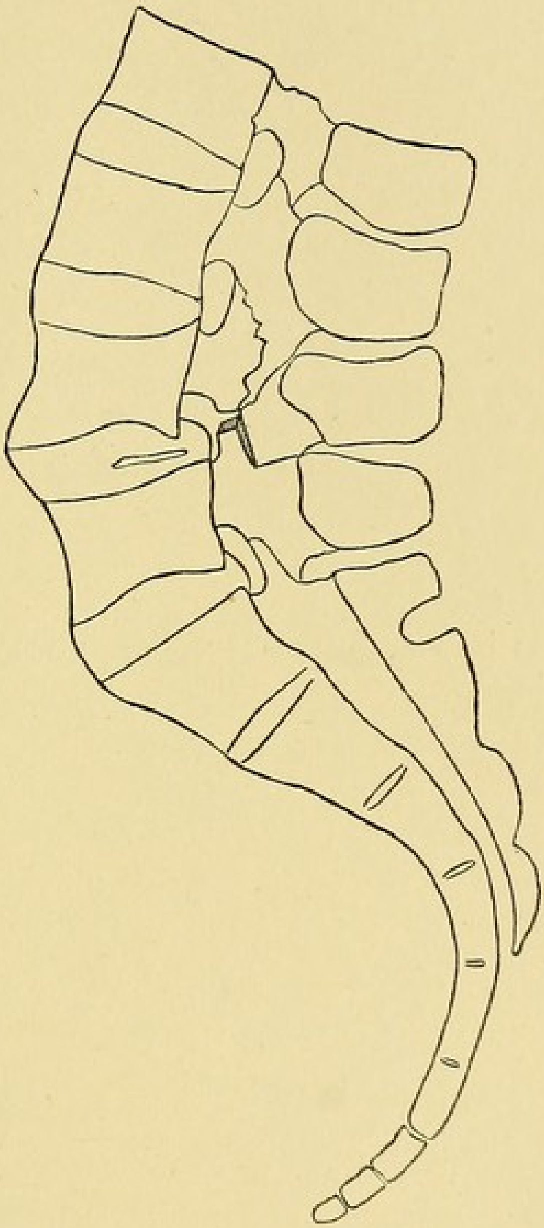
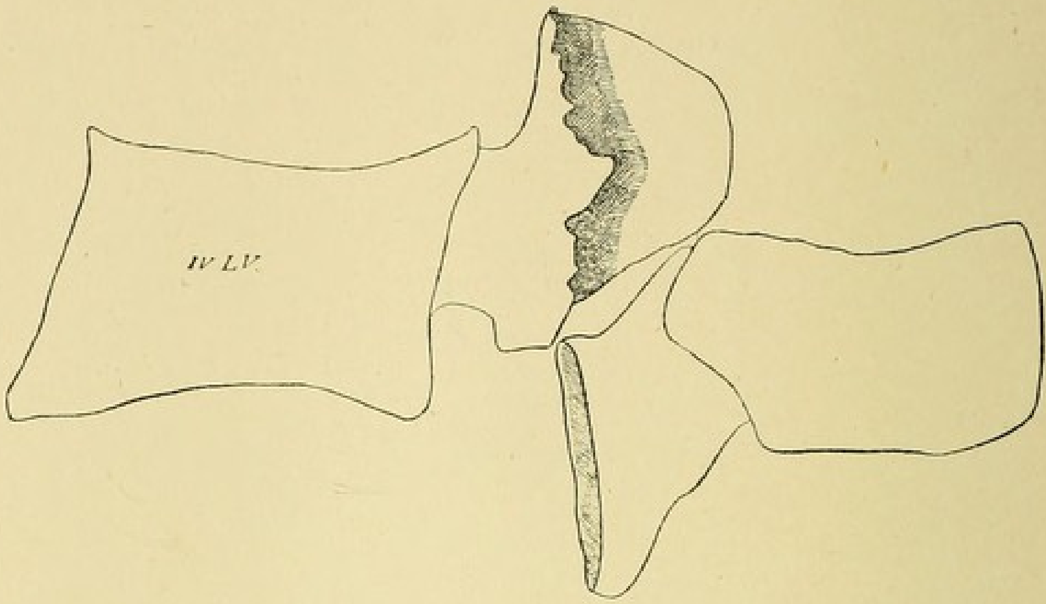


Fig. 29 shows a vertical median section of the lower part of the spinal column of the coal-trimmer. The superior articular process of the fifth lumbar vertebra is flattened superiorly where it articulates with a corresponding surface on the inferior articular process of the third lumbar. The cavity in the fibro-cartilage between the bodies of the fourth and fifth lumbar vertebræ is also represented. The articular processes of the third and fifth vertebræ have gradually cut through the intervening portion of the lamina of the fourth during the over-extension of the spine and the succeeding rotation, so that there is first a violent impact of the processes into the lamina, followed by a lateral grinding movement. Finally, the two articular processes come into contact, and changes result in consequence.



In Fig. 30 the separate portions of the fourth lumbar vertebra are shown in their relative positions. This condition has been observed by several, and has been regarded as resulting from congenital non-union of the bony centres.

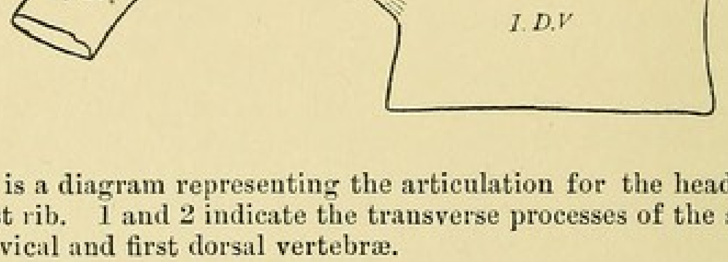


Fig. 31 is a diagram representing the articulation for the head of the first rib. 1 and 2 indicate the transverse processes of the seventh cervical and first dorsal vertebræ.

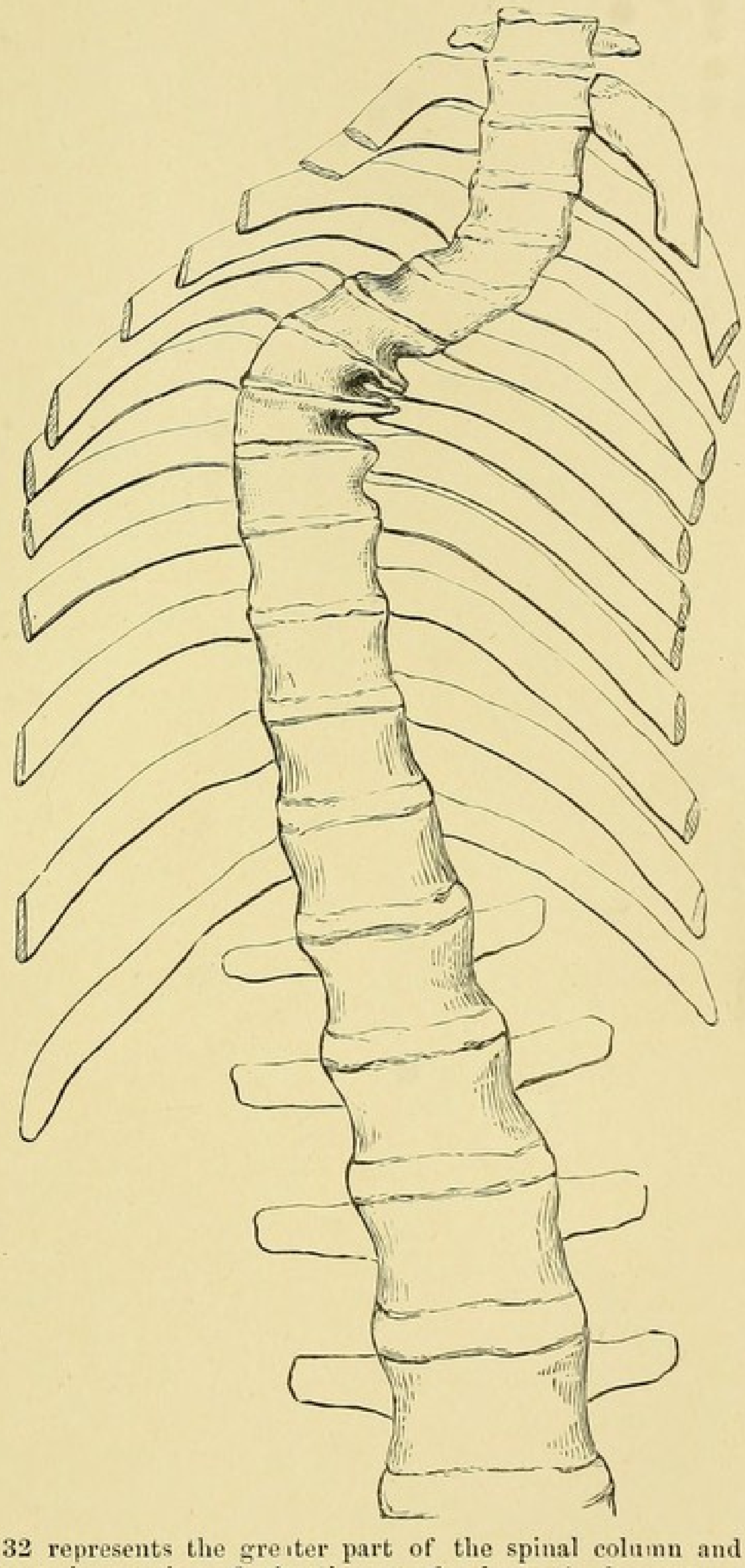
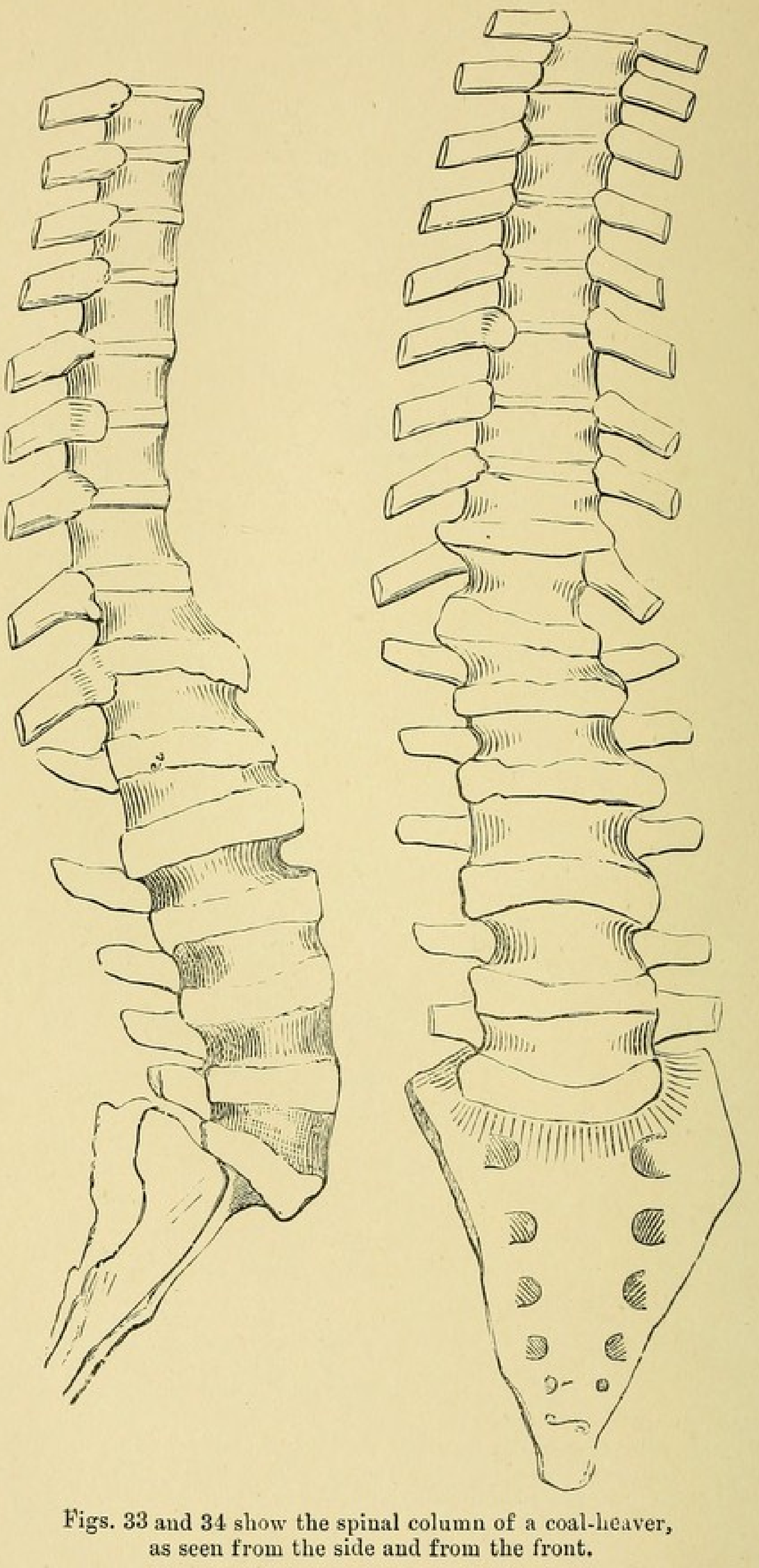


Fig. 32 represents the greater part of the spinal column and the posterior portion of the thorax of a brewer's drayman, whose body I examined in the dissecting room of the hospital.



Figs. 33 and 34 show the spinal column of a coal-heaver, as seen from the side and from the front.

in the form of the several portions of the vertebræ in the intervening fibro-cartilages, and in arrangement of the vertebræ, ribs, &c.; or look at the spine

Fig. 35 represents the fourth and fifth lumbar vertebræ and the sacrum of the coal-heaver in vertical antero-posterior section, and illustrates the form of spondylolisthesis found in this class of labourer.

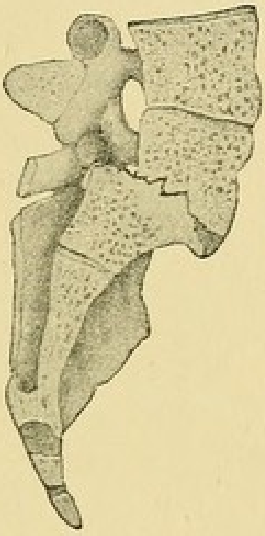
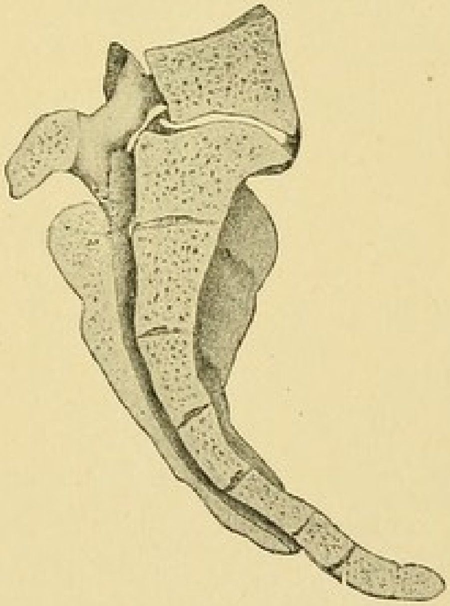
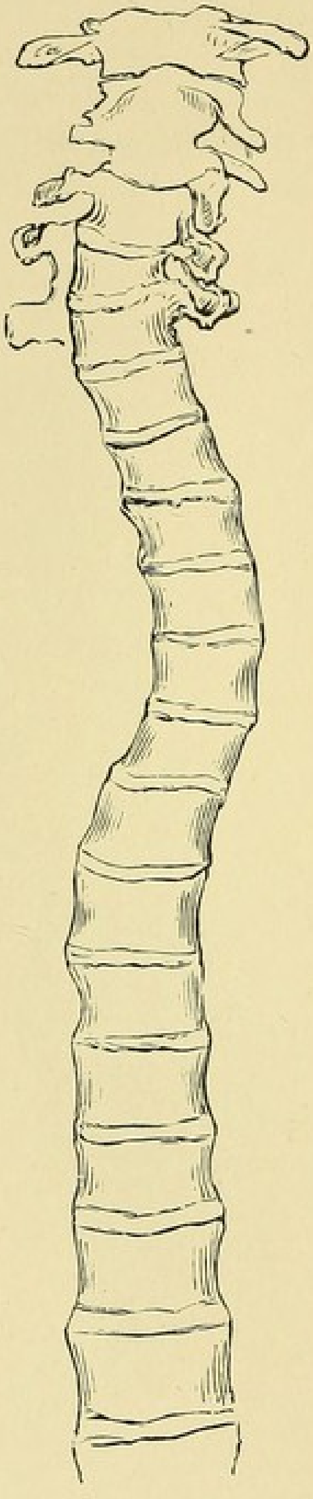


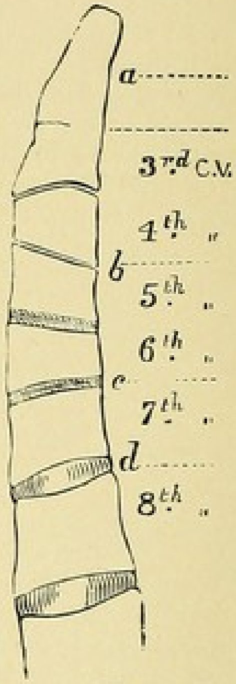
Fig. 36 shows the form of spondylolisthesis that occurs in such labourers as carry heavy loads on their backs less heavy than those borne by the coal-heaver, and who pick them off and replace them on the ground. The arthrodial joint seen between the fifth lumbar vertebra and altered upper piece of the sacrum is produced by this greater freedom of movement.



of the coal-heaver, and notice the obliteration of the dorsal and lumbar curves, the removal of the amphi-arthrodial joints between the lumbar vertebræ, with



37.



38.

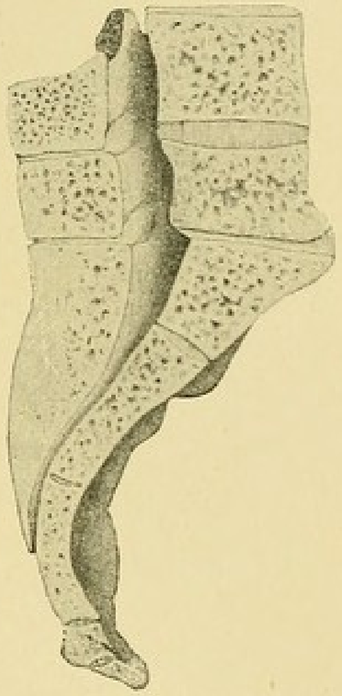
Fig. 37 represents, as seen from the front, the spine of a man who was employed in carrying on his head loads of some considerable weight.

Fig. 38 represents the upper part of this spine in vertical antero-posterior section, and shows the considerable destruction of the fibro-cartilages in the cervical region which results from the habitual transmission of abnormal pressure.

their more or less complete synostosis, together with the downward and forward displacement of the fifth lumbar vertebræ off the sacrum, dignified by the name spondylolisthesis. See Figs. 32, 33, 34, 35, and 36.

The conditions which result from carrying habitually heavy loads on the head are well shown by Figs. 37, 38, and 39.

Fig. 39 presents a condition the reverse of spondylolisthesis, namely, a displacement of the straightened or even anteriorly concave lumbar spine backward upon the sacrum, and the consequent transmission of a large part of the superjacent weight through enormously developed dense lumbar and sacral spinous processes. This condition results from carrying on the head, or the load being habitually borne in front of the chest or trunk.



On examining thin columns in section you are at once struck by the remarkable alteration in the composition of the bodies of the vertebræ in response to the specialisation of function and fixation of the direction of the lines of pressure. From a careful analysis you are led to formulate the law that "*compact tissue is made use of when force is transmitted almost entirely in one direction, and that cancellous tissue is employed to meet force applied in many directions.*" You will find this true of the skeleton of the so-called normal subject, and of labourers of all classes.

Also observe the remarkable changes in the joints of the shoulder girdle which result from the transmission of a considerable pressure from the carrying of a heavy load upon the back or shoulder, a study of which enabled me to throw quite a new light upon

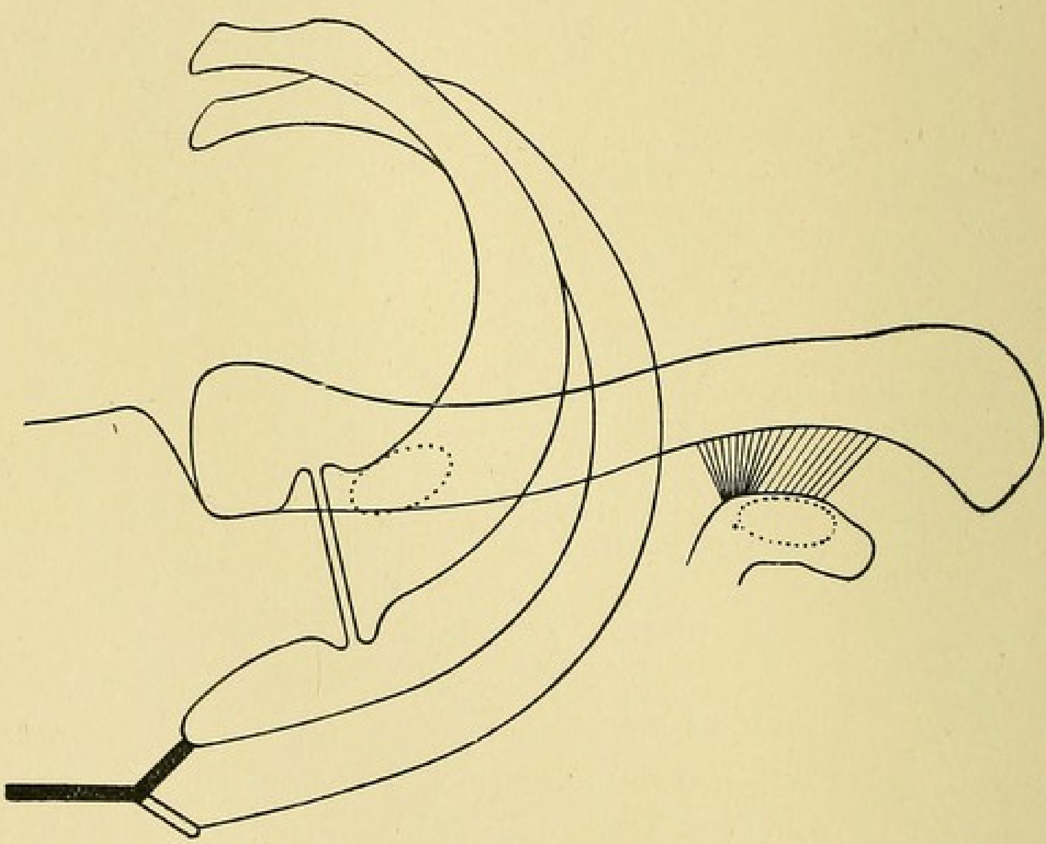


Fig. 40.

the mechanics of this part of the body * (see Figs. 40 and 41).

The new joint which is evolved between the clavicle and first costal arch, the early and complete

* "Pathology of changes produced by pressure on the trunk and shoulder-girdle," 'Guy's Hospital Reports,' 1886.

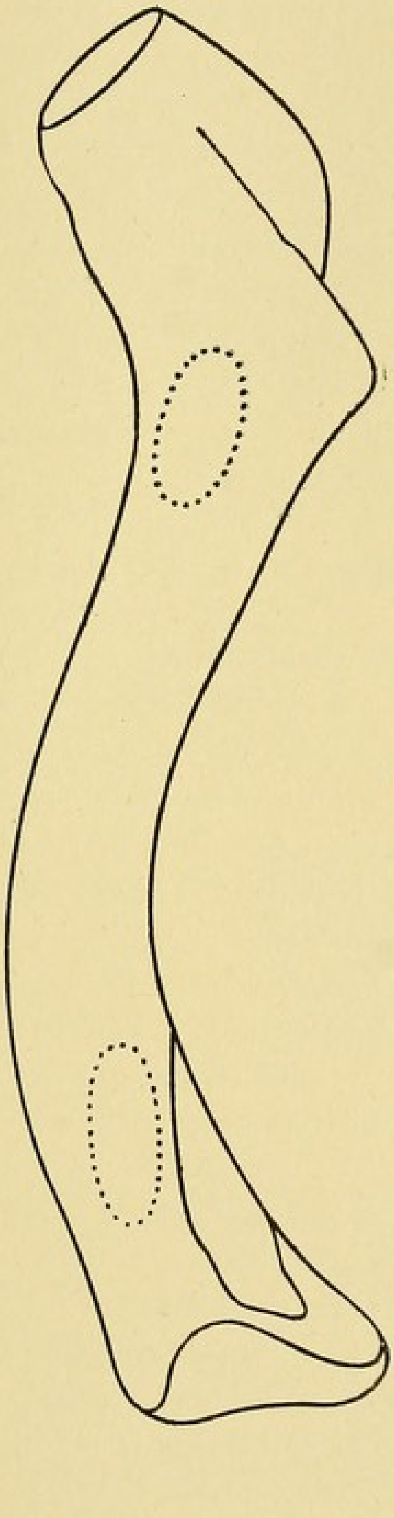


Fig. 41.

In Figs. 40 and 41 are shown the changes produced by such a specialisation of the functions of the upper extremity. The new joint which is formed between the coracoid process and clavicle, owing to the forcible habitual impact of these bones on one another in complete flexion of the shoulder-joint, teaches us how rotation of the scapula upon the clavicle in this movement is limited, and the manner in which the coracoid process is broken by indirect violence, and not by direct violence as is usually taught.

ossification of the first costal cartilage, the formation of a joint in its substance, first of an amphiarthrodial character and later of a typical arthrodial type, and the changes in the manubrio-gladiolar joint afforded me the means to explain the mode of transmission of force from the arm to the spinal column, to show that fracture of the first costal arch was a comparatively common accident, and to explain the mode of its production, together with that of fracture of the sternum by indirect violence. The bearing of this knowledge on our practice is too extensive for me to do more than refer to it in this lecture, and I merely mention these facts because, like anything important and obvious, they are beneath the notice of the anatomist, who appears to do his utmost to mislead the surgeon.

Many of the changes in the form of the ends of the bones and in the character of the joints were formerly observed by pathologists, and were by them regarded as examples of a disease called rheumatoid arthritis, with which, of course, they have no causal connection or relation whatever, though they are in appearance somewhat similar.

The human skeleton retains what is regarded as its normal anatomy only as long as it is called upon to perform normal functions, and those not excessively.

I would now point out to you that, for the so-called normal condition of the skeleton, it is necessary during growing life that the individual shall combine attitudes of activity with attitudes of rest, and that the attitudes of activity as well as those of rest be varied in character. By an *attitude of rest* I mean a position in which the superjacent weight is transmitted through a joint, or joints, with a minimum of expenditure of muscular energy, the form of the bones and the ligaments sustaining the chief strain, the muscles in many cases performing only the passive function of a ligament.

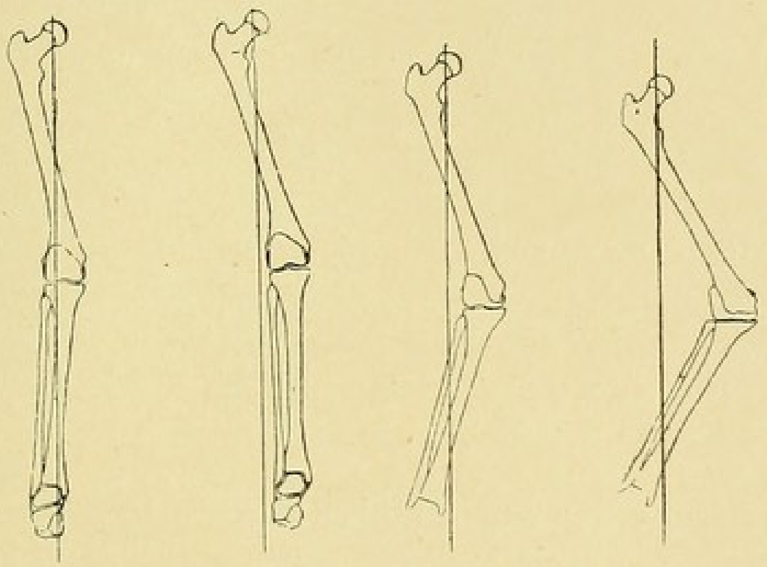
As already explained, during the single assumption of an attitude of activity there exists a tendency to change, both in the forms of the bones and of the joints, resulting in the alteration if the attitude be assumed habitually. So also, during the period of a single assumption of an attitude of rest, there exist tendencies to change, both in the form of the bones and of the joints, resulting in the alteration if the attitude be constantly adopted. This occurs very much more readily and extensively in the growing subject than in such as are fully developed, for the following reason, which I will state in the form of a general law, the importance of which you will readily perceive.

In the young subject, *the rate of growth of any portion of an epiphysial line varies inversely as the amount of pressure it transmits.* In other words, if one half of an epiphysial line transmits habitually an amount of pressure which is greater than normal, the amount of bone which it develops is correspondingly less than that normally produced. If, on the contrary, the other half of the epiphysial line is subject habitually to a subnormal pressure, the amount of bone developed by it is proportionately greater than the normal. In all the resting postures the mechanism of the skeleton is such that one portion of a growing line is exposed to an abnormal amount of pressure, while another portion is exposed to a much less or even subnormal amount of pressure. The frequent assumption of a single attitude of rest, not corrected by suitable variations in the attitudes of activity and rest, results finally in a progressive alteration in the form and function of the bones and joints. The soft parts intervening between portions of bone which habitually transmit an abnormal amount of pressure, first become thinned and fibrous, and later may be completely removed. If the bones move freely upon one another, the exposed osseous surfaces become dense and eburnated; but if very little movement takes place the opposing surfaces of bone may unite. It is obvious that when these changes have advanced to any extent they cannot be obliterated by treatment, the original form of the skeleton being lost for ever. This law has a most important bearing on the evolution and treatment of acquired deformities.

One knows also that the more vigorous and robust the child, the less likely is he to assume attitudes of rest for any time; while the feeble-bodied and frail is but little disposed to expend his scanty muscular power in activity, but prefers to assume such easy postures as make as little demand as possible upon his store of energy, the particular variety of resting posture varying to some extent with the age, surroundings, and often also with the occupation of the individual.

If you accept as true the views which I have attempted to place before you, I will pass on to the consideration of the causation of knock-knee.

If the active erect posture be assumed, and a plumb-line be dropped through the head of the femur, it will be seen to fall much inside the centre of the joint. If the easy erect posture be assumed, and the weight of the body be supported upon one leg, the total weight of the body falls upon the knee-joint through a point in a transverse vertical plane which is still more external to the centre of the joint. If this posture be habitually adopted, the outer portion of the growing lines of the femur and tibia form bone more slowly than normal, while their inner segments form it more rapidly. Consequently the internal condyle becomes longer, and the outer shorter than in the normal skeleton. As the external femoro-tibial angle diminishes, the patella is



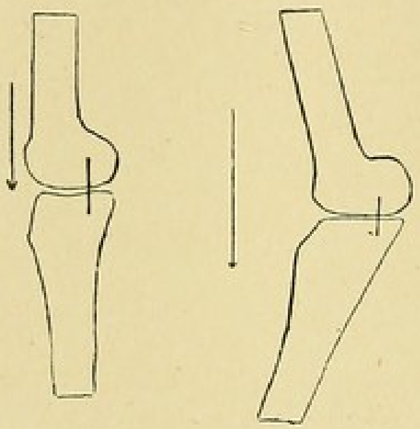
42 43 44 45

Figs. 42 and 43 represent the mechanical conditions of activity and rest, and Figs. 44 and 45 the progressive diminution in the external femoro-tibial angle.

displaced further and further outwards, till finally it rests on the outer surface of the external condyle in the most advanced condition of knock-knee.

Associated with "knock-knee," but sometimes arising independently of it, is the condition called "back-knee." This results from an abnormal amount of force being transmitted through the anterior segment of the growing lines in a position of rest.

In such positions of activity as are occupied in running, you see that the plumb-line falls very considerably internal to the knee-joint in a vertical transverse plane, during which period the several portions of the growing lines are exposed to conditions of pressure the reverse of those existing in the resting posture.



46 47

Fig. 46 represents the knee-joint as seen from one side; and from the position of the lateral ligaments, and of the transverse axis of rotation of the lower end of the femur, it is apparent that in the easy erect posture the anterior portion of the growing lines transmits much more pressure than the posterior part, and when this posture is habitually assumed, the conditions figured in 47 result.

Therefore, to remove this deformity by other means than operation, it is necessary to apply a mechanical contrivance which shall act in such a manner that the amount of pressure transmitted through the several portions of the growing line be reversed, and the consequent rate of bone formation altered till the normal form is obtained, while at the same time attempts are made to improve the patient's general nutrition, to make him avoid such attitudes of rest as were originally responsible for the development of the deformity, and to assume as constantly as possible attitudes of activity, and especially such as are antagonistic in their action to this particular attitude of rest. These same principles apply with equal truth to the treatment of the other resting deformities, and will therefore not be recapitulated.

Now we will pass on to the consideration of flat-foot. *The attitude of activity of the foot is one of considerable adduction, or, as it is sometimes called, inversion.* The so-called arches are raised, and the inner margin of the foot forms with that of its fellow an angle which is open backwards. You can see this to perfection in a very fast runner, whose well-developed and highly trained muscles retain his feet in a position of extreme activity. Watch such a man walk or run, and you see that he turns his toes inwards to a considerable extent, so that the slightly concave inner margins of his feet form an angle open backwards. That boots should be made to fit the foot in such an attitude is obvious, though shoemakers insist on rendering the mechanics of the foot insecure by forcing the great toe outwards instead of allowing it to come inwards as it should. The form of the boot is of vital importance not only in the treatment of flat-foot, but of all the resting deformities, and it should receive the closest attention and care of the surgeon.

The position of rest of the foot is that of abduction, in which the arches are depressed while the inner margin of the foot is rendered convex, and forms with that of its fellow an angle of considerable size open forwards. *This position becoming fixed, and later exaggerated, is called flat-foot, which is, therefore, simply the fixation of the foot in its position of rest.* Adduction and abduction of the foot take place in the subastragaloid joint. It is taught in anatomical works that adduction and abduction take place to a considerable extent in the ankle-joint when in a position of extension, but this I showed in a paper in the 'Journal of Anatomy and Physiology,' April, 1888, to be absolutely incorrect.

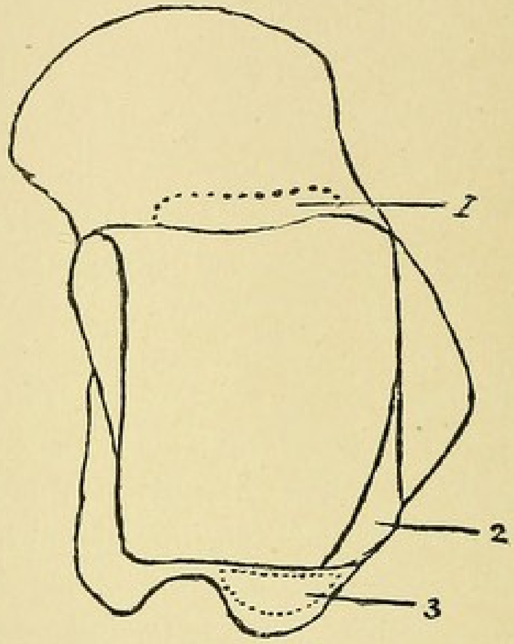
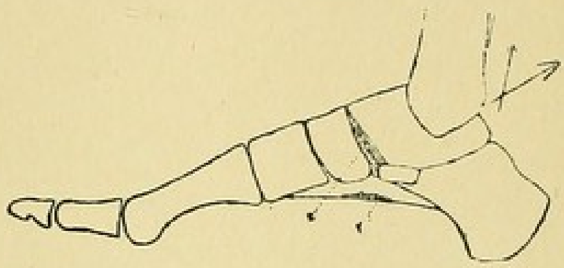


Fig. 48 represents the upper surface of the astragalus of a sailor. The bone of this labourer is chosen because it illustrates remarkably well the several points to which I wish to call attention. You see two facets indicated by dotted outlines, marked respectively 1 and 3, immediately in front of and behind that articular surface which alone anatomists describe. These articulate with corresponding facets on the margin of the under surface of the tibia. It is by the impact of the tibia upon these surfaces that the movements of flexion and extension are limited, and not by the resistance offered by ligaments as described in works on anatomy. The presence of these undescribed portions of the ankle-joint and their function form additional examples of the fact that where possible the mechanics of the joints of the human body are so arranged that extreme movements are controlled by the impact of bony surfaces upon one another, strain upon ligaments being reduced to a minimum. The figure 2 points to a triangular area referred to above as being a part of the upper articular surface. It is bevelled off from the rest by the pressure exerted upon it by the posterior ligament, the posterior inferior tibio-fibular ligament and the posterior portion of the external ligament in extreme flexion of the ankle-joint. This area, to which I gave the name "ligamentous facet," does not articulate with the tibia or fibula in any position of the joint. For fuller particulars I would refer to the paper "On Movements of the Ankle-joint."

This has arisen in consequence of two optical illusions. One is that anatomists have included a triangular area of the upper surface in the astragalus in the outer surface, so making the upper articulating surface look much narrower behind than in front. This triangular area articulates with the posterior ligaments of the ankle-joint in flexion of that articulation. This apparent narrowing of the astragaloid facet posteriorly suggested to the mind of the anatomist that in extension of the joint some lateral movements of this bone took place between the malleoli. This suggestion was confirmed by the fact that in forcible flexion of the ankle-joint adduction and abduction of the subastragaloid articulation is impossible while these movements are permitted freely in forcible extension. It did not occur to him apparently to test the truth of his assertions on the dead body.

Movements of adduction and abduction of the foot take place almost entirely in the subastragaloid joint, there being associated with them a change in the mutual relations of the bones of the tarsus and metatarsus to one another. The movement is not simply a rotation of the foot around the long axis of the astragalus, but in adduction it is associated with an elevation of the height of the arches of the foot, its inner margin being rendered distinctly concave, while in abduction the arches are depressed, and the inner margin of the foot is rendered distinctly convex. (In a succeeding lecture I will deal more fully with the mechanics of these so-called arches.) To explain the causation of this, I must call your attention to a strong ligament which had escaped the attention of anatomists till I described it in a paper in the 'Guy's Hospital Reports' for 1886–7, p. 252. It is continuous with the inferior calcaneo-scaphoid ligament, with which its fibres run parallel. It is attached to the anterior portion of the sustentaculum tali, and from this its fibres run forwards, upwards and outwards, to be attached to the tuberosity and to the upper margin of the scaphoid. This I called the *superior internal calcaneo-scaphoid ligament*.



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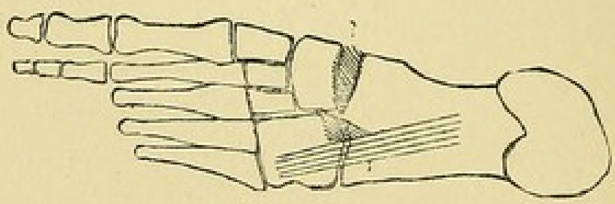

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Fig. 49 represents the inner aspect of the foot, and Fig. 50 its under surface, while in a position of adduction or of activity.

You may remember that the tendon of the tibialis posticus, immediately before its insertion, sends a process downwards and backwards to the sustentaculum tali; when the tibialis posticus contracts, it, by this double insertion, besides tending to pull both bones upwards, tends also to approximate them.

In drawing up the tubercle of the scaphoid, it winds up the superior internal and inferior calcaneo-scaphoid ligaments, approximating therefore the sustentaculum tali and scaphoid, and displacing the head of the astragalus outwards upon the greater process of the os calcis, where, in labourers who are in the habit of carrying heavy loads, a new joint is developed, for obvious economical purposes.

The rotation of the os calcis results in a partial forcible separation of the opposing concavo-convex surfaces of the os calcis and cuboid, which, being opposed by the long and short ligaments, results in an elevation of the outer arch also.

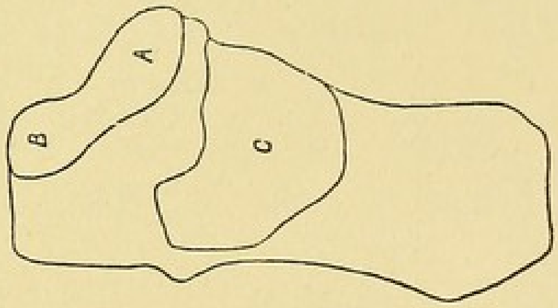
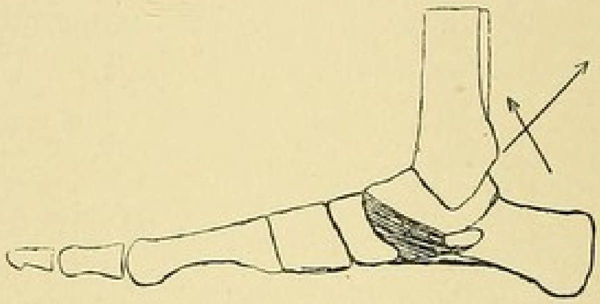


Fig. 51 represents on the upper surface of the greater process of the os calcis, the facet B, which results from the habitual assumption of the active posture of the foot, associated with the transmission through it of a considerable pressure.

In abduction, the sustentaculum tali and tuberosity, being free from the strain exerted by the tendon of the tibialis posticus, fall apart, partly on account of the cessation of the traction exerted by the bifid tendon, and partly because the consequent rotation of the scaphoid upon the astragalus is followed by an unwinding of the calcaneo-scaphoid capsule, resulting in its *apparent lengthening*. This apparent lengthening has suggested the explanation of flat-foot which is usually given, namely, that it is due to yielding of the inferior calcaneo-scaphoid ligament, which is described as being an elastic structure. This is obviously absurd. The head of the astragalus occupies the increased interval between the tuberosity of the scaphoid and the sustentaculum tali, and the opposing surfaces of the cuboid and os calcis coming into accurate apposition, the outer arch reaches its limit of depression.

When the foot is retained habitually in the



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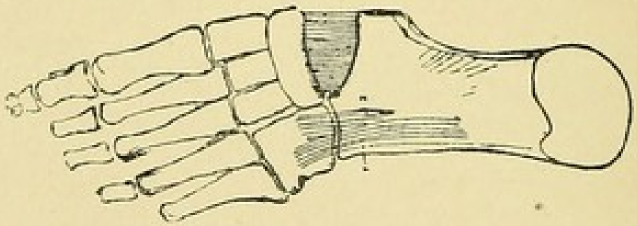

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Figs. 52 and 53 represent the foot in the posture of rest or of abduction.

attitude of rest, or of abduction, it becomes fixed in that position, the patient experiencing pain in that portion of the head of the astragalus which is only saved from direct pressure by the unwound calcaneo-scaphoid capsule, and it is pain of the same character as that felt in hallux valgus, owing to abnormal pressure being exerted upon the articular surface of the inner portion of the head of the bone. Pain is also felt in the upper part of the calcaneo-cuboid joint, owing to stress of opposing bony margins, and also externally owing to the impaction of the external malleolus upon the os calcis. The fixation of the foot is, in early cases, due to the violent contraction of the abductor muscles which oppose the movement of adduction because it is painful, and in later cases adduction is opposed by changes in the form of the bones and joints of the nature of a mechanical arthritis.

If an injury of the part is sustained or if it be affected by a painful condition as rheumatism, the patient obtains much greater relief when the limb is in the position of perfect rest, consequently the foot is abducted; and as the rest is often necessarily prolonged, fixation of the foot in that position results.

We will pass on now to the consideration of dorsal excurvation and lateral curvature.

The term dorsal excurvation of young life, or the more popular one of *round shoulders,* is applied to a condition which results from the prolonged habitual assumption of the symmetrical posture of rest without the correction which a combination with the active erect attitude affords.

Strip the patient, and on examination you observe that the dorsal spine is *flexed almost to its extreme limit,* the head being displaced forwards and on a much lower plane than that occupied in the active erect posture, the clavicles slope forwards and downwards, and the scapulæ rest on the side of the chest rather than on its posterior aspect. By this means the angular prominence formed by the shoulder is reduced to a minimum, and gives rise to the term "round shoulders."

Pass a tape measure around the thorax at the level of the nipples, and you will see that during ordinary respiration the difference between the thoracic measurement in expiration and inspiration is practically *nil, the chest being in a position of*

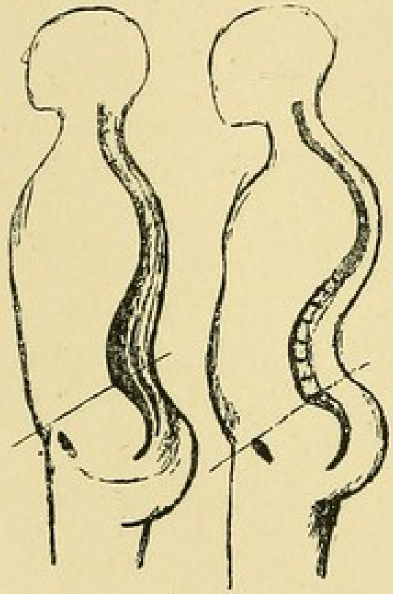

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Fig. 54 represents a vertical antero-posterior section through the spine in a position of activity, namely, the active erect posture; and Fig. 55 a similar section in a position of rest, which, when fixed by its habitual assumption, is called "dorsal excurvation of adult life" or "round shoulders."

practically complete expiration, and that the breathing is being carried on almost entirely by means of the diaphragm. Though this is particularly marked in this condition and in lateral curvature, it exists in a less degree in patients showing any of the other resting deformities.

The convexity of the lumbar curve is diminished so that the whole length of the spinal column forms a long single curve, the summit of whose convexity corresponds to the mid-dorsal region, while the pelvis is over-extended upon the femora if the patient is standing.

If the skeleton of a typical case be examined, the bodies of the dorsal vertebræ are seen on vertical antero-posterior section to be elongated slightly from before backwards, and to be wedge-shaped, the base of the wedge being directed backwards, its depth

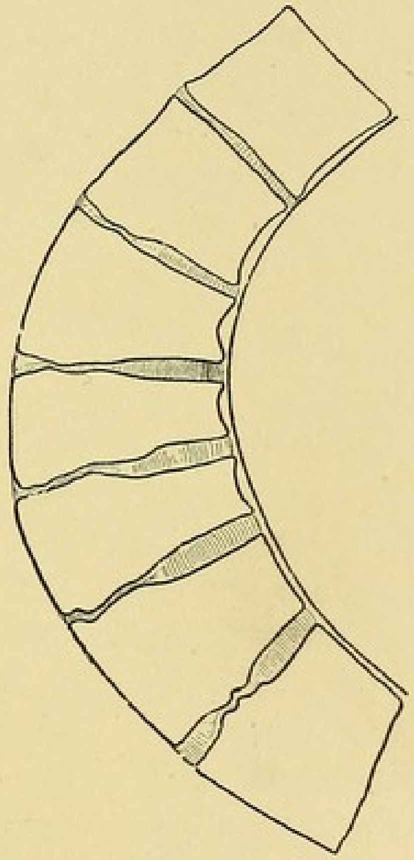


Fig. 56 represents in a vertical antero-posterior section through the summit of the dorsal curve the changes that take place in the shapes of the bodies of the vertebræ, and in the thickness and character of the fibro-cartilages in the condition called dorsal incurvation when of long duration.

being in excess of the normal measurement of the posterior surface of the body, while the anterior surface of the body is very considerably under its normal depth. This fixation of the dorsal spine, together with the corresponding depression of the ribs and sternum, renders it impossible to raise the clavicles and scapula into the position which these bones should occupy when in the active erect posture. The conjugate of the brim of the pelvis is slightly diminished, owing to a yielding of the sacrum around a transverse axis passing through its centre, the promontory passing downwards and forwards. This alteration in the conjugate of the brim is of importance in the female subject. It is very trifling in amount in the non-rachitic subject, but should this bone be softened by imperfect nutrition this condition may be a very important feature of the deformity. These changes are all found in a very exaggerated condition in feeble old age, and they are very well illustrated by Figs. 58, 59, and 60.

The condition itself is shown in Fig. 57.

What happens as regards the spinal column during the assumption of this position of rest from the active erect posture is briefly a rotation of the pelvis around a transverse axis in a direction the reverse of that undergone by each of the superjacent vertebræ with the changes resulting from deviations from the normal in the rate of bone formation at the several portions of epiphysial lines in consequence of the abnormal pressures to which they are exposed. When the bones have altered in form, but little can be done to remedy the deformity, but in cases of moderate severity teaching the patient to breathe deeply, by expanding the chest to its utmost, and then expelling forcibly as much air as possible during expiration, will not only open out the dorsal curve and increase the size and capacity of the chest, but it will oxygenate the blood and tissues as thoroughly as possible, and so improve the vigour and vitality of the individual. *In fact, it is impossible for the normal subject to retain the body in the positions of*

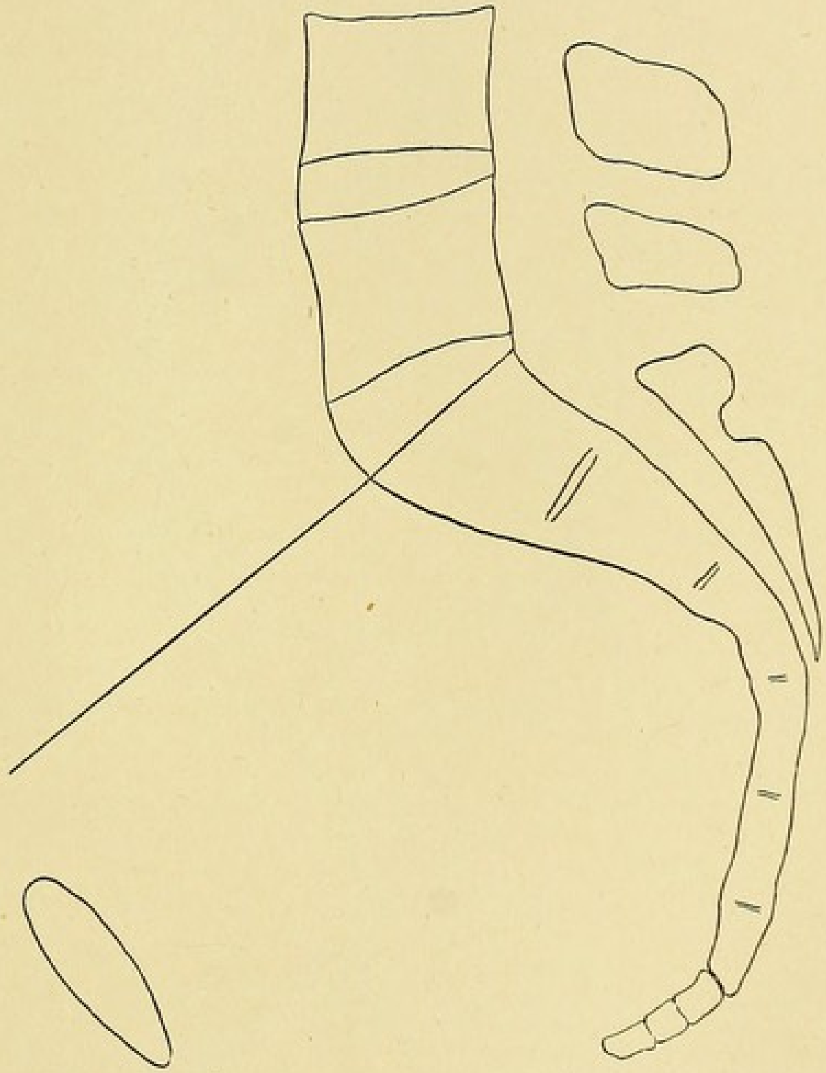


Fig. 57 represents in outline, and half the natural size, a vertical median section through the sacrum and fourth and fifth lumbar vertebræ, obtained from a fairly vigorous adult affected with marked though not extreme dorsal excurvation acquired during young life. Though the changes are but slight, since this was not a very severe case, they are sufficiently obvious for the purpose of demonstration. The conjugate of the brim measured three and a quarter inches, and the prolongation of the direction of the plane of the facet in the upper surface of the sacrum was separated from the symphysis by an interval of three quarters of an inch.

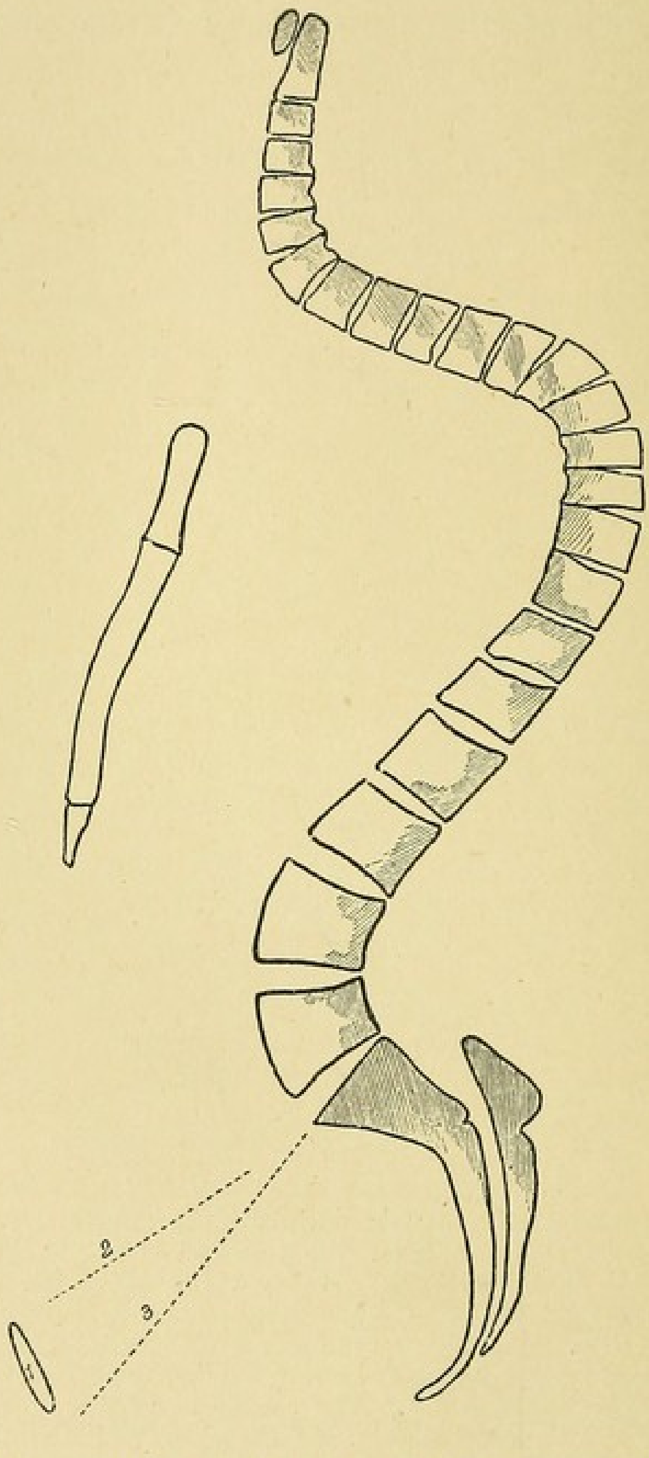


Fig. 58 shows the trunk of a feeble old subject in vertical antero-posterior section.

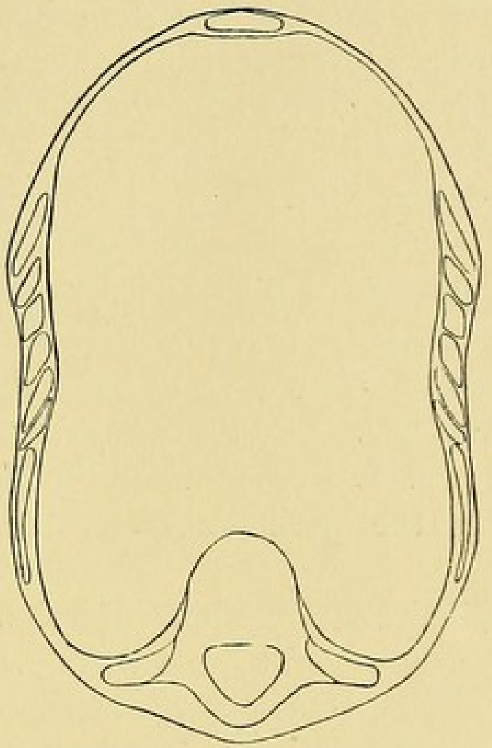


Fig. 59 shows a transverse section through the thorax of the same case.

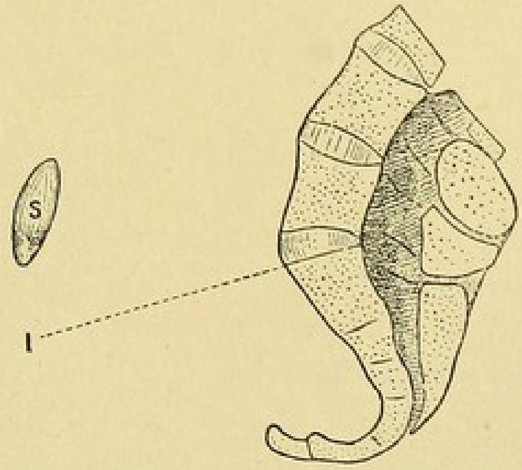


Fig. 60 is a vertical median section of the pelvis of an aged female, showing a slightly different variety of the deformity.

rest which become fixed as dorsal excurvation and lateral curvature when a very deep inspiratory effort is made. This exercise, with a view of habitually changing as much air as possible during respiration, is of equally great importance in the treatment of all the resting deformities.

The habitual assumption of the active erect posture, the avoidance of the particular position of rest which was primarily responsible for the deformity, gymnastic exercises, plenty of real air, rest in the recumbent posture, tonics, sea-bathing, &c., will all be found of service in removing the deformity, and in improving the patient's general condition and physique.

The detailed explanation of the physiology, anatomy, and causation of lateral curvature is, perhaps, more difficult to understand than that of the other resting deformities. I will state it as briefly as I possibly can, and if you wish to study the subject more fully I will refer you to a paper of mine on the subject in the 'Transactions' of the Royal Medical and Chirurgical Society, 1889, entitled "The Causation and Pathology of Lateral Curvature of the Spinal Column."

If the easy erect posture be assumed, the individual standing on one leg, usually the right, the other knee being kept bent, the pelvis is rotated around two axes. It is over-extended upon the right femur, so moving around a transverse axis. At the same time it is fixed in a position of extreme adduction upon that bone, so moving around an antero-posterior axis. The result of this double movement is that the plane of the sacral facet moves around an oblique axis intermediate between these, its surface being made to look backwards and to the left. Each of the superjacent vertebral discs rotates around a similar oblique axis, the degree of obliquity of the axis varying with the locality, since the presence of the ribs and the relation of the bony to the fibro-cartilaginous discs determine the formation, not of one single curve in an oblique plane, but of three curves in which are practically two planes. Since the axis around which each body moves is an oblique one, the apex of the spinous process does not deviate from the middle line to an extent which at all approaches the deviation of the centre of the body of each vertebra. Consequently the leverage action exerted by the transverse process and bodies of the vertebræ in the dorsal region produces the remarkable alteration in the form of the thorax with which we are so familiar.

A slight diminution of the conjugate of the brim of the pelvis is sometimes observed for the same reason as in dorsal excurvation.

Perhaps I may put this more simply. A rotation of the pelvis around an antero-posterior axis alone would produce a rotation of each of the superjacent bodies around an antero-posterior axis, and three curves would be developed in a plane at right angles to the axis of rotation.

A rotation of the pelvis around a transverse axis, such as takes place in over-extension of the spine on the thigh-bones, produces of necessity a rotation of the superjacent bodies round a transverse axis. This results in the opening out of the lumbar curve with an increase of the dorsal curve.

In the rotation around an antero-posterior axis the segment of the fibro-cartilage corresponding to the concavity of the curve is more compressed than that on convexity.

In the rotation around a transverse axis the anterior half of the fibro-cartilage is more compressed than the posterior. Consequently in the concavity of the lateral curve the segment of fibro-cartilage which is most compressed is the antero-lateral, while the postero-lateral, on the side of the convexity, sustains the least.

In rickets, whose most obvious characteristic is perhaps such imperfect nutrition of the bony system as results from indigestion in young life, *the epiphysial line, which is large, and irregular in outline, reacts to pressure in a much more marked manner than does the epiphysial line of the child which is merely wanting in vigour.* Consequently when the bones are rachitic, the changes already described in the ends of the bones are much exaggerated.

But besides the changes in the lines owing to a general want of firmness of the diaphyses, these alter in form as well, and the deformity is so rendered more considerable. Besides those already described, there are certain deformities that are peculiar to the rickety child.

As the rachitic child assumes the sedentary posture, the thorax is flexed abruptly upon the lumbar spine, and the lumbo-sacral and sacro-iliac joints are in a position of very considerable flexion. The constant assumption of this attitude results in the eleventh and twelfth dorsal and the first and second lumbar vertebral bodies assuming a wedge shape, an angular curvature of more or less abruptness resulting. The sacrum yields around a transverse axis, and the posterior portions of the iliac bones are

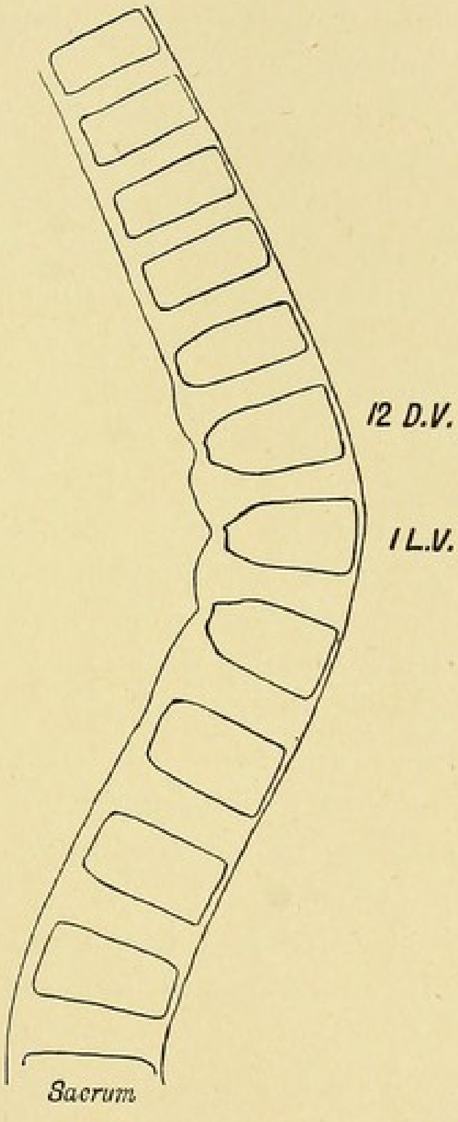


Fig. 61 represents a vertical antero-posterior section through the dorsi-lumbar spine from a case of rachitic spinal deformity. It shows the changes in the form of the lower dorsal and upper lumbar bodies, and the excessive proportion of fibro-cartilage.

displaced forwards, producing a considerable diminution of the conjugate diameter of the brim of the true pelvis, and its peculiarly transversely oval form.

This deformity is sometimes spoken of as rickety spine or kyphosis, or as dorsal excurvation of infancy. A similar though very much slighter degree of deformity may develop in the non-rachitic under the same mechanical influences.

When knock-knee develops in a rachitic subject the changes in the adjacent ends of the tibia and femur are associated with a yielding of the shafts of these bones, so that they together form a fairly uniform curve with its convexity directed inwards.

Bow-legs are developed only in the rachitic subject, before the child has learnt to stand, knock-knee not developing till a later period. As the child learns to stand or walk a plumb-line dropped through the head of the femur falls internal to the knee-joint. The soft diaphyses bow outwards, while the inner portions of the epiphysial lines transmit an excessive pressure, the growth of the inner portions of the adjoining ends of the femur and tibia being subnormal, and those of the outer segments greater than normal. The patella is displaced inwards till it may rest upon the inner surface of the internal condyle.

Both in knock-knee and bow-legs there is associated with the curvature in a transverse plane a varying degree of curvature in a vertical antero-posterior one. This is consequent upon the forward displacement of the lumbo-sacral articulation just described, which of necessity produces an over-extension of the hip-joints and a flexion of the knee-joints. I have considered this fully in a paper* in the 'Journal of Anatomy and Physiology,' 1887.

* "A very important factor in the causation of some of the curves which develop in mollities ossium, rickets, and osteitis deformans."

Figs. 62, 63, 64, 65, 66, and 67 illustrate the mechanical conditions present in these deformities. Figs. 62 and 63 represent in outline the outer and the anterior margins respectively of the femur and tibia in a case of bow-legs, the dotted outline corresponding to the position of the knee-joint. Fig. 62 shows the yielding in a transverse plane, and Fig. 63

Fig. 62.

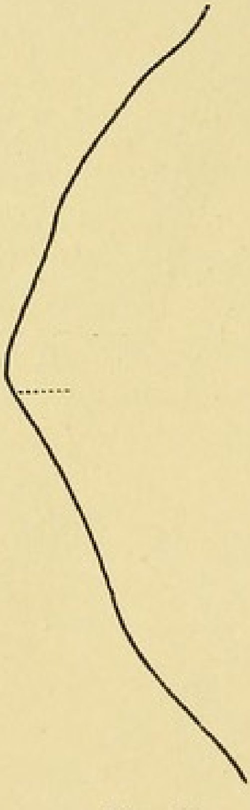


Fig. 63.

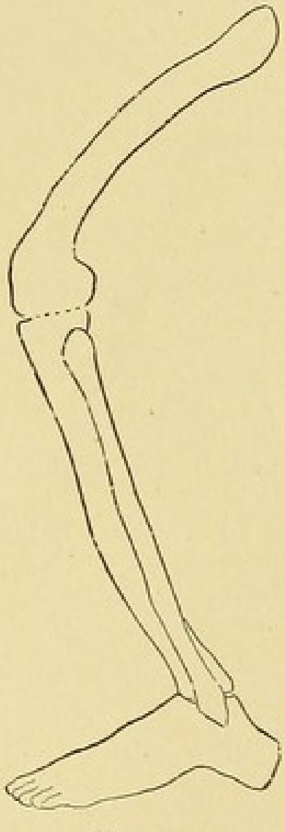


Fig. 64.

that in an antero-posterior plane. The bowing in the latter plane is indicated in more detail in Fig. 64.

In Fig. 65 I have represented the outlines of the curves of the long bones of the leg in a case of knock-knee in an antero-posterior plane, A B indicating the femoral, and B C the tibial portions of the limb. Fig. 66 shows the curve in a transverse plane. Fig. 67 illustrates this deformity more fully.

The degree of flexion of the knee-joints in these deformities varies directly with the amount of

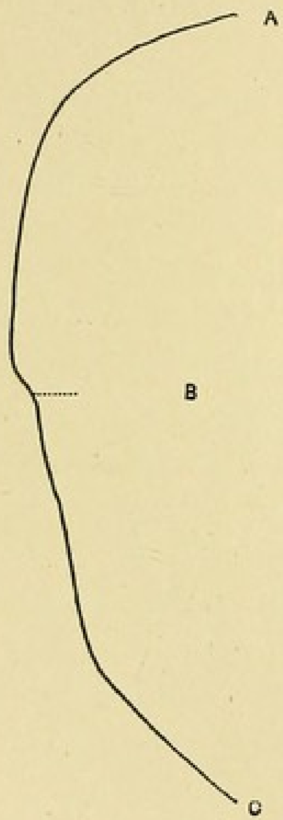


Fig. 65.

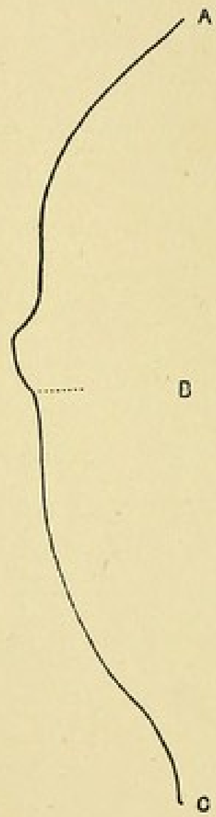


Fig. 66.

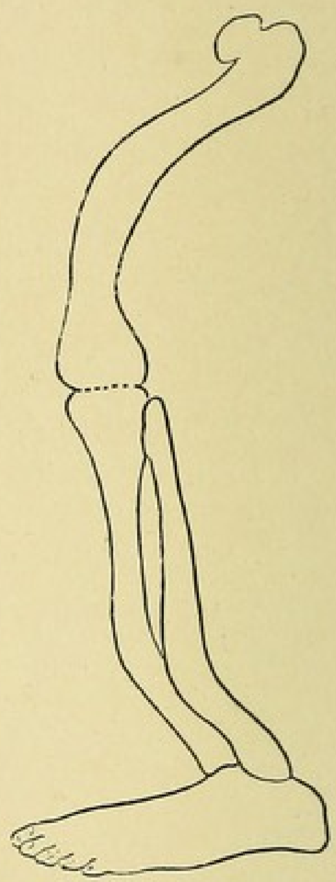


Fig. 67.

forward displacement of the lumbo-sacral joint. Similar changes occur in osteitis deformans and mollities ossium, in which, however, the epiphysial line is not present as it is in rickets.

SOME OF THE CONSEQUENCES OF WEARING BOOTS.

Gentlemen,—I will first call your attention to several points in the normal anatomy and physiology of the foot, in order that we may be in a better position to consider its pathological conditions and the other changes in the body which may follow them.

It is no wonder that the surgeon of the present day is so unfamiliar with those pathological changes and their causation, since his knowledge of the anatomy and physiology of this part of the body is very scanty and very incorrect, for the reason that the anatomist has taught him very little.

Take 'Quain's Anatomy,' consisting of two large volumes, prepared apparently for the instruction of students in the knowledge of the several structures in the body, and of the functions of the bones, joints, and muscles. It contains in large print a more or less accurate account of these structures, and in the case of the muscles there are, in very small print, a few lines devoted to their relations, while their variations are described at considerable length. Varieties have had a curiously disproportionate interest for the anatomist, with apparently no compensating advantage to the student.

But when we look for the description of the functions or the physiology of the bones, joints, ligaments, and muscles, which surely are of vital importance to the student and to the surgeon, we find that they are either not referred to, or if they are, it is in small print, most briefly, often incorrectly, and occasionally unintelligibly.

Returning to the consideration of the foot, I have already shown you in the preceding lecture that it moves upon the tibia and fibula around a transverse axis only, and not around a vertical axis as the writers of text-books would lead you to believe.*

It is an unfortunate thing that anatomists have applied the term "arches" to the foot. They describe it as consisting of an inner and an outer longitudinal arch, and of a transverse arch, supported chiefly by ligaments, and to some extent by the plantar fascia. The arches are said to be capable of being flattened by pressure from above, thus securing elasticity, and to recover their position when the pressure is removed. For the rest of the description I will refer you to 'Quain's Anatomy,' page 185, vol. i.

It is this assumed analogy to the arrangement of the arch that has led to an imperfect understanding of the physiology and pathology of the foot.

If you desire to find out the manner in which the muscle or muscles which influence the position of the foot act, you will find on page 266 the following description :—"The tibialis anticus and peroneus tertius are flexors of the ankle ; the tibialis posticus and peroneus longus and brevis are extensors. The two tibial muscles acting together produce the movement of inversion of the foot, in which action they are aided by the flexors of the toes." *No further mention is made as to the action of the tibialis*

* 'Quain's Anatomy,' 1882, vol. i, p. 178.

posticus. Supplied with this very scanty information on the physiology of the foot, one feels how hopeless it is to teach the student anything about the causation and pathology of flat-foot and of other deformities, and it is easy to understand why he is so ready to accept the imaginary explanation that flat-foot (as the condition is graphically, but very unscientifically termed) results from a stretching of ligaments and a consequent falling in of arches, since it follows as a natural sequence upon his incorrect and imperfect knowledge of the normal anatomy and physiology of the part.

I would advise you to obliterate from your mind the impression that there exists any close similarity between the mechanics of the foot and those of an arch, and let us analyse the movements that are permitted in the foot, starting with the knowledge that the ankle-joint is practically a perfect hinge-joint.

Regard the foot as consisting of two parts, the os calcis forming the back part, and the scaphoid, cuboid, and the bones in front of them the anterior part. These include between them an angular interval, being joined externally at the calcaneo-cuboid joint, where these two sections of the foot rotate around an axis which is more or less vertical, its direction varying somewhat with the size of the intervening angle.

The calcaneo-cuboid joint performs this hinge function securely by means of the long and short plantar ligaments, whose fibres have such directions as permit of a limited movement in either direction.

Internal to the hinge, these two portions of the foot are connected by a corkscrew-like ligament, which, when unwound, permits of the greatest interval between the os calcis and the anterior segment, and when wound up reduces the angle to its smallest dimensions.

The astragalus is fixed and balanced on the os calcis by means of an interosseous ligament which allows this bone to rotate around a vertical axis, so that when the interval between the segments of the foot is reduced, the head of the astragalus passes outwards on to the greater process of the os calcis, and when the angle is greatest the head of the bone passes inwards and occupies the space. Figs. 68 and 69 illustrate the relative positions of the two parts of the foot in abduction and adduction respectively.

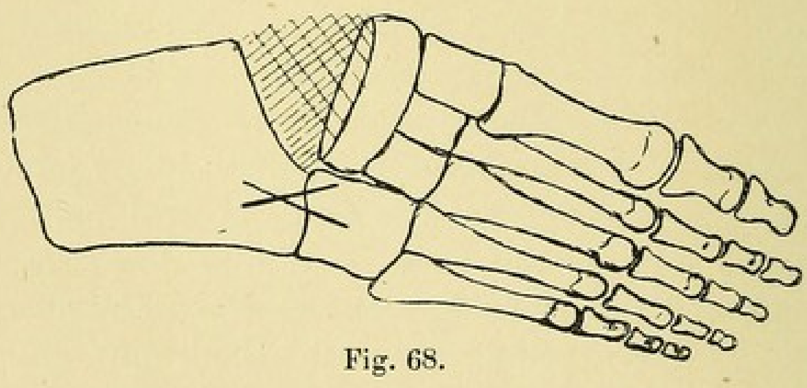


Fig. 68.

I will now show you with this dissected foot the two movements permitted in the subastragaloid joint, neither of which is limited entirely to that joint. Each is a sequence of movements, and though the greater part takes place in the subastragaloid joint, yet every joint in the foot is affected slightly, and every bone is altered in position and direction.

The first posture we will consider is that of adduction of the astragalus upon the rest of the foot, or abduction of the foot upon the astragalus. It is that assumed passively when the individual occupies the attitude of rest, and it is *the position of rest of the foot.* In this attitude the bones of the foot are retained in their relationship to one another solely by ligaments and fasciæ, the first process of the tibialis posticus tendon serving the purpose of a ligament, the muscles of the leg and foot taking no share in the position *except such as is required to balance the several joints.* (See Fig. 68.)

Abduction of the foot is also produced as an active posture by the contraction of the peronei and extensor muscles of the foot.

The second position is that of adduction of the

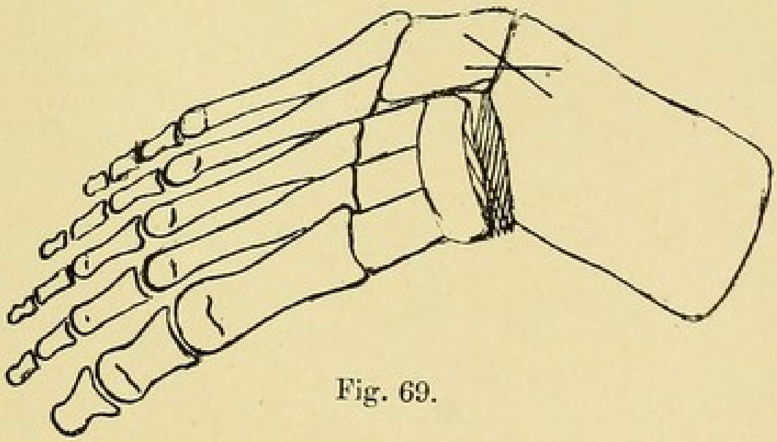


Fig. 69.

foot upon the astragalus, and it is correctly described as *the position of activity of the foot.* It is produced solely by the action of the tibialis posticus muscle, *the other muscles only serving to balance the several joints.* (See Fig. 69.)

Neither position consists of a movement of the several bones as a whole upon the astragalus. Observe this foot in a position of passive abduction or of rest, and you see the head of the astragalus projecting inwards, and the calcaneo-scaphoid capsule elongated to its utmost capacity ; the scaphoid articulates with the outer segment of the head of the astragalus, while its tuberosity is separated by a considerable interval from the sustentaculum tali ; the long and short plantar ligaments are arranged in their longest diameters, and the articular surfaces of the os calcis and cuboid are in accurate apposition, the cuneiform and metatarsal bones all being directed forwards and outwards. If you stretch a bit of string between the head of the first metatarsal bone and the inner tubercle of the os calcis, a considerable portion of the foot lies internal to it, and this line includes with the vertical antero-posterior plane a considerable angle, open forwards. Now it was because of this *apparent elongation* of ligaments, especially of what the anatomists call the inferior calcaneo-scaphoid ligament, *that the so-called stretching of ligaments* arose.

You will observe in examining this specimen that there surrounds the lower and outer, lower and inner, and most of the upper part of the astragalo-scaphoid joint a capsule of ligamentous fibres, the direction of which is spiral or oblique to the long axis of the foot. This capsule, consisting of obliquely arranged fibres, is absent externally and above, where it has blending with it the astragalo-scaphoid ligament and much of the superficial portion of the internal lateral ligament of the ankle-joint, both of which structures prevent any downward displacement of this portion of the capsule. This capsule is formed from without inwards by what the anatomists call the interosseous calcaneo-scaphoid and the inferior calcaneo-scaphoid ligaments, and besides these by a ligament which I described for the first time—the *superior* *internal calcaneo-scaphoid.** Practically these ligaments are directly continuous, and are functionally inseparable.

Notice that *the obliquity of the direction of the fibres and their length increase from without inwards,* and that the ligament is thickest and apparently cartilaginous in structure internally where it bears the pressure of the head of the astragalus externally, and of the tendon of the tibialis posticus internally.

Observe also that the process of the tibialis posticus tendon to the sustentaculum tali runs backwards from the scaphoid tubercle in such a direction that it forms a comparatively small angle with the tendon as it approaches it, so much so that in abduction it takes on the function of a ligament solely.

As I exert traction on the tendon of the tibialis posticus the tubercle of the scaphoid is raised by the strain transmitted along it, and it is approximated to the sustentaculum tali directly by the slip passing to that bone and indirectly by the winding up of the corkscrew-like fibres of the capsule, which is a necessary consequence of the rotation of the scaphoid around an antero-posterior axis. The head of the astragalus is displaced outwards and upwards on to the greater process of the os calcis. Associated with the rotation of the scaphoid and with its inward and backward movement upon the astragalus, with the inner half of which it now articulates, you see that of necessity the cuneiform bones and the metatarsal bones follow it in its movement, so much so that in extreme abduction the first metatarsal bone and great toe form with the same bone in complete adduction an angle of about 50° or more. The great toe in

* 'Guy's Hospital Reports,' 1886, p. 252.

this position is directed forwards and inwards, and takes a very important share indeed in the support of the foot.

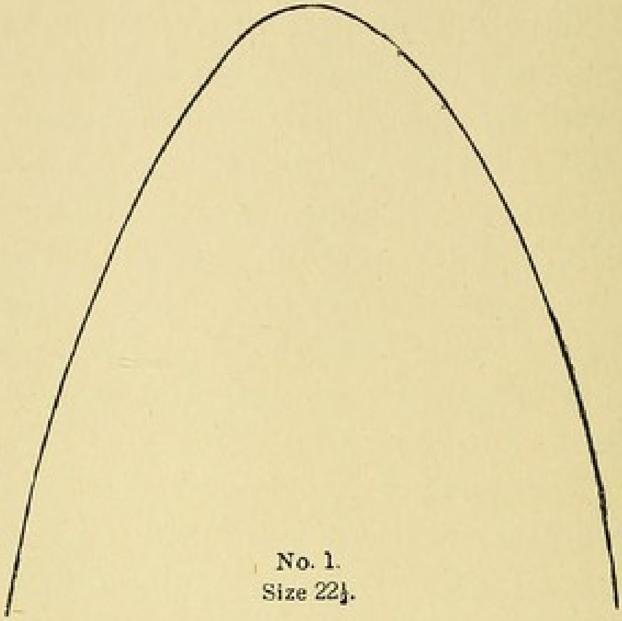
A string stretched from the inner tubercle of the os calcis to the head of the first metatarsal bone includes a considerable interval between it and the inner margin of the foot.

You see practically the truth of what I stated earlier, namely that the tibialis posticus is able to and does perform alone the movement of adduction of the foot, and that all the other muscles are engaged simply in retaining the equilibrium or balance at the several joints.

We know that the anatomy of a part only remains normal while it is called on to perform functions which combine attitudes of activity with those of rest. The fixation of the position of activity is seen in the labourer who carries very heavy loads, while the fixation of that of rest is familiar to you as flat-foot, a term which might be dropped with the greatest advantage. I would suggest instead HABITUAL OR FIXED ABDUCTION OF THE FOOT, since it expresses at the same time both the condition and the mode of its production.

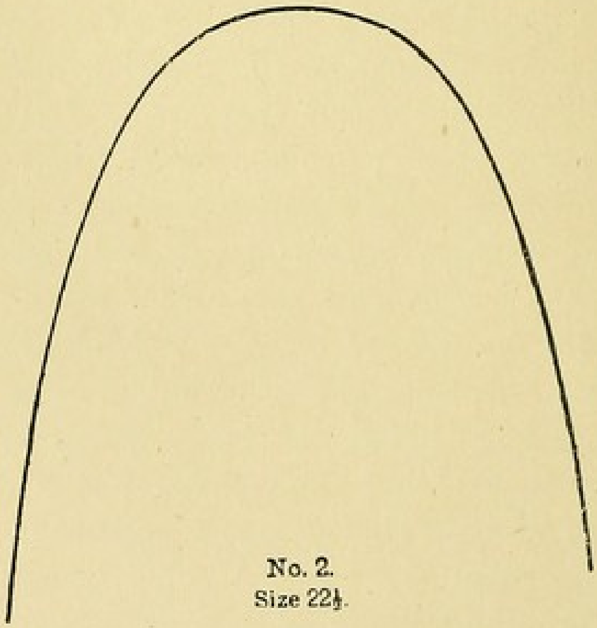
Now I want to call your attention to the fact that there is no movement of flexion possible in the mediotarsal joint apart from the movements of adduction or abduction of the foot on the astragalus. If you raise the heel from the ground and stand upon the front of the foot, besides the movement of the ankle-joint around a transverse axis, the foot of necessity assumes a position of adduction upon the astragalus, the head of which occupies a situation external to that occupied when the foot is flat on the ground. This is of extreme importance clinically, since every part of the foot is in a position of considerable activity, entailing a great demand upon the flexor muscles of the leg, and especially the tibialis posticus, and for its secure assumption free inward movement of the great toe, through which the superjacent weight is largely distributed and securely balanced. Again, as the attitude is a strained position of activity, the whole of the muscles of the leg are called into play to retain the normal equilibrium of the ankle and other joints, the position of the former joint being one of extension. That the freedom of movement of the great toe inwards in this position is of vital importance to the security of the attitude is obvious to the most superficial observer, and anything that opposes its inward movement, or, worse still, anything that forces this toe outwards, must add enormously to the insecurity and difficulty of the position. Notice also that in this posture the toes while flexed at the interphalangeal joints are extended upon the metatarsal bones, and such a position of the toe when it has become fixed is described as "hammer-toe."

Now what is done to the foot by the boot? I will take the boots worn by a large number of women, since they caricature the mechanical disadvantages of the boots used by men. In order to remind you of the shapes of boots and shoes usually worn by fashionable women, and often exaggerated by those who imitate them, I have cut some illustrations out of a trade advertisement. Some are marked as being especially made to fit only one foot, namely, as rights and lefts, but a number are supposed to be used for either foot indiscriminately. Figs. 70, 71, 72, and 73 represent the shape of the soles with



No. 1.
Size 22½.

Fig. 70.



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Size 22½.

Fig. 71.

their trade sizes, and I am given to understand that the most pointed variety is the form in greatest demand. I would refer you to any trade adver-

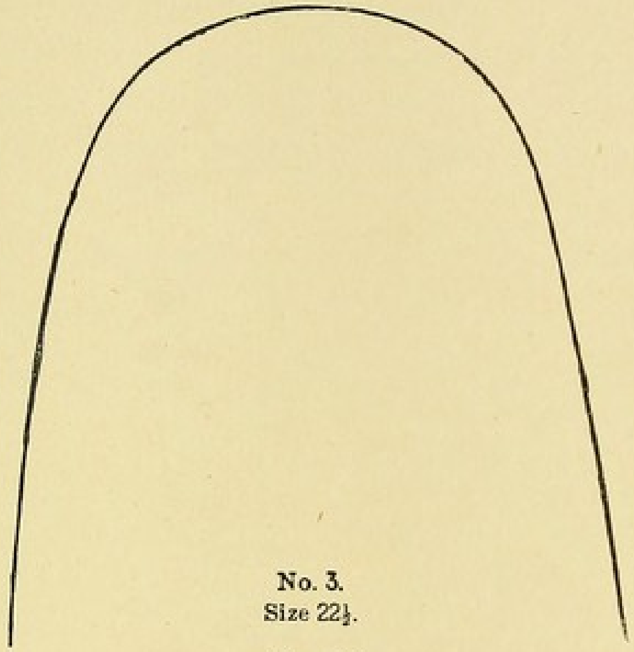


Fig. 72.

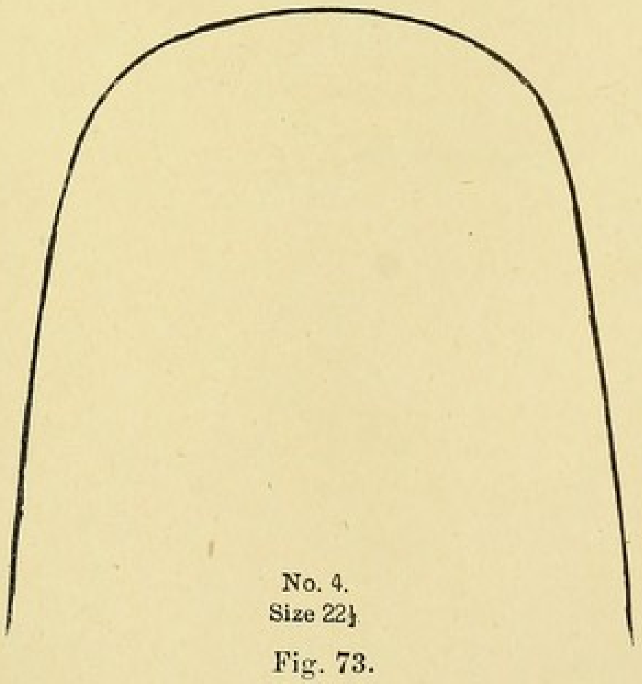


Fig. 73.

tisement for further particulars. Figs. 74 and 75 represent average boots and shoes. You observe that the lower end of the heel is placed so far forwards that it practically necessitates the wearer assuming the posture of standing on the front of the foot, though of course a considerable proportion of the superjacent weight is transmitted through the heel.

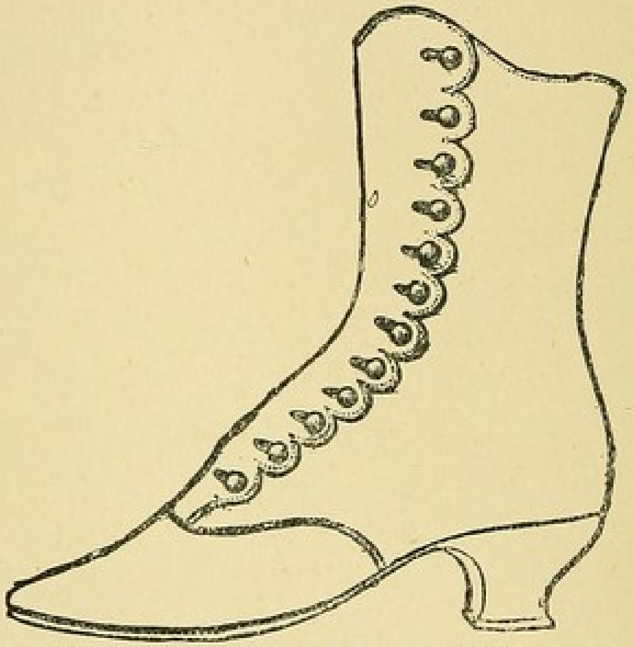


Fig. 74.

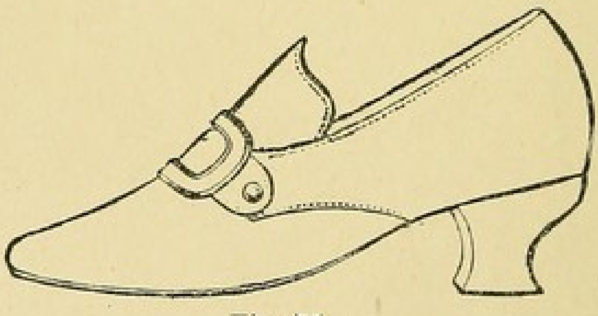


Fig. 75.

The habitual use of such boots on this account leads to a comparative fixation of the position, owing to the muscles, ligaments, fasciæ, and bones accommodating their length and form to the continually assumed attitude; and this you may observe in any vigorous middle-aged woman when she raises her bare foot from the ground. Fig. 76 represents this condition.

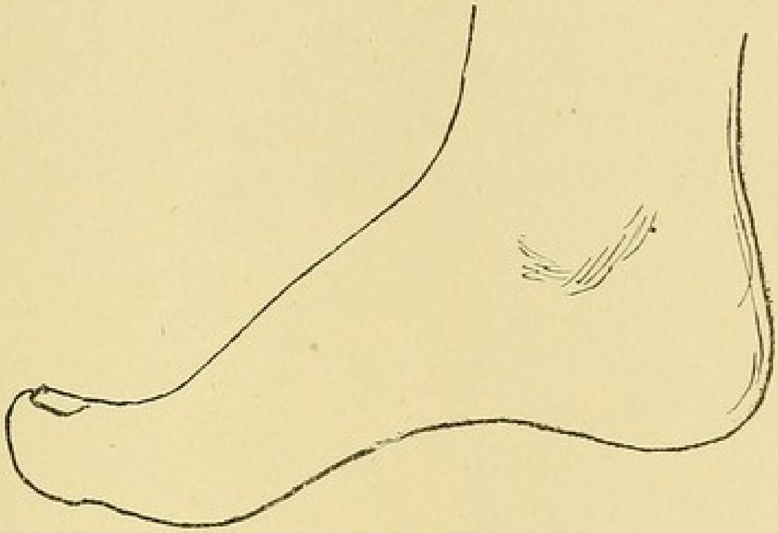


Fig. 76.

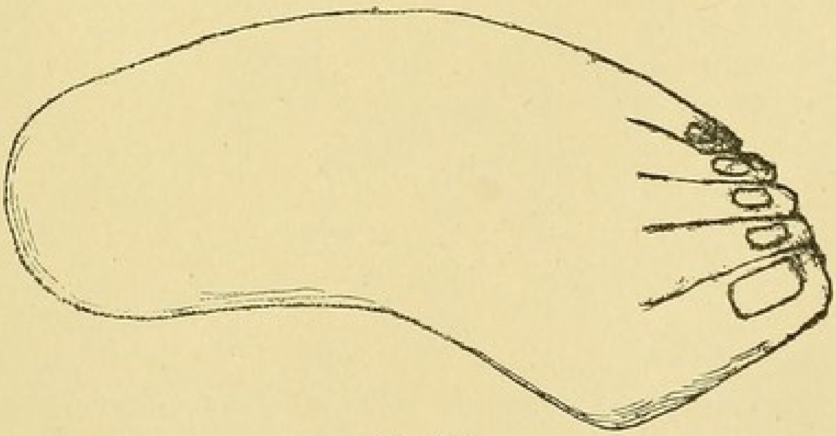


Fig. 77.

Owing to the shape of the front of the boot, the great and second toes are displaced outwards and the fourth and fifth inwards. (See Figs. 77 and 83.) One would imagine that the inner aspect of the great toe would approximate closely to the corresponding portion of the "upper," as it is called; but an examination of a foot in the boot shows that while the head of the first metatarsal bone forms a projection from the inner aspect of the upper, the inner margins of the upper and great toe include between them a surprisingly large angle, the real outward displacement of the toe being therefore considerably in excess of its apparent displacement. The skin on the under surface of the great toe is thin and silky

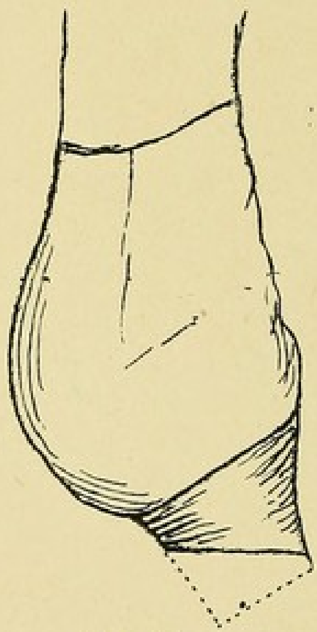


Fig. 78.

instead of being dense and tough, as it is in the normal foot on account of the pressure sustained habitually by it.

The outward displacement of the great toe renders the position of activity much more difficult and insecure, and by the over-action of the tibialis posticus the wearer tends to rub the heel down externally, and if the individual be not very vigorous the muscles may suddenly lose their accuracy of balance, and the movement of excessive adduction is suddenly exaggerated, the foot being displaced inwards. The condition is not uncommonly described as weak ankles, and if the heel be allowed to become worn the term "growing out of the ankle" is applied to it. The cramping of the other toes besides the great toe also assists in the production of this insecurity. Fig. 78 represents a back view of the left boot of a poor patient with so-called "weak ankles."

If the wearer be feeble, or obliged to stand for long periods, the tibialis posticus gives up the struggle and permits the foot to assume such a position of abduction as the presence of the heel allows, the latter wearing down on the inner side and the inner ankle becoming prominent. This is popularly regarded as "growing in of the ankle." When the position has been occupied for some time any movement between the opposing articular surfaces becomes painful, and the muscles, especially the extensors and peronei, oppose adduction of the foot, or indeed any movement whatever in the subastragaloid joint, and *abduction* from being *habitual* becomes *fixed.* Fig. 79 represents a back view of the left foot of a poor patient affected with so-called "flat-foot."

Such pressure as is exerted by the "upper" upon the great toe produces many troubles. The soft parts are compressed by the edge of the nail to such an extent that ulceration ensues, first in the outer fold and later in the inner. This condition has, with the usual habit of observers, been ascribed to the wrong cause, and is described as "ingrowing toe-nail," as if the nail itself were primarily at fault.

Starting with this false pathology, the surgeon frequently does not turn his attention to the cause of the trouble, namely, the pressure resulting from the badly shaped boot, but treats the effect, and applies dressings to the ulcerated surface, or he cuts the edge of the nail, or tears it from its bed, and in some cases he removes the bed with the knife or caustic.

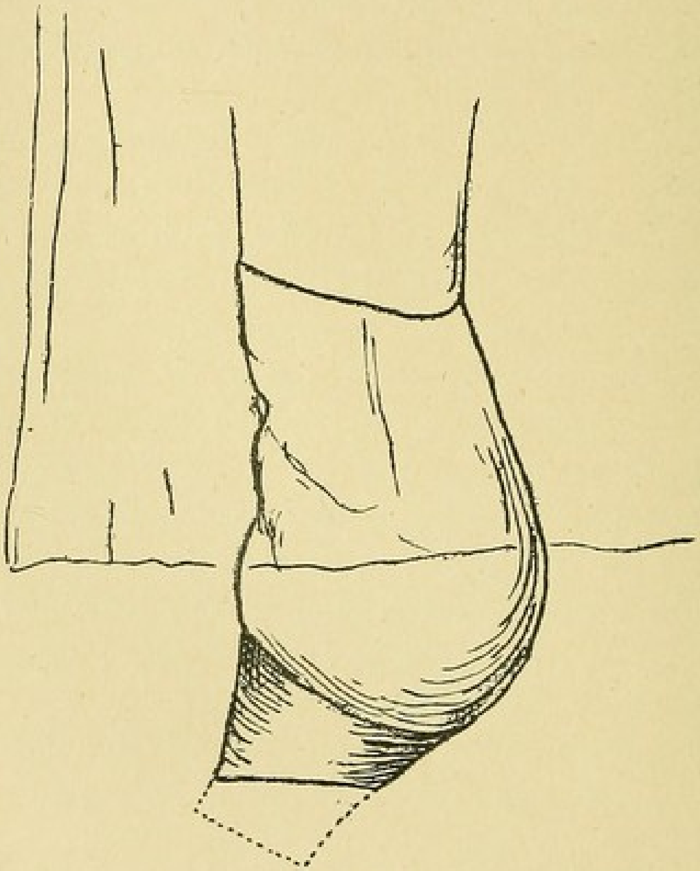


Fig. 79.

The lateral pressure that the nail of the great toe has to sustain, even with any form of boot, is shown by the change in form which the terminal phalanx acquires on this account. It follows in consequence on the varying pressures sustained by the several portions of the growing line.

Fig. 80 represents the terminal phalanx of the right great toe. The outward displacement of the phalanx on the metatarsal bone results in a compensatory shortening of the external lateral ligament, and owing to the alteration in the direction of the line of traction along the tendon of the extensor longus pollicis, which is habitually contracted in its balancing function, rendered difficult by the mechanics of the boot, this tendon is displaced and becomes prominent.

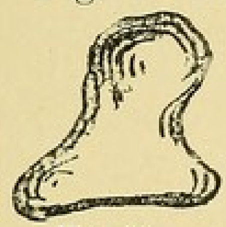


Fig. 80.

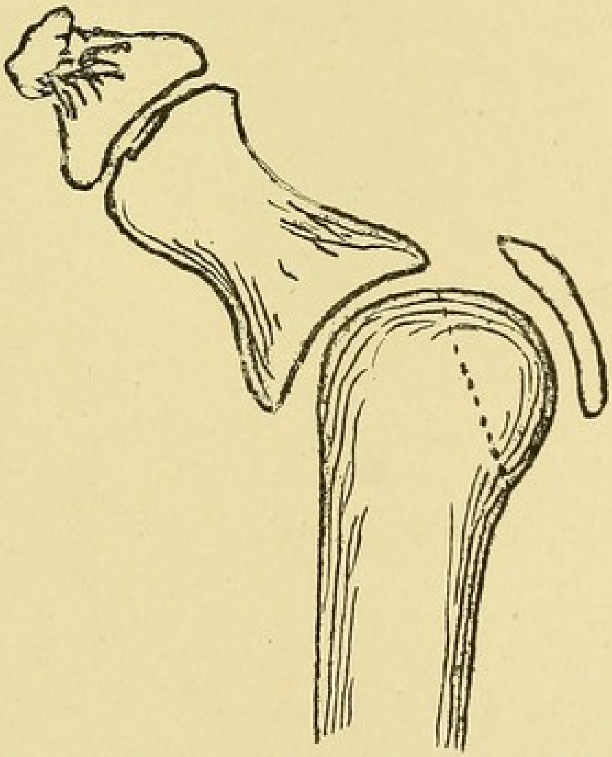


Fig. 81.—The dotted line indicates the track taken by the chisel in the operation referred to.

Fig. 81 represents the great toe of the left foot displaced outwards in the manner described. The bursa over the inner portion of the head is shown. The inner aspect of the articular cartilage covering the head of the bone is exposed to abnormal pressure, and has forced upon it the performance of a function for which it was not evolved. To meet this a bursa develops in the superjacent connective tissue to shield its surface as far as possible, so long as it retains the structure and sensitive character of articular cartilage. Pressure may be sufficient to cause inflammation and

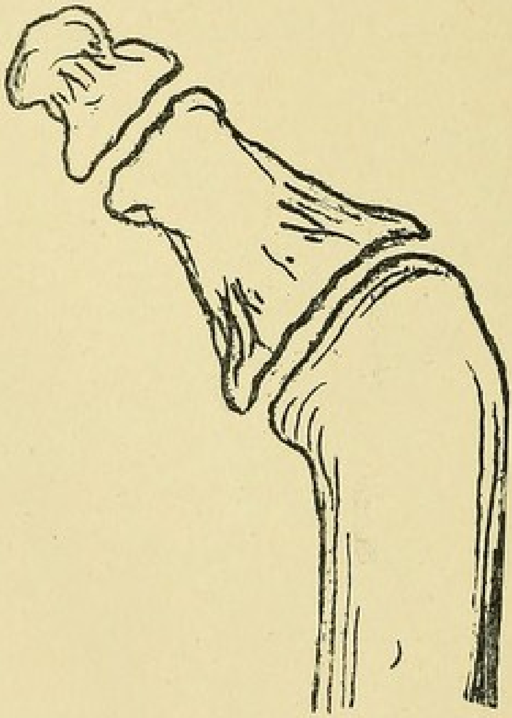


Fig. 82.

even suppuration of the bursa, which having developed for the advantage of the joint, now forms a source of pain to the individual and of danger to the articulation. As time goes on this area of hyaline cartilage, having ceased to perform its articular function, loses its normal structure, and becomes converted into synovial membrane, and later into periosteum. Associated with this change in the cartilage, the portion of the bony head beneath it wastes, and for the same reason the bursa, which is no longer required, disappears also. Therefore after the individual has survived for a sufficient period of time, the deformity has ceased to be productive of pain or even discomfort. A knowledge of this led me to practise chiselling away this portion of the head of the metatarsal bone in the young subject, when much pain was experienced, and when the patient refused to wear any but the most fashionable boots. By so doing a premature senile change in the part was brought about at once. The base of the first phalanx and the outer part of the head of the metatarsal bone accommodate themselves to one another, new bone and articular cartilage being developed. The painful state resulting from the inflammation of the bursa is spoken of popularly as "bunion." Fig. 82 shows the condition as existing in advanced life.

As I pointed out before, in their position in the boots the toes, which are flexed at the interphalangeal joints, are over-extended upon the metatarsal bones. The habitual over-extension of the metatarso-phalangeal articulations and flexion of the inter-phalangeal joints become fixed because of a compensatory contraction of the several ligaments and tendons that are shortest in this position, and a deformity which is called "hammer-toe" is developed. This condition affords another conspicuous instance of the manner in which the surgeon may mistake the effect for the cause, since the deformity is often attributed to contraction of ligaments, or of muscles, or both. The non-recognition of the correct cause would not matter so much to the patient were it not that the surgeon bases his treatment upon his false pathology, and it has frequently been my experience to find ligaments and tendons divided and muscles galvanised, usually without the slightest benefit, no direction whatever having been given as to boots.

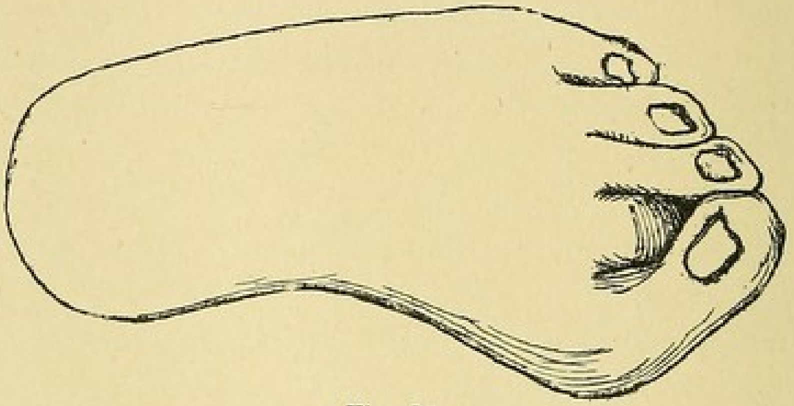


Fig. 83.

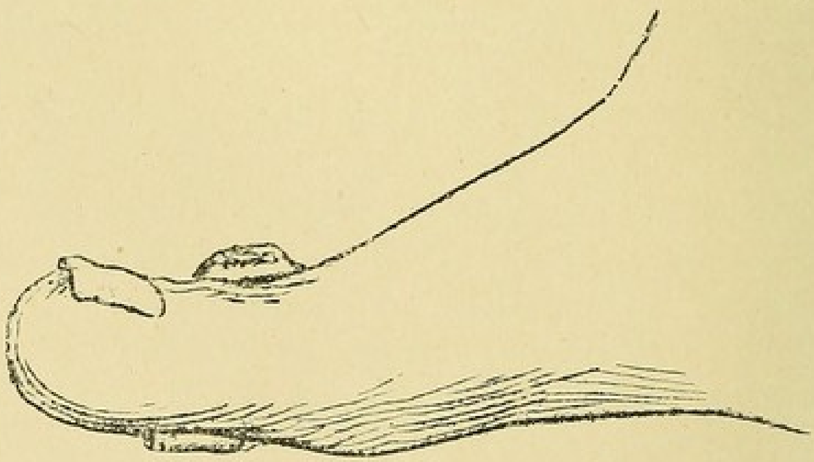


Fig. 84.

Now the toe that is most liable to be forced into this position is, for obvious reasons, the second toe, since the extremity of the great toe occupies the place which should be retained by it. It sustains a double pressure. This is shown from above in Fig. 83, and from the inner aspect in Figs. 84 and 85.

The head of the bone covered with articular cartilage becomes sheltered by a bursa, which may become inflamed, when the individual frequently experiences considerable pain. The under surface of the head of the metatarsal bone and the end of the toe are driven into the sole of the boot, and often develop soft corns, which not uncommonly also become very painful.

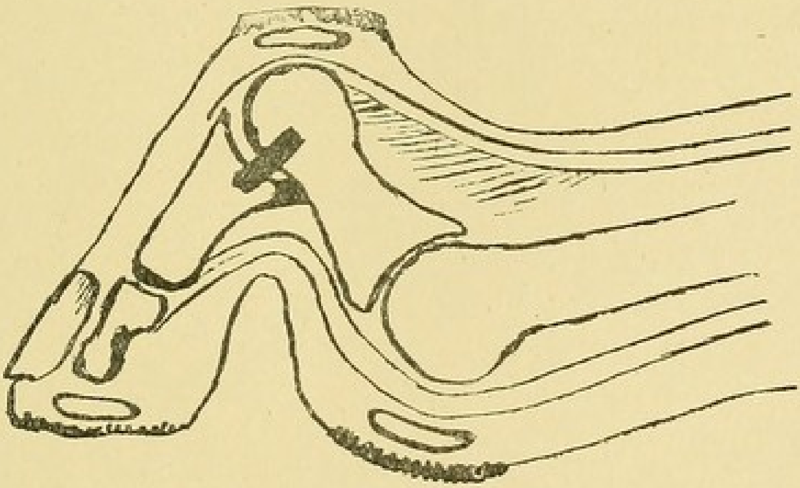


Fig. 85.

The under surface of the head of the metatarsal bone is exposed to an unaccustomed pressure by the permanent dorsal displacement of the first phalanx, and a corn with a bursal arrangement not unfrequently results. Though the second toe is the one usually affected in this way, two, three, or even all the toes may be similarly displaced from the same cause, and the conditions may become so extreme that the heads of the metatarsal bones may finally be driven through the skin. Fig. 86, taken from page

409 of 'Trans. Path. Soc.,' 1886, illustrates such a case. Owing to the extent of the backward and upward dislocation in this case the tendons of the flexor muscles were displaced laterally, and occupied the intervals between the metatarsal bones. The articular extremities of two of the metatarsal bones were carious and eroded, while all were altered in form and deprived of articular cartilage.

In the case of the great toe in this deformity the tendon of the long extensor toe acquires a mem-

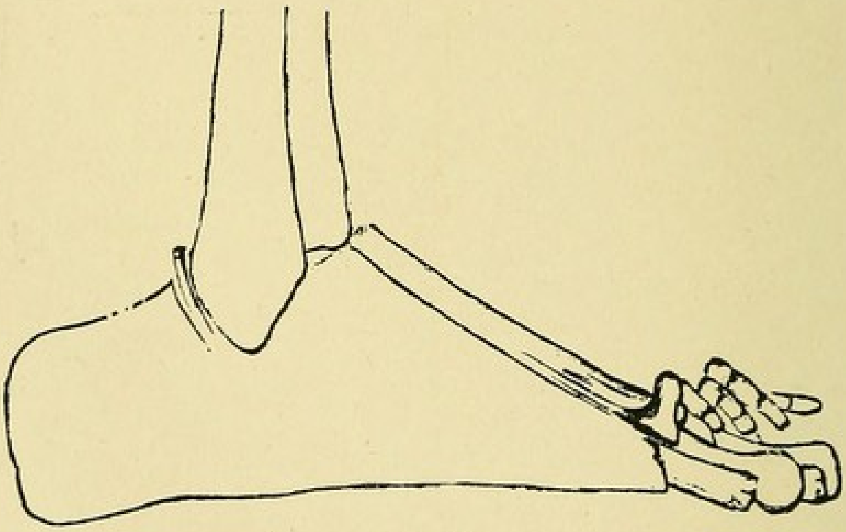


Fig. 86.

branous insertion into the base and whole length of the first phalanx, the attachment to the terminal phalanx being gradually divorced from the remainder of the tendon by the pressure exerted by the boot upon the distal portion of the first phalanx.

Fig. 87 represents diagrammatically in a lateral view of the great toe the acquired aponeurotic attachment of the tendon of the extensor to the whole length of the first phalanx, and its separation from the terminal one.

It is clear that there results of necessity from the use of these boots a limitation of the normal function of the muscles which act upon the several parts of the feet, since the foot is for all practical purposes fixed in an apparatus which controls very considerably the range of movement of the various bones on one another, the foot with its several parts moving almost as if they were ankylosed into one solid mass. Practically the mechanical condition, as regards the freedom of movement of the muscles of the leg, is in extreme cases much on a par with that present in a patient who has had an amputation of the foot. Now anything that limits the mobility of the joints on

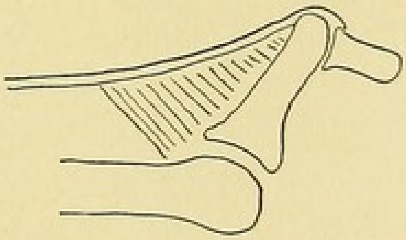


Fig. 87.

which a muscle acts, of necessity lessens the contractile capacity of that muscle, and deprives the limb of a very important and powerful influence in forcing the blood upwards through the deep veins. A considerably disproportionate strain is thrown upon the superficial veins, whose valves soon yield, and a varicose condition results. This may occur in a Syme's or Chopart's amputation, in fixation of a leg due to the development of mechanical arthritis in its joints because of a badly united fracture of the tibia or fibula or of both bones, in the fixation of the leg in a rigid leathern or other case, and in many other analogous conditions. Following on the varicosity and imperfect aëration of the blood there is a varying amount of œdema with local depreciation of vitality.

The stagnation of blood is more marked in the case of the internal than of the external saphena vein; consequently any condition resulting from it would naturally be greater in the area of distribution of the former. Stagnation of blood means impaired vitality, and consequently a diminished resisting capacity. The pressure exerted by the boot upon the veins of the foot serves to cause a more rapid change of blood in them; but it is in the skin on the inner side of the leg immediately above the boot that organisms can most easily obtain a foothold. They produce to the naked eye an inflammation which the dermatologist calls eczema, adding to it the term "varicosum," to distinguish it from other varieties of superficial skin infection, and he applies lotions, &c., which almost always contain a germicide, to the part, and perhaps gives the patient drugs. Later, the organisms obtaining a deeper hold on the skin, a condition spoken of as an ulcer arises. As it varies in appearance, the terms applied to it are as different as the forms of treatment, and are often about as useless.

I think you will readily understand that the boots and shoes as worn by women are in this manner very important factors in producing the varicosity of the veins of the leg with its consequences, which are so commonly seen in them; and the knowledge of the cause will be of great assistance to you in treating such conditions, especially in their early stages.

That the fixation of the foot is largely responsible for a very limited amount of pedestrianism and for the general want of tone and health is too evident to require any remarks from me ; and that knock-knee, lateral curvature, and dorsal excurvation, like flat-foot, arise to some extent very commonly—both directly and indirectly—from their use and from consequences of their use must be apparent even to the most superficial of observers. Yet one is constantly asked to see cases of these resting deformities which have been treated often for long periods of time, and one finds them almost always wearing boots which are as neat-looking and danger-

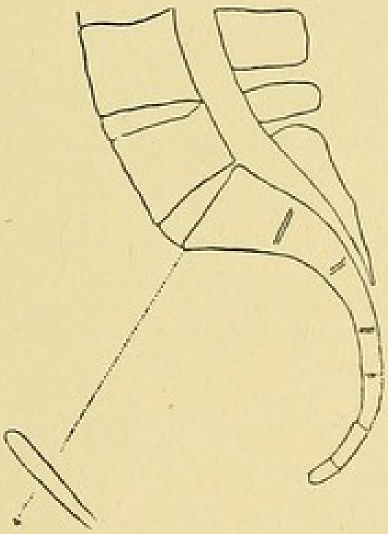


Fig. 88 represents a condition of the pelvis which at first sight closely simulates that associated with dorsal excurvation, namely, the diminution in the diameter of the conjugate of the brim of the pelvis, and the altered inclination of the facet on the first piece of the sacrum. This, however, is due to a separation or dissociation of the first piece of the sacrum to form one vertebra in excess above what are apparently the entire sacral series.

ous as they can possibly be, and I do not remember that on inquiry I ever gathered that any attention whatever had been paid to that part of the patient's attire the capacity of which for harm is nearly equalled by the supporting apparatus which some still continue to apply.

The sandal as worn by the ancients is probably the best substitute for walking bare-footed. In it there was no obstacle to the perfect assumption of the attitude of activity, which was hardly influenced by the strap which passed up between the great and second toes. Recently a very moderate imitation of the principle of the sandal has been revived in the use of a vertical steel plate between the great and second toes, with an alteration in the outline of the inner margin of the sole to allow of the inward movement of the great toe in adduction of the foot. Unfortunately the boot is not pleasing to the eye. It seems very probable that if the conservatism of women as regards the mesially pointed toe can be removed, and our shoemakers are taught something about the structure and functions of the part they treat so cavalierly and painfully, men, and possibly even women and children, may be shod to their advantage, and not to their very serious detriment.

If I had more time at my disposal I would show you how the presence of the heel over-extends the lumbo-sacral joint, and tends to dissociate the first piece of the sacrum (see Fig. 88) and produce a supernumerary vertebra. This cannot, of course, be brought about during a single lifetime, but I believe that it is by the transmission of this tendency that the actuality is produced in the offspring.* This over-extension of the lumbo-sacral articulation, by altering the arrangement of the superjacent weight, tends to limit the movement and consequently the development of the upper part of the chest, breathing being performed to a disproportionate extent by the abdomen and lower ribs. This can be verified clinically without any difficulty. When the tendency is transmitted to the offspring, and becomes an

* "Can the existence of a tendency to change in the form of the skeleton of the parents result in the actuality of that change in the offspring?" 'Journal of Anatomy and Physiology,' January, 1888.

actuality, allowing for the moment such a causal relationship, you find associated with the supernumerary vertebra a very small upper chest, as determined by the measurement of the arcs of the ribs and the intervals between the ribs, by the relative size of the manubrium to the gladiolus of the sternum, and a corresponding increase in the size of the lower part of the chest, with often an additional rib below.

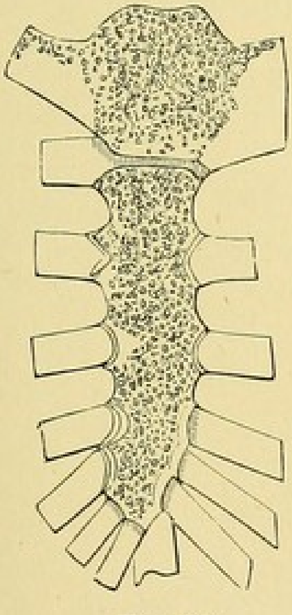


Fig. 89.

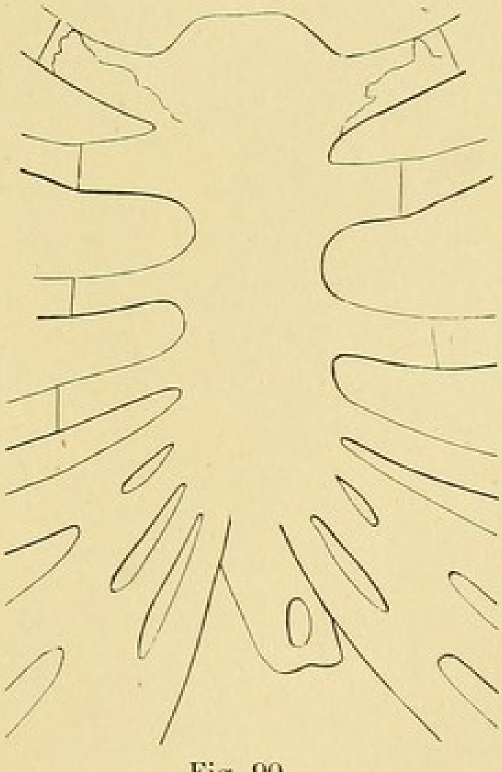


Fig. 90.

There is sometimes present the greatest irregularity in the upper ribs, both in their spans and in the level of the attachments of their cartilages to the sternum, occasionally with some fusion of the ribs or cartilages and asymmetry of the portions of the spinal column.

Figs. 89 and 90 represent such a condition of the sternum and costal arches. Fig. 91 shows the somewhat similar condition of the cervical rib, with which the undeveloped upper chests of Figs. 89 and 90 were confused till I explained the differences and the factors determining them. Fig. 92 represents a case in which the cervical ribs were comparatively small and unattached to the first costal arch. The first thoracic ribs were very massive and of abnormally

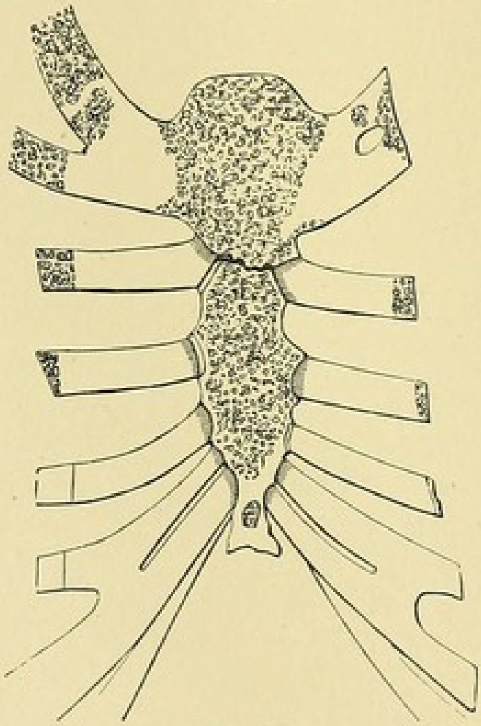


Fig. 91.

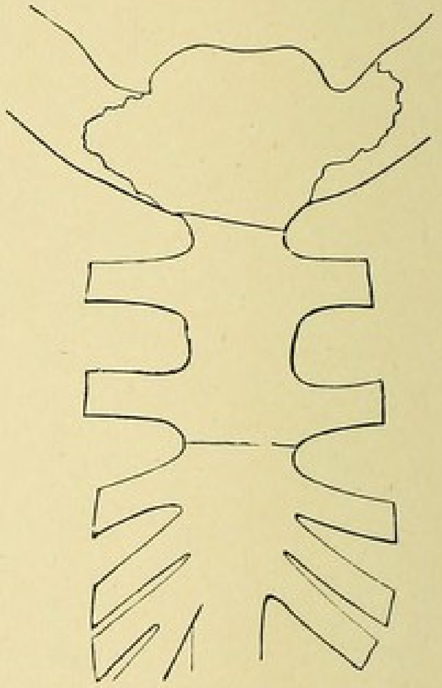


Fig. 92.

large arcs. Notice, among other things, that in Figs. 91 and 92 the manubrium is relatively large and the gladiolus small, while in Figs. 89 and 90 the reverse is the case; also that while in Figs. 89 and 90 seven costal cartilages articulate with the gladiolus, in Figs. 91 and 92 only five are connected with this part of the sternum. As a matter of fact the actuality develops but very rarely in the female subject as compared to the male, probably for the reason that the tendency resulting from the mechanical pressure and limitation of movement exerted by the large uterus during pregnancy being transmitted, opposes, more or less effectually, the tendency to the dissociation of the sacral vertebra, the changes in the chest, &c. These changes which I believe to result from heels are both of great scientific and practical interest, and if you care to go into the subject more fully you will find it discussed, and cases fully described, in papers in the 'Journal of Anatomy and Physiology,' and in the 'Guy's Hospital Reports,' 1883–4* and 1885–6.†

In order to prove the possibility of a tendency being transmitted as an actuality, I also made use of the conditions of fusion of the fifth lumbar vertebra with the sacrum, as well as that of *asymmetry of the costal arches and of the sternal pleurostea.* The latter, I found, appears for the first time in the monkey when it loses its tail, and exists occasionally in man. In the latter its presence is explicable either on the ground of its being a retrocession to an ancestral type, or that the intervening ancestors had not yet parted with a characteristic which, except in man, is peculiar to one simian group. The loss of the tail throws greater prehensile functions on the forearms, and to this, I believe, is due the asymmetry. During the time the weight of the body is borne by one arm the tendency to asymmetry exists.

* "Cervical and Bicipital Ribs in Man."

† "Pressure Changes in Trunk and Shoulder-girdle."

SOME CLINICAL OBSERVATIONS

ON THE

PRINCIPLES INVOLVED IN THE SURGERY OF FRACTURES.

We will consider in order the various changes in the skeleton that may ensue in consequence of a fracture of one or more long bones; the unequal degree in which these changes take place in the upper and lower extremities; the factors determining their development; their clinical symptoms; the principles which should guide us in our treatment of fractures, so that we may avoid these changes altogether, or reduce them to minimum proportions, and the best manner in which these principles can be applied. I would remind you that the normal form of our bones and joints exists only so long as we lead a normal existence, combining various movements of activity with attitudes of rest. I have shown you that if the growing subject assumes solely attitudes of rest, avoiding movements of activity, deformities arise, which are due chiefly to changes in the joints and ends of the bones, as, for example, knock-knee; and again, if one movement, or sequence of movements of activity is assumed habitually, and other attitudes of activity with those of rest avoided, as in the labourers we have considered, a deformity characteristic of the attitude of activity is developed, a deviation from the normal arising in consequence, being also due chiefly to changes in the articulations and in the ends of the bones.

Obviously, then, our anatomy remains normal only as long as our mechanical relationship to our surroundings continues so, and any variation in the mechanical relationship is followed by definite physical changes in the bones and joints.

In other words, the problem of evolution is a purely mechanical one, and its proof is telescoped into the lifetime of a labourer or into that of a child suffering from one of the resting deformities. These are the experiments that nature makes for us, and by their consideration we become able to understand larger problems.

The form and structure of a joint remaining normal only as long as the mode of transmission of force through it remains normal, any alteration in these lines of force transmission is followed by changes in their structure proportional in degree.

Nature, again, makes other experiments for us in which she alters, more or less completely, the direction and the mode of transmission of force through one or more joints of a single limb. This comes about by a fracture of a long bone, whose fragments unite in such a manner that the axis of the one corresponds no longer with that of the other; and as the angle formed by these axes with one another is often great, or if parallel, as they are frequently separated by a considerable interval, owing to overlapping of fragments, the mechanics of the joints formed by the ends of these bones, as of others influenced by the alteration in the lines of force, are changed in a definite and measurable degree from the normal.

The joints of the lower extremity offer us a much better field in which to study this subject further than those of the upper, for the reason that the weight of the body is habitually transmitted through the former, and in consequence the changes which develop in them must be very much exaggerated as compared with those which arise in the latter. Therefore we will proceed to examine the conditions of the joints of the lower extremity which result from fracture. We find that for convenience' sake they may be divided into two distinct groups, though there is, of course, no sharp definition in the character of the changes. The very important factor which determines this variation in the results of pressure is the "age" of the individual, and its influence is one that must, as you will see, affect very materially the character of our treatment of fractures.

In the comparatively young adult considerable deformity, and the consequent alterations in the physiology or functions of the joints influenced, bring about changes which are, perhaps, best described by the term "adaptive." By this I mean necessary changes in the form, and perhaps in the planes of the articular surfaces, without the texture of the articular cartilage being other than absolutely normal, together with a corresponding alteration in the limits of attachment of the ligaments and synovial membrane, both of which are normal in structure and function, while the secretion of the latter is not excessive in amount.

After a certain period of life, which varies within wide limits with the habits, occupation, and surroundings of the individual, but which may be roughly averaged as about forty years, this being probably much too high an estimate for labouring people, an altogether different series of changes takes place. These I have called "passive," for want of a better and more descriptive term. They consist in the removal of the articular cartilage at such places where the altered physiology of the joint causes the transmission of an amount of pressure which is abnormally great as compared to that which the same surfaces transmitted previous to the injury. After the cartilage is destroyed, the same factor, associated with unaccustomed friction, produces sclerosing, eburnation, and gradual removal of the opposing exposed surfaces of bone. The area and form of the articular surfaces are also modified by deposition of cartilage and bone on the margins, the synovial membrane becomes more bulky and develops abnormal fringes, and the synovial fluid is secreted in a quantity often largely in excess of what is normally sufficient. The ligaments may have their attachments displaced and their functions very materially altered, owing, to some extent, to changes in the axis around which rotation takes place. Such conditions used to be regarded by the pathologist as indicative of the presence of a disease which was known by names such as rheumatoid arthritis, osteo-arthritis, rheumatic gout, &c.; and he would be a daring student who, at an examination table, would designate these changes as being other than due to this disease. Perhaps the best term to apply to them was one for which I am responsible,* namely, "mechanical or traumatic arthritis;" remembering,

* "Chronic Traumatic Arthritis," 'Lancet,' January 30th, 1892.

however, that these changes resulting from fracture form but a small group of that very comprehensive class.

As to the clinical manifestations of these conditions, the "adaptive" changes are often unassociated with any pain or discomfort, except, perhaps, for a short time after the patient begins to get about, though to this general rule I have seen numerous exceptions where much pain and very considerable disability resulted even in childhood; but the "passive" changes are on a very different footing. Their presence means that in their slighter degrees of development the patient experiences a feeling of insecurity in, or imperfect control over the movements of the part, and in their most marked forms a degree of pain that sooner or later absolutely incapacitates the sufferer from transmitting the weight of the body through the joints of the leg for any useful purpose.

Nor is this the only trouble. Should the patient be affected with true rheumatoid arthritis, gout, or rheumatism, the chances are that the damaged joint or joints will be first attacked, or be more severely affected than others. Again, as all movements in the joints cause pain or discomfort, the patient uses the muscles of the limb in a very partial manner, retaining part or the whole of the limb more or less completely rigid. As a result of this, the foot and leg become œdematous, organisms readily establish themselves on such areas of the skin where the vitality of tissues is most depreciated, and eczema and later ulceration develop. As illustrations of the clinical conditions presented by the progressive development of "passive" changes I will describe briefly two typical cases, not that they are remarkably severe, but because they represent very fairly the subsequent career of a very large number of patients who sustain fracture of the long bones of the leg at or after middle life, the fragments not having united in a good position.

A. B—, a powerful blacksmith, æt. 40 years, was admitted into a large general hospital in London in January, 1894, suffering from a fracture of the shaft of the femur about its centre. He was under the care of a very able and distinguished surgeon, who directed the leg to be put up in a plaster spica. He remained in the hospital nine weeks. His medical attendant asked me to see him about the end of the year with a view to operative interference. The fractured leg was 2½ inches shorter than its fellow. On placing him on his back at rest the sound limb rotated outwards to its normal limit, while the inner margin of the foot of the damaged limb occupied a vertical plane. Owing to pain in the hip, knee, and ankle-joint, which continued to increase in severity, the man was unable to walk without a stick, and was quite incapable of following his employment. I did not consider that anything short of amputation which he desired would relieve him. To suggest amputation as the primary treatment for a simple fracture of the femur would appear ridiculous, but the result of the usual surgical treatment of such a fracture may be so disastrous as to make the sufferer beg for the limb to be removed. Now here was a patient placed under the most favourable circumstances imaginable, yet what can be more deplorable than the result? The same applies equally to the next case.

J. H—, æt. 49, a bricklayer's labourer, was admitted into the same hospital in the early part of May, 1894, suffering from a Pott's fracture. A plaster case was applied, and he left the hospital on crutches ten days later. The case was removed in three weeks, and the patient hobbled about with the aid of a stick. He suffered so much pain in his foot that he sought admission into an infirmary, where he remained for several months. He recovered so far that he could get about slowly without a stick, though his foot caused him very great pain on movement. He had to give up his occupation of bricklayer's assistant, as he could not climb a ladder, and as a general labourer he with difficulty, and in much physical distress, managed to earn a third of what he used to previous to the injury. The pain was situated chiefly in the subastragaloid joint. The seat of fracture is still evident as a depression, the displacement not having been reduced.

As an example of "adaptive" changes, I will merely relate one case out of a large number, since it shows that such a considerable alteration in the mechanics of the joints resulting from the unusual deformity and shortening must have determined very marked deviations from the normal in their form and details. I was asked to see a lady of about 25 years of age, who some time before had been thrown from her horse and sustained a fracture of the tibia and fibula below their centre, followed at once by great swelling. She had been treated by back and side splints. Her medical attendant had the advantage of the assistance of a very able and well-known London surgeon. I mention this not that I want to find fault with the treatment, but on

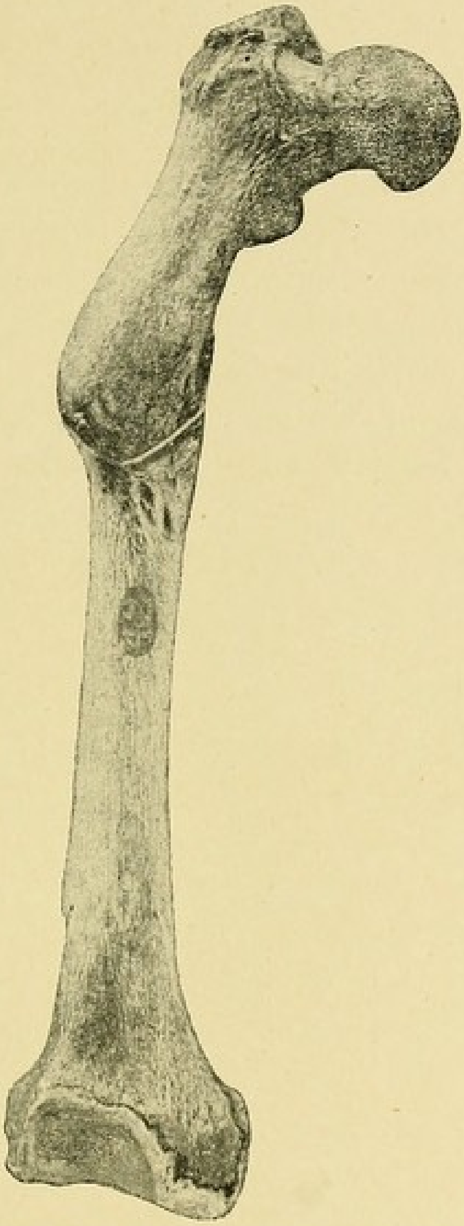


Fig. 93 is printed on a larger scale than the other illustrations, in order to show in greater detail the several anatomical changes which take place in the joints because of the alteration from the normal manner in which pressure is transmitted through them in consequence of the changed form of the bone resulting from its fracture, and which are well marked in this particular specimen. Much of the deformity which exists has been produced by the leg and lower fragment having been rotated inwards during the process of repair to such an extent that the inner margin of the foot occupied a vertical plane, the rest being due to hæmorrhage into and inflammation of the soft parts about the fracture, and the lower end of the upper fragment being of necessity forced outwards and forwards by the ascent of the lower fragment on its inner and posterior aspect. Observe the alteration in the form of the articular surface of the head, pressure being transmitted through newly-formed bone outside and somewhat in front of the head; also in that of the lower end of the bone, where the disproportionate amount of weight sustained by the inner condyle has brought about extensive mechanical changes in it, the other condyle being almost normal.

the contrary I wish to point out that by means of the usual methods it is clear that nothing more could have been done under the circumstances. When I saw her the inner margin of the foot occupied the vertical plane, while its fellow included with it an angle of about 50°. The damaged limb was almost exactly two inches shorter than its

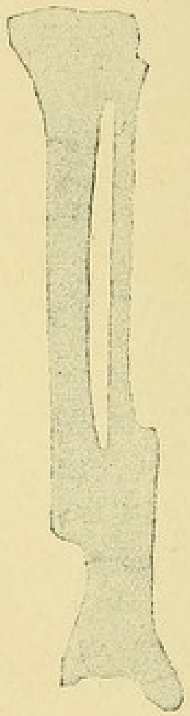


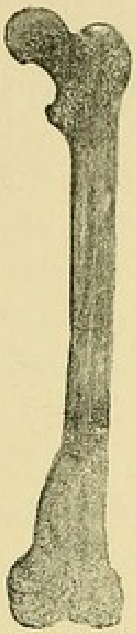
Fig. 94 represents the usual displacement in fracture of both the tibia and fibula. Observe that the lower fragments correspond to the vertically placed foot, while the upper occupy the normal position of rest of the limb.

fellow. She was a fine tall woman, and wished me to perform some operation by means of which her shortened leg could be lengthened. This I was unable to do while she refused my alternative suggestion of shortening the other leg.

Here, although there was this considerable shortening and the lower fragments were displaced backwards and outwards behind the upper, she experienced, after a considerable interval had elapsed since the injury, no pain, discomfort, or insecurity in the use of the several joints. She wore a boot padded in its interior so as to compensate for much of the shortening, and this entailed a certain peculiarity of gait that caused her much mental distress, and prevented her from dancing. From a matrimonial point of view she was enormously depreciated by the results of the injury.

Before passing on to the consideration of the mechanical principles that must guide us in our attempts to restore the fractured bone to its original form, we must first investigate the obstacle which so often prevents this being effected.

We have surrounding the long bones a mass of muscular and tendinous structures, enclosed and bound down by more or less dense layers of fascia, which fit accurately over them in their conditions of contraction or relaxation. Around this there is a sheath of loose areolar tissue, which is covered in by the comparatively unyielding skin. If in the dead body one of the long bones of the leg is broken through and the fragments are displaced upon one another, it is often possible, by traction and manipulation, to establish accurate apposition in most bones. A very little experience of fractures in the living subject shows one that the conditions in it are altogether different, and a careful observer will notice that the difficulty presented seems to vary directly with the amount of hæmorrhage into and subsequent swelling of the soft parts round about the seat of fracture; also that, in consequence,



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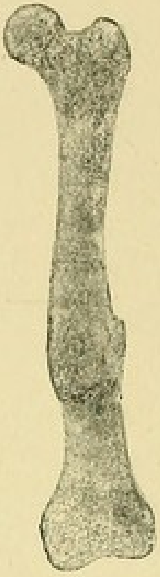

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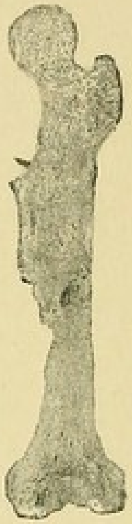

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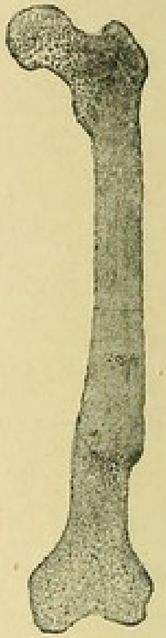

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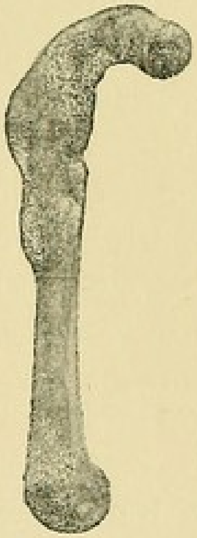

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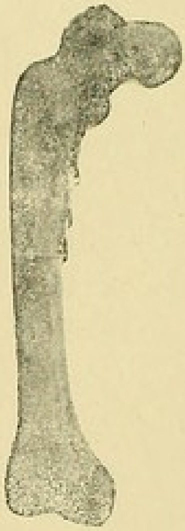

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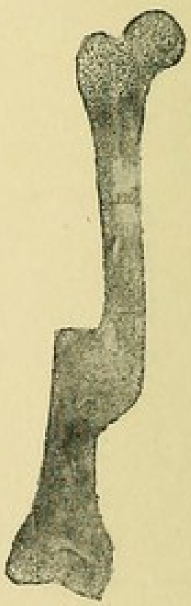

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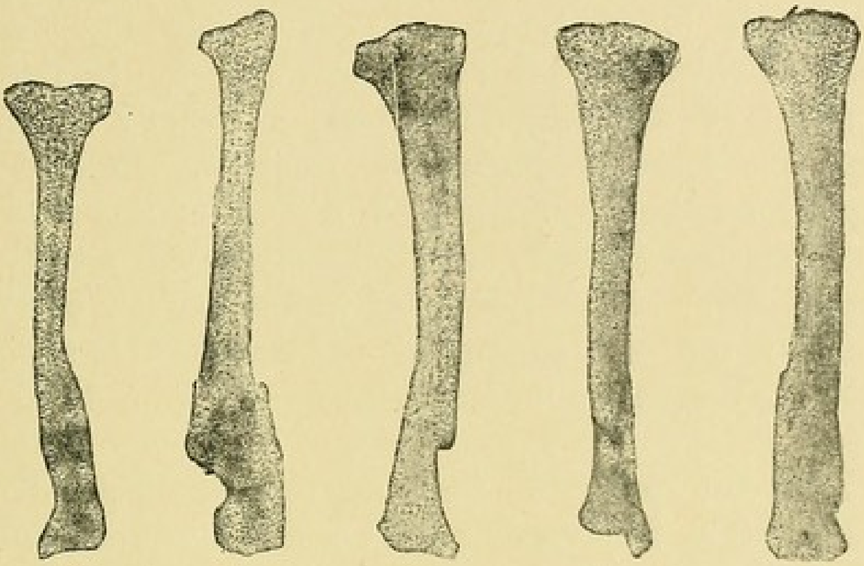
Figs. 95 to 101 represent fractures of the femur in which deformity has resulted from the causes already described.



102 103 104 105 106

Figs. 102 to 106 show similar conditions of the tibia and fibula. A careful examination of each specimen shows that this deformity, with the consequent physical depreciation, could have been readily obviated at the time of the fracture by the simplest surgical procedures, it being hardly fair, perhaps, to signify the usual methods by such an attribute.

if the fracture is situated in a part surrounded by an abundant quantity of soft structures, and the injury producing the fracture was so severe as to lacerate the tissues considerably and displace the fragments upon one another, very much more opposition is experienced to the approximation of the fragments than when the fracture occurs in a thin, feeble, old subject, with scanty, flaccid soft parts, and in which the bone had yielded to very slight amount of force.

If you examine into the physical conditions, you see that the tissues surrounding the long bone constitute ties in its length, and are practically incapable of extension. In a fracture these are lacerated, blood is poured out freely into and beneath them, and this is encouraged by the overlapping of the fragments, which usually results from the force producing the fracture. Following rapidly on the hæmorrhage is a more or less active inflammatory process, which involves the muscles, fasciæ, fat, and skin relaxed in the length of the limb by the overlapping of the fragments, which itself may even be increased by it to a considerable extent.

You can readily understand that such physical conditions as I have described render it practically impossible to place and retain the surfaces of a recent oblique fracture in apposition by traction and manipulation, and that the restitution of the fragments into their normal relationship to one another is impracticable till the material which has shortened up the ties in the length of the fractured bone has been removed, and this cannot take place for many days.

The mechanical principles which must guide us in our treatment are, therefore, two; and here I may say that I am considering especially the peculiar circumstances presented by fractures of the lower extremity, though it is obvious that they apply with equal force to those of the upper limb also.

1. The axes of the fragments must be made to correspond as nearly as possible. This is effected by placing the patient in the supine posture at rest, and by observing the foot of the sound limb; by measuring the angle included between its inner margin and a vertical plane the degree of normal outward rotation of the thigh is readily deter-

mined. By placing the foot of the damaged limb in exactly the same position the axis of the lower fragment will be made to correspond with that of the upper. This occurs only when the opposition, produced by the shortening up of the ties in the length of the limb by blood and inflammatory material, has been eliminated by their absorption, sufficient traction being exerted in the length of the fragments in the meantime.

2. The second principle follows necessarily what I have already said, namely, that sufficient traction must be exerted upon the fragments in their length till absorption of the blood and inflammatory material has been effected to bring the broken surfaces into apposition. It is apparent that the amount of traction, together with the duration of the period during which it is exerted, must vary with the extent of hæmorrhage and subsequent inflammatory effusion, since in some cases where they are so small as to be practically absent it is possible, by exerting a moderate amount of traction and by manipulation, to reconstitute the bone in its normal shape, and to retain the broken surfaces in apposition by means of a plaster case; while in others the amount of hæmorrhage and inflammatory exudation may be so considerable, and their absorption so long delayed, that union in an unsatisfactory position results. Though I had some idea that the influence exerted upon the ties of the long bones by hæmorrhage and inflammation was considerable, I never became alive to the immense resistance they offered till, in 1893, I cut down upon the simple fractures of the tibia and fibula with a view of reconstituting these bones in their original form by uniting the fractured ends

by steel screws.* In these cases I found that, even after the skin and muscles were freely divided in order to expose the fracture, a very moderate amount of hæmorrhage and effusion was sufficient to resist what traction could be exerted upon the foot and lower fragments, so that it had to be supplemented by the use of elevators and lion forceps before it was possible to fix the broken surfaces accurately together with wire or steel screws. It is of the truth of this that I have found most difficulty in convincing others; indeed, it would seem that it is necessary for the surgeon to see or perform such an operation to realise this fact.

I do not think that I ever placed much reliance upon the considerable influence supposed to be exerted for some time upon portions of the long bones by muscles attached to them, and which is described diagrammatically and in detail in many of our surgical and anatomical works. Its influence in any particular case can be accurately gauged by administering an anæsthetic. Surgeons mistook this supposed factor in producing deformity, which in my opinion is practically non-existent, for the resistance offered by hæmorrhage into and inflammation of the soft parts about the fracture, and many lines of treatment and forms of apparatus were based on this false assumption.

How this traction is to be exerted on the leg below the fracture must vary with its position. If the fracture is low down and near the ankle, and there is much swelling, it is obvious that but little

* "A Method of treating Simple Oblique Fractures of the Tibia and Fibula more efficient than those in common use," 'Trans. Clin. Soc.,' vol. xxvii, 1894.

force can be applied, since the pressure that must be exerted locally by the extension apparatus upon inflamed and distended parts soon becomes unbearable.

In the paper referred to I confined myself to the consideration of the treatment of fractures of the tibia and fibula, and I proved, from a careful examination of a large number of cases in which such fractures had been sustained at or after middle life, that, as regards the physical capacity of the labourer to perform his accustomed heavy work, or, in other words, his financial value as a machine, he is enormously depreciated under the methods of treatment at present adopted. This is naturally most conspicuous in such as are largely dependent on the perfect control of their lower extremities during the performance of their occupation, such as firemen, decorators, scaffolders, &c.

It would seem that, except in the case of fracture of the patella, this branch of surgery, namely, the treatment of fractures, has made no progress of any kind for a very long period of time; and even in fracture of the patella we find surgeons suggesting and making use of methods of a very imperfect character, rather than continuing the excellent and very simple measures employed by Lord Lister. I said just now that the surgery of fractures has not progressed; I ought, instead, to have said that it has retrograded in a very marked manner, and this chiefly in consequence of the use of rigid cases which are applied soon after the receipt of the injury. The best example of these is called Croft's splint, after the distinguished surgeon who is credited with inventing it.

This method of treatment is both cheap and bad. It is cheap, since it entails less expenditure on the hospitals, the patient being sent home at once, or sooner than would have been the case if older modes of treatment were adopted; also the services of a mechanician are not required for the preparation of the splint.

It is bad, since the presence of hæmorrhage and effusion in any quantity renders it impossible to replace the fragments at once in accurate apposition, and the fixation produced by the surrounding case ensures, with more or less certainty, union of the fragments in an unsatisfactory position. In the less recent forms of surgery, when fractures of the tibia and fibula were treated by means of splints, there was more chance of there being less variation in the axes of the fragments, since, in spite of the vertical foot-piece, the foot and lower fragments often rolled outwards; and as it was the rule to leave the seat of fracture uncovered, it was constantly under observation, and any marked deformity that became obvious on the subsidence of the hæmorrhage and effusion could be diminished by manipulation. Certainly, in general hospitals, the treatment of these cases rested to some extent with the surgeon, and was not left almost entirely in the hands of his subordinates as it is at present owing to the use of the Croft or similar splint. While I believe that a certain number of fractures of the tibia and fibula occurring during or after middle life can be treated satisfactorily (I do not mean that the bones can be restored to their original form) by extension, care being taken to ensure the symmetrical rotation of the fragments, I am even more convinced than I was that in oblique fractures of both bones, especially when occurring somewhat low down, the wisest course to pursue is to cut down on the fractured ends, and by means of steel screws to retain the broken surfaces in accurate apposition, having first effected this by traction on the foot and lower fragments and by leverage exerted on the fragments by elevators, assisted with lion or sequestrum forceps.

In any case of fracture of the bones of the leg occurring in one to whom complete control of the limb is essential in order that he may earn his daily bread, when the surgeon is doubtful whether he can bring and retain the fractured surfaces in accurate apposition, he should expose the fragments, and ensure a perfect result by the simplest of mechanical means. The greatest obstacle to firm union of the bones in this procedure is extensive splintering of the ends, and this sometimes renders the operation very difficult or even impossible.

In drilling the fragments the greatest care has to be taken, and the surgeon must remember that the barrel of the screw requires the construction of a hole of larger lumen than the part cut for the thread. If on driving home the screw the resistance offered appears to be excessive, the screw should be withdrawn at once, and the hole enlarged.

The operation relieves the patient at once from the pain which results from the slightest movement of the fragments on one another, and so removes any painful spasmodic muscular contraction. It also frees him from much of the tension and discomfort due to the presence of blood and inflammatory material in the soft parts.

How surgeons can remain satisfied with the results in these cases which statistics show they now obtain appears to me inexplicable, and I feel sure that they will soon realise the utter inefficacy of the modes of treatment still in use.

Passing on to the consideration of fractures of the femur occurring at the same period of life, namely, during and after middle life, I believe that the subsequent financial capacity of the individual is often depreciated to an extent not very far below even if not in excess of that which exists in fractures of the tibia and fibula; and this would appear to be due to the incomplete recognition of the two important principles which I have called attention to in this lecture, namely, the retention of the lower fragment in a degree of rotation which is or which will subsequently become symmetrical with that of the upper, and the necessity of exercising traction till the ties in the length of the limb have reached their normal limit. Both these principles must be applied in the treatment; either alone is insufficient to obtain a satisfactory result. The physical conditions in the case of the femur lend themselves much more readily to treatment by mechanical apparatus alone than do those which exist in fractures of the tibia and fibula. In fractures of the upper two-thirds of the shaft of the femur difficulties may not infrequently be experienced, which may seem to the surgeon to be insurmountable by these simpler means; and in such cases he may with advantage expose the ends of the fragments, and fix them accurately together.

I have not investigated systematically the subsequent history of any long series of cases of fracture of the femur sustained by labourers during or after middle life, but I have examined very many who were depreciated mechanically to such an extent that they could only get about with very great pain and difficulty, and were unable to follow their original active pursuits; and it is well to remember that once these conditions have resulted, it is practically impossible to remedy them by operative interference. Action must, if possible, be taken before the fragments have united. If operative interference is attempted after union has taken place in a bad position, it often involves such considerable risk as in many cases to render the operation hardly justifiable, particularly as it is impossible after the fragments have united to reconstitute the bone in its original form, since a considerable portion of its length comprising the overlapping ends must be cut away in order to permit of the sectional surfaces of the shaft being brought into apposition. This must be borne in mind by those surgeons who imagine that a mechanical failure having resulted, it is open to them at a later date to rectify the disastrous result by operative means. They may effect an improvement, but they cannot by any means or by any operation restore the deformed bone to its perfect form, and the altering and painful joints to their original normal painless state.

Perhaps of all fractures of the lower extremity, none would seem to lend themselves more readily to or to call for operative interference than the conditions which result from sudden and forcible excessive abduction of the foot, and which are usually described as Pott's fracture, since the broken bone is of small calibre, and is placed comparatively superficially. It is also dense in structure, and can therefore hold securely the wire or other material used to retain the fragments in apposition should it be necessary to use such. In these fractures the results obtained at present under any form of treatment are, in my experience, frequently most unsatisfactory. If on the dead body one saws through the fibula in the position in which it is usually fractured, and forcibly displaces the lower fragment, it is occasionally possible, by adducting the foot, to replace the fragments more or less imperfectly in apposition. I should imagine that it was from the study of such experiments on the dissected body that the forms of splints used for their treatment were founded; though, from a consideration of the mechanics of the part, I am very doubtful indeed that any experiments have ever been carefully carried out, otherwise the present modes of treatment would have been discarded long ago. In the case of fracture in a living subject, where the displacement is considerable, the injury is often followed at once by a certain amount of hæmorrhage, and after a very short interval by considerable inflammatory effusion. I found on many occasions, on exposing the fracture, that forcible adduction of the foot not only does not serve to bring the fragments into apposition, but by traction on the bruised and inflamed peronei, and upon the skin stretched by inflammatory exudation beneath it, the displacement is, if anything, exaggerated. In other words, in a Pott's fracture in which there is a distinct displacement of the fibular fragments it is, in my experience, impossible to reconstitute that bone in its normal form by manipulation of the foot, while it may be effected with certainty through an incision two or three inches in length.

Passing to the consideration of fractures of the long bones of the upper extremity and of the clavicle, I would remind you again that these bones are more favourably placed than those of the lower extremity, since they do not transmit anything like the same amount of pressure through them. On this account a considerable amount of deformity or limitation of movement may ensue upon a fracture or fractures sustained during or after middle life, without their being accompanied as a matter of course by any marked progressive pain in the neighbouring joints. Yet in the arms mechanical changes of the "passive" type may develop occasionally to a considerable extent, and they are more marked and more depreciating to the value of the individual as a machine when the physiology, and consequently the anatomy, of the joints have been previously altered by the prolonged pursuit of a laborious occupation—such, for instance, as that of the coal-trimmer or shoemaker. Therefore we may conclude that in fractures of the upper extremity it is not a matter of such vital importance to reconstitute the fractured bone or bones in their original form as it is the leg.

In fractures of the clavicle, where there is much displacement which cannot be remedied by some appliance, and in young children where great difficulty is experienced sometimes in preventing considerable overlapping, and again in some comminuted fractures of this bone, the ends of the fragments should be exposed, drilled, and connected accurately with silver or other suitable wire. The innumerable considerable deformities which are so frequently seen in consequence of fracture of the clavicle, occurring especially in young life, appeal strongly to the surgeon, and reproach him with incompetency since he is satisfied to allow his hands to be tied by an obsolete creed rather than use his common sense in treating these conditions.

Again, in fractures of the humerus involving either epiphysis, how much good can be done by exposing the fragments, placing them in accurate apposition, and connecting them, if necessary, by wire or screw! while under the ordinary methods a permanent limitation of movement and depreciation remains, or the subject is exposed to a subsequent operation, a joint being very probably resected.

I do not suppose that my experience is singular, but I have seen a large number of cases of fracture of the long bones of the upper extremity in which there was considerable deformity, limitation of movement, loss of power, limited control over muscles and involvement of nerves, as the musculo-spiral, all of which would have been avoided by operative treatment.

It comes to this, that *very many of these conditions cannot be treated satisfactorily by methods other than operative,* however skilful, able, or experienced the surgeon; while anyone possessed of a competent knowledge of surgery and a moderate amount of manual dexterity can obtain the best possible results by operation.

It has often puzzled me how an operator who does not hesitate to mutilate the bones of a rachitic subject with the osteotome, chisel, or saw, and who readily accepts the responsibility of excising an elbow-joint which has become fixed from fracture of one of the bones forming it, should consider an operation on a simple fracture as of so much more serious a nature.

Gentlemen, I do not wish you to go away with the idea that in every case of fracture of the long bones of the limbs in which you cannot place the fragments in accurate apposition, occurring in a subject dependent for his livelihood on the more or less perfect usefulness of that limb, or in one in whom symmetry of form is a matter of the greatest importance, you are to expose the fragments and to unite them with steel screws or wire, any more than you should perform any other important surgical operation, unless you are confident, not only of your ability to do the operation skilfully, but also of the absolute cleanliness of yourself and your assistants, and that the surroundings of the patient as regards nursing, hygiene, &c., are such as would justify you in accepting what must always be a great responsibility, since failure in any of your precautions may entail on the patient loss of life or limb. If after careful consideration you are of opinion that an operation is the best course to pursue, and you are convinced that you are justified in accepting the risk of its performance, you should inform the patient fully of the various results which are likely to ensue from mechanical arrangements and from operative measures, so that he may be in a position to decide as to what choice he will make. I think you will find that in proportion as the surgeon acquires confidence in the safety of his operative procedures, begotten of a thorough knowledge and careful application of the principles of aseptic surgery, so you will see him interfering actively with increasing frequency in the treatment of simple fractures of all kinds; and the various methods by which it is attempted to reconstitute fractured bones in their original form by means of splints will, except in a small proportion of cases, fall into disuse.

TREATMENT OF SIMPLE FRACTURES BY OPERATION.

Sufficient time has elapsed since I commenced systematically in 1893 to treat by operation fractures of the long bones, in which I was unable by manipulation, splints, &c., to retain the surfaces of the fragments in accurate apposition, to make me feel that it would be of some interest to you if I reconsidered the subject in the light of the knowledge gained by such experience.

In a paper entitled "A Method of treating Simple Oblique Fractures of the Tibia and Fibula more efficiently than those in Common Use," published in the 'Transactions of the Clinical Society' for 1894, I pointed out that—

1. The results of treatment of fractures of the bones of the leg by manipulation and splinting were most unsatisfactory, since the mechanics of the limb are very considerably damaged, and the wage-earning capacity of the labourer often enormously depreciated. The extent of this depreciation varies, of course, with the degree of perfection of control of the lower limb required by the particular trade of the individual. For instance, a steeplejack or fireman would most probably have to give up his employment, while a shoemaker or tailor need experience no ill effects as regards his wage-earning capacity.

2. The results also vary greatly with the age of the individual at the time the injury was sustained. In young life considerable alteration in the mutual relationship of the axes of the fragments to one another may after a time be met by accommodation changes in the articular surfaces, and by a modified rate of growth of bone in the epiphysial line in accordance with the law I formulated, viz. *that the rate of bone formation in the several parts of an epiphysial line varies inversely with the pressure transmitted through them.*

After a certain period of life such parts of the opposing surfaces of articular cartilage which, in consequence of this alteration of the mechanism of the adjacent joints, sustain an abnormal amount of pressure, undergo the changes I have fully described under the head of pressure changes as *mechanical* or *traumatic arthritis.** These are generally regarded by pathologists as evidence of the presence of a disease called rheumatoid or osteo-arthritis.

3. That in a simple oblique fracture the chief obstacle to replacement of the fragments in accurate apposition is the *hæmorrhage into and inflammation of the soft parts, which constitute ties in the length of the limb,* with consequent approximation of their points of attachment. In compound fractures in which there is a free exit for the blood there is not the same difficulty in restoring the bone to its normal form.

4. That spasmodic muscular contraction affords a very slight and transitory obstacle to the replace-

* "Causation and Pathology of the So-called Disease Rheumatoid Arthritis, and of Senile Changes," 'Trans. Path. Soc.,' 1886; "Chronic Traumatic Arthritis," 'Lancet,' January 30th, 1892; and 'Clinical Journal,' February 12th, 1896.

ment of fragments. It, such as it is, can be measured and placed in abeyance for the time being by putting the patient under an anæsthetic.

5. That the method of splinting fractures of the lower extremities had, up to that time, been placed upon a false basis from the principles entailed in the application of the vertical foot-piece.

Later I extended my observations to the varieties of fractures which result from excessive forcible abduction of the foot, which are usually described by surgeons as Pott's fractures, and I found that these were followed by results which were, as a rule, more disastrous than almost any class of fracture of the lower extremity. On cutting down on the fragments of the fibula and exposing them freely, and attempting to restore them to their normal relationship by the methods of manipulation described as efficient for the purpose, it was at once obvious that it was impossible to reconstitute the bone in this manner, and that nothing short of the elevation of the fragments and their forcible apposition by means of forceps associated with the use of a wire suture would bring about the desired effect. Reconstitution of the fibula at once restored the foot to its normal form.

When the internal malleolus was broken off and displaced, the restoration of the fibula to its normal form by operation brought the fragments of the inner malleolus into accurate apposition, and rendered it unnecessary to connect them with wire.

If, however, the lower extremity of the tibia was not restored to its normal form by the reconstitution of the fibula, it could be readily drilled and sutured in a similar manner.

A consideration of the results of fracture of the femur, and indeed of all other long bones in the body, showed me that surgeons were mistaken when they said that they were able to bring the broken fragments into accurate apposition, and to restore the bone to its normal form, by means of manipulation and splinting.

All this I pointed out very clearly, and hoped to obtain definite scientific statements supported by some kind of evidence from those who would not accept these views.

My strongest supporter, and a very staunch one too, was Mr. Alfred Parkin, of Hull. I found that his views coincided very closely with mine. He stated them, together with some of the experiences on which they were based, in a letter to the 'Lancet,' April 21st, 1894, written in his usual clear and incisive manner. Dr. J. W. Smith also stated what he knew from personal knowledge of the disadvantages which result from the usual treatment of fractures in a letter in the same copy of the 'Lancet.'

I expected to experience opposition in two directions. I believed that many surgeons would say that the statements I had made as to the bad results obtained by the treatment of fractures by manipulation and splinting were very much exaggerated, and that they were able to succeed in restoring the broken bone to its original form, and that the mechanics of their patients and their wage-earning capacity were but slightly, if at all, affected in consequence of the accident; also that they would substantiate this by the production of the subsequent history of cases that had been under their care, and which I presumed could be obtained with little difficulty.

In order to meet this objection I made very extensive inquiries of medical men practising largely among the labouring classes, of instrument makers, of large employers of many kinds of labour, of the labourers themselves, and of those who have to do with assisting the poor both inside and outside our infirmaries. To supplement my observations by independent evidence I asked two of my house surgeons, Messrs. Steward and Beddoe, and two dressers, Messrs. Roberts and Clapton, all keen and absolutely reliable men, to see and investigate as many of these cases as they could. These gentlemen kindly did so, and furnished me with most convincing corroborative evidence. At my request Mr. Beddoe put together a number of these cases of Pott's fracture and fracture of the shaft of the femur, and published them in a very carefully written and most interesting paper in the 'Lancet,' June 1st, 1895, under the title "The Treatment of Fractures."

Mr. R. P. Rowlands, who as dresser had under his care several cases of fractures which I had treated by operation, published his views on the subject of Pott's fracture in the 'Guy's Hospital Gazette,' February 29th, 1896. He has treated the subject in a most masterly, logical, and scientific manner, and I would strongly urge you to read it. I can best illustrate the form of objection referred to above by quoting from a lecture on the modern treatment of fractures given by Mr. Marmaduke Sheild, published in the 'Clinical Journal' of May 15th, 1895, and bearing directly on this question, since I have no doubt it represents the views of most surgeons on the subject. Written carefully, chiefly with the object of contradicting the principles involved in my suggestions, it forms a good subject for our study and criticism. He took as the text for his paper the following statement, with which I concluded a lecture on the subject, and which was published in the same journal :*—" *The treatment of fractures as it exists at present is a disgrace to surgical practice.*"

I will quote freely from this very excellent paper, and ask you to follow me closely, as his statements and arguments seem to me to prove rather than negative my views on the treatment of fractures. He says, " The technical difficulties of dealing with a bad fracture are almost too numerous to mention, but I will support Mr. Lane when I fearlessly assert that the majority of students and medical men ignore the subject, or give it such scant attention that the ultimate results of fractures are too often deplorably bad. Actions for malpractice in the treatment of fractures are still too common, and a badly united broken leg, leading to lameness and deformity, is a lasting advertisement of incapacity to the surgeon who is so unfortunate as to be responsible." I do not remember ever having suggested " that the majority of students and medical men ignore the subject, or give it such scant attention that the ultimate results of fractures are too often deplorably bad ;" nor do I accept the assumption of cause and effect contained in these words as correct. And again, " If infinite pains and trouble be taken over even oblique fractures, the results are far different from what Mr. Lane would lead us to believe ; and the results of private

* 'Clinical Journal.'

practice treatment by careful surgeons would probably show, in the vast majority of cases, excellent results without any operative interference. I here speak largely from my own experience."

Now as to how this is to be effected is shown by the following extract from Mr. Marmaduke Sheild's lecture, which I quote at length in order that you may be able to formulate from a careful consideration of it some definite mechanical principles which should guide you in your treatment, which he states have proved so successful in his hands.

"I may now give a sketch of how I believe a fracture should be treated, and will take as an illustration a bad case of oblique fracture of the leg. In the first place, I long ago learned from the practice of a distinguished surgical baronet the folly of attempting at once to fix a bad fracture in accurate position. *The 'setting,' as the public persist in calling it, should be postponed until the inflammatory effusion has to some extent subsided, and the blood is beginning to be absorbed. The spasmodic contraction of muscles, so marked when they are at first irritated and partially lacerated, subsides markedly in a week or ten days.* Hence I should place the limb on a comfortable back splint, with side splints, and sling it in a Salter's cradle. The seat of fracture should be exposed, and a cold lotion, composed of spirit, lead, and water, constantly applied on strips of lint. Bullæ should be at once pricked with a fine needle. Tight splinting and rigid confinement with bandages should be avoided. In a week or ten days I should, under ether, get the fracture into good position, and this would be greatly aided by having the knee well bent, and making extension from the foot. Splinting should be most carefully carried out, pads being introduced where needful, and the limb should be inspected daily, the most scrupulous care as to application of the splints and position being observed. In a month or five weeks leather splints with straps and buckles should be applied; these must be made by a skilled instrument maker. Towards the sixth week the bones will be firmly uniting, and the limb should be daily taken out of its leather case and gently massaged. The ankle and knee should receive especial attention, being rubbed and moved; as union progresses massage and movement are executed more vigorously. It is especially important that *all movements*, as those of abduction and adduction of the foot, should be carried out. This necessitates the movement in their sheaths of the tendons round the ankle. Hot douches of sea water are also most beneficial. In bad cases massage has to be kept up for at least six weeks to two months, and I affirm very strongly that in the after treatment, which is generally quite ignored, lies largely the successful results or otherwise of bad fractures."

"Should the ankle or knee be stiff, movements under gas should be at once instituted. In a fracture near a joint, such as a bad Pott's fracture, the treatment is essentially the same, except that about the tenth day the foot is encased in a carefully applied plaster apparatus, the patient being deeply anæsthetised and the parts held in proper position by an assistant until the plaster is firm. The foot must be at right angles to the leg, and a little inverted. At the end of the fifth week leather supports are substituted, and prolonged massage insisted upon. In all fractures in the vicinity of the joints, except the hip, I have found the plaster apparatus, applied under anæsthetics after the swelling has subsided, the most advantageous. It will be noted that I have laid no stress upon the oblique foot-piece, as so strongly advocated by Mr. Lane." *

"I have had such good results with the vertical foot-pieces, taking care that the great toe, patella, and anterior superior spine are in the same line, that I see no reason to alter this method. It will be thus seen that I estimate to get a good result; and the most careful and watchful personal care of the surgeon is needed over a period of some two months or more. Besides, I would strongly maintain that much of the success obtainable is due to the mechanical skill of the surgeon, and specially to the celerity and ease of his bandaging, to his care in padding, strapping, and such like small details, of which the least is often the most important."

Though he criticises adversely the various reasons I have given which in my opinion render it necessary to operate, and though he allows that, owing to the ignorance of the subject by the majority of surgeons, the ultimate results of fractures are too often deplorably bad, he asserts that a good result can be obtained by a skilled surgeon who treats the case in a very complex manner for some two or more months. He wisely avoids any statement as to the necessity of bringing the broken ends into accurate apposition, and of restoring the bone to its original form. Allowing the statements to be true, my experience would lead me to conclude that, as there are many surgeons who possess in a high degree of development the qualities that would appear to command success

* "Fallacy of the Vertical Foot-piece," 'Brit. Med. Journ.,' 1894.

in the treatment of these fractures, their frequent failures must be due to their not taking sufficient pains for a sufficient length of time. Now if the highly accomplished few fail so constantly by the use of such methods, what can the majority hope for? A careful examination of the cases that have come under my care has unfortunately not shown that the result bore any relation whatever to the skill, dexterity, or carefulness of the surgeon.

I must leave you to decide how far, in your opinion, Mr. Sheild is justified in continuing to apply the principle, or the want of principle, involved in the use of the vertical foot-piece solely on the ground that he fancies he has obtained such good results with it, when it has been clearly shown to be mechanically false and productive of still further displacement. It is quite open to him to try to demonstrate that the statements and arguments I used are incorrect, since these observations can be readily made on the living and dead body. Should he succeed in satisfying himself and us in this manner as to the correctness of the mechanics he advocates, we would willingly consider his evidence as an argument in favour of the use of the particular apparatus; but we cannot accept his statements unless supported by intelligible arguments, and some more definite and tangible evidence than he produces.

If we wish to consider ourselves scientific surgeons, we must be guided in our practice by well-recognised mechanical principles, and not follow blindly a creed which can be proved by naked-eye evidence to be false *merely because we are imbued with the belief that it afforded us such results as in the past we were satisfied to call good.*

The word *good*, as used in this sense, is most misleading; it is really meant to imply *not absolutely bad*. It must not satisfy us now-a-days, and perfection, or the nearest approach to it, must be our goal. We must accept no compromise.

The second form in which I expected that objection would be taken to operation was on the ground that it is possible to obtain accurate apposition by means of manipulation and splinting alone. Most of those who have criticised my treatment have avoided this line of argument, and have stuck to that illustrated by Mr. Marmaduke Sheild in his paper, namely, that their particular results as regards the patient's well-being and comfort were so good that they could not be improved on by operation, without, however, affording us any scientific evidence of the truth of their statements. Mr. Christopher Heath, in a clinical lecture "On Fractures of the Lower Limb," published in the 'Lancet' of January 4th, 1896, furnishes us with an excellent illustration of this argument, which is put forward with all the knowledge and lengthy experience gained by a most able and distinguished surgeon in a large general hospital.

The following remarks are extracted from his lecture:

"I would remind you how important it is, in fractures of the leg particularly, that the fracture should be set thoroughly and accurately. Of course I know well that there are many difficulties. *Immediately after the accident all the muscles of the limb are more or less in a state of spasm, and tend, therefore, to pull the bones into abnormal positions; but that state of spasm passes off in the course of a few hours, and* *you can generally manage, with care and patience, to put the limb into a proper position; and unless that is done, and done accurately, the surgeon has not treated the case properly.* Looking at this specimen from the museum, you can see that there has been a fracture of both the tibia and fibula, and the probability is that they were broken by direct violence, because the fractures are nearly opposite one another, whereas, if the accident had occurred from indirect violence, the fracture of the fibula would have taken place higher up. I therefore think that we should be right in saying that this was a case of direct violence, causing, as you can see, very considerable displacement."

"The lower fragment of the tibia passing behind the upper fragment, union in this case has been very complete, abundance of callus having been thrown out, but the patient recovered with a shortened and deformed limb. This is just the class of case of which I was thinking when I emphasised the importance of thoroughly setting a fracture. In this case apparently there has been no thorough setting or keeping of the parts in apposition. The first thing to see to in such a case is relaxation of the muscles while extension is applied to the limb. The thigh is flexed, and an assistant should pull on the thigh in the manner shown, the lower part of the thigh being firmly clasped and held perpendicularly to the recumbent body; the leg is then flexed to a right angle with the thigh, so as to relax the muscles of the calf, and the surgeon, grasping the foot, can manipulate for fracture or dislocation. It is in this form of fracture of both bones of the leg that I would recommend you occasionally to flex the limb at the seat of fracture if you cannot get the bones into good position. This may seem a dangerous proceeding, but it is not so hazardous as one would think, though you must nevertheless be very careful to avoid making a simple fracture compound. In the average case, however, you can set the fracture in the way I have described without much trouble, and in compound fractures you can manage it with greater ease ; and, moreover, you can insert your finger and feel if the two ends are in accurate apposition. In compound fractures also you will be able to thoroughly investigate the presence of a spiculum of bone preventing accurate apposition, and no one would hesitate to push the bone out of the wound and saw off such a projecting spiculum. In cases of compound fracture where you find the moment after you have set the limb that the bones become displaced again, it would be quite within the bounds of good surgery to divide the tendo Achillis subcutaneously, or to drill the two fragments and put in pegs or screws to hold the bones together ; and I may say that this method of pegging or screwing has been recommended by an enterprising surgeon not only for compound, but also for simple fractures. *But I cannot conceive how anybody can believe that it is justifiable to convert a simple into a compound fracture ;* and of this I am quite certain, that the majority of surgeons for the present will remain content with the usual methods of treatment."

As you see, Mr. Christopher Heath has no hesitation in asserting *how important it is, in a fracture of the leg particularly, that the fracture should be set thoroughly and accurately ; and unless that is done, and done accurately, the surgeon has not treated the* *case properly.* I heartily agree as to the correctness of this teaching, but I would assert without the slightest hesitation that it cannot be brought about by manipulation in the case of simple oblique fractures of the lower extremity. Such fractures form a very large proportion of injuries to the leg. It may be done in compound fractures in which the opening in the skin and adjacent soft parts has been sufficiently large to allow of the free discharge of blood. Curiously enough, both these surgeons, as do surgeons generally, regard *the spasmodic contraction of muscles as being the important obstacle to restitution of the bone to its normal form.* This, however, would exist in at least as great a degree in compound fractures as in the simple ones. The difficulty of replacing the bones in the former is small as compared with that present in the latter. Since Mr. Christopher Heath says that "the state of spasm passes off in the course of a few hours," it can offer but a very temporary obstacle. But I have found that *the difficulty experienced in effecting reduction increases rapidly with the inflammatory changes that take place in the soft parts about the fractures.* Let us go back to Mr. Marmaduke Sheild's paper, and see what he says about it. These are his words: "Mr. Lane's second point, that the shortening is due to hæmorrhagic effusion and inflammation rather than to muscular contraction, seems to me hardly proved. *Indeed, I cannot but hold that the contrary is the case,* seeing the remarkable manner in which great shortening and deformity can be reduced under deep ether anæsthesia. This I have witnessed so often that I cannot be mistaken. Should the parts be left displaced for weeks or months until structural softening of the muscles occurs from the organisation of inflammatory material, I could then understand the immense resistance encountered by Mr. Lane; but this with ordinary careful treatment should not occur. Though muscular contraction may have been overrated in producing the deformity in fractures, I feel sure that the consideration and treatment of it in practice is of the greatest importance." If Mr. Sheild does not consider that hæmorrhagic effusion and inflammation are the forces opposing restitution of the fragments, why does he postpone the "setting" until the inflammatory effusion has to some extent subsided, and the blood is beginning to be absorbed? It seems to me that what success he has obtained is due to an unconscious recognition of what I have clearly demonstrated. These two gentlemen appear to have very different views about the manner in which the same cause acts. They both assert that spasmodic muscular contraction is the important obstacle to reconstitution of the fractured bone. How does this knowledge guide them in their treatment? Mr. Christopher Heath considers that "this spasmodic muscular contraction passes off in a few hours," and presumably he postpones placing the fragments in accurate apposition till such time has elapsed, and then does it, as he supposes, effectually and at once.

Mr. Marmaduke Sheild states that "the spasmodic contraction of muscles subsides markedly in a week or ten days," when he proceeds "to get the fracture into good position." It would appear, however, that in his cases some factor exerts an influence considerably beyond this period from the constant attention he found the fractures required. Now this factor is undoubtedly extravasation of blood and its consequences.

In order to accentuate still further the remarkable divergence of opinion that exists among surgeons as to the period and manner in which the "setting" should be effected, I have extracted the following from an address on the treatment of fractures by Mr. Pearce Gould, published in the 'Lancet,' June 12th, 1897:

"*Having arrived at a full and correct diagnosis, the next point to attend to is to reduce the fragments at once, at the earliest possible moment, remembering that lapse of time always increases the difficulties in doing this, never lessens them, and even makes them insuperable. This reduction of the fragments must be complete or perfect at once; we must not rest in any halfway house, content with improvement to-day in the hope of still further correction to-morrow.*"

Also, "*The causes of this displacement [of the fragments] are either the fracturing force, the action of gravity, or the pull of muscles.*" These three factors would appear to constitute the "difficulties" previously referred to, but how they are exaggerated by delay is not very clearly stated. In reference to the period of setting, contrast this, for instance, with Mr. Marmaduke Sheild's very positive statement as to "*the folly of attempting at once to fix a bad fracture in accurate position,*" a form of practice he learnt from a distinguished surgical baronet. These diametrically antagonistic views make one long for definite arguments and scientific facts in support of them which could be met in a logical manner. I have merely called your attention to these statements to show that while surgeons hold very similar views as to the mechanical factors that oppose the reduction and retention of the fragments of a broken bone in accurate apposition, yet they would appear to obtain equally good—in fact, if one can interpret their language according to its usually accepted signification, perfect results by methods which to the ordinary mind are mechanically absolutely antagonistic both in practice and in principle.

I can quite understand the position of a surgeon at the present day who would argue in something like the following manner :

"I am perfectly aware that, except under special circumstances, we have never been able, and can never hope to be able to restore the displaced fragments of a bone broken obliquely to its original form, as we imagined, or pretended to imagine we did. At the same time, although the fragments unite in such a manner that their axes form angles with one another, and although there is a variable and often considerable amount of shortening and deformity, yet in the young subject these do not generally prevent the sufferer obtaining in time a very useful limb, and after middle life patients in easy circumstances do not often suffer more than a moderate amount of pain and inconvenience. I must candidly acknowledge that inquiries made among the working classes show that the results of fracture, especially after middle life, are too often very disastrous to the wage-earning capacity of the individual, such depreciation varying directly with the necessity of a perfect performance of the functions of the damaged part to the particular labour in which he is engaged. On the other hand, I am of opinion that if all those who now readily accept the responsibility of treating fractures by manipulation and splints were to attempt to restore these broken bones to their normal form by operative measures, the risk to life and limb would, taken as a whole, be much greater than it is at the present time."

All this I would willingly admit. But I do not understand the position of the surgeon who still asserts that he is able by manipulation and splints to restore bones to their original form, and does not support his statements by facts when such statements are called in question.

Personally, I do not think that the spasmodic contraction of muscles exerts any appreciable influence whatever, and that it may be left out of consideration in our treatment. One has only to expose the displaced fragments in a case of fracture of the tibia and fibula when the patient is deeply under an anæsthetic, and when, therefore, all spasmodic contraction may be assumed to be absent, and to endeavour by traction, elevation, and forceps to bring the broken surfaces into accurate apposition, in order to recognise that there is some other very powerful force which opposes such replacement, and requires to be met by a corresponding opposing force. This force bears a direct proportion to the extravasation and inflammation present.

I have nothing to add to what I have already said as to the causation and treatment of fractures, and especially of those of the lower extremity.* My more extended experience has served to prove still more thoroughly the correctness of the attitude I took up as to the wisdom and safety of operative interference.

* "Some Remarks on the Treatment of Fractures," 'Brit. Med. Journ.,' April 20th, 1895; "Clinical Lecture on Fractures," 'Guy's Hospital Gazette,' July 20th, 1895.

Perhaps a few hints of the details of treatment of several forms of fracture may be of service to you. Elevators, sequestrum, and lion forceps, combined with tractors for manipulation, will be found the most suitable and effective means for bringing the

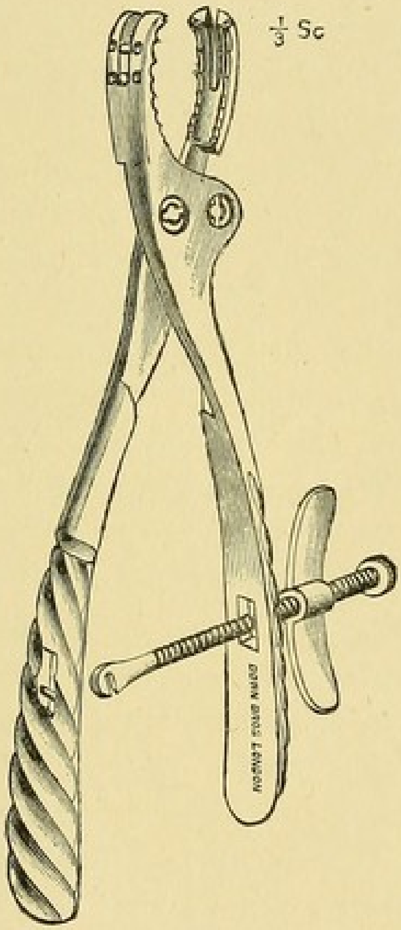


Fig. 107.

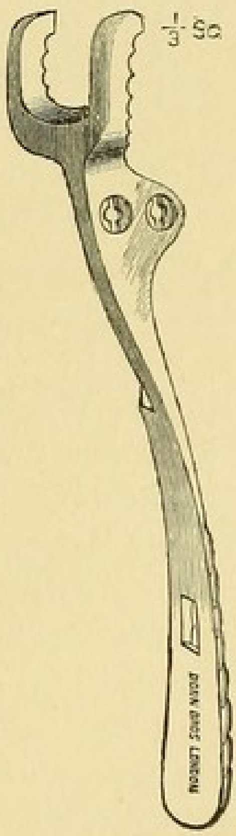


Fig. 108.

fragments into accurate apposition, and for retaining them there till you have connected the bones. A modification of the ordinary lion forceps has been devised by Mr. Peters (Figs. 107 and 108). It is of such a form that holes may be drilled through the blades in almost any direction, obviating the difficulty one so often experiences of finding a suitable place other than that beneath the blades of the forceps, where the bone can be perforated by the drill, and through which the screw or wire can be passed to the best advantage. In fractures of both bones it is hardly ever necessary to expose the fibular fragment, as the ends of that bone usually come into position when the tibia has been restored to its normal form. If they do not come into perfect apposition it is not a matter of very great importance if the fracture is situated in the upper half of this bone, since the mechanics of the ankle-joint are not appreciably altered by a slight variation in the axis of the fragments so high up in the shaft. If, however, the fibula be fractured in its lower fourth, and its continuity is not established when the tibia is reconstituted, the surgeon should cut down upon it also.

The direction of the fracture through the tibia varies very definitely with the mode in which it is produced. When it results from indirect violence it is very oblique, each fragment usually presenting a V-*shaped extremity, which must be made to enter and fit accurately a corresponding angular interval in the opposing fragment* (this condition is represented in Fig. 109). We are asked to believe that this can be effected by various manipulations on one occasion by some surgeons, or by a remarkable combination of methods of a suspiciously ill-defined character extending over a long period of time by others. Those who operate in these cases will find that to secure such accurate coaptation of surfaces as will restore these bones to their normal form will very often make quite as great a demand on the skill of the surgeon as any operation in surgery, and I believe that the difficulty which is frequently experienced is so great that it will prevent operative interference in this particular form of fracture from coming into very general use. *When produced by direct violence, fractures present very different characters, being very much less oblique and often quite transverse in direction* (this condition is represented in Fig. 110). They are, unless comminuted, usually much easier to reduce when the ends of the fragments are exposed, but without operative measures it is almost always impossible to reconstitute, providing the fracture be *simple*, if the fragments overlap, owing to the greater amount of hæmorrhage and laceration of the small parts which are associated with this form of violence. If, as happens, the patient comes under the care of the surgeon *immediately* after the receipt of the injury, before blood has been effused into the soft parts, the most important obstacle to reduction is absent, and the bones may occasionally be at once restored to their normal form. If the fracture is *compound*, and blood has escaped freely from the wound, the same difficulty need not be experienced. The incision I find most generally useful is one along the anterior margin of the tibia, supplemented by a transverse one running backwards from its centre, and crossing the fracture about the middle. By means of this both the inner and outer aspects of the tibia can be seen sufficiently to enable the surgeon to get at them with his instruments. You will find that the lower fragment of the tibia is almost always displaced upwards, outwards, and backwards behind the upper. Having got the surfaces into accurate

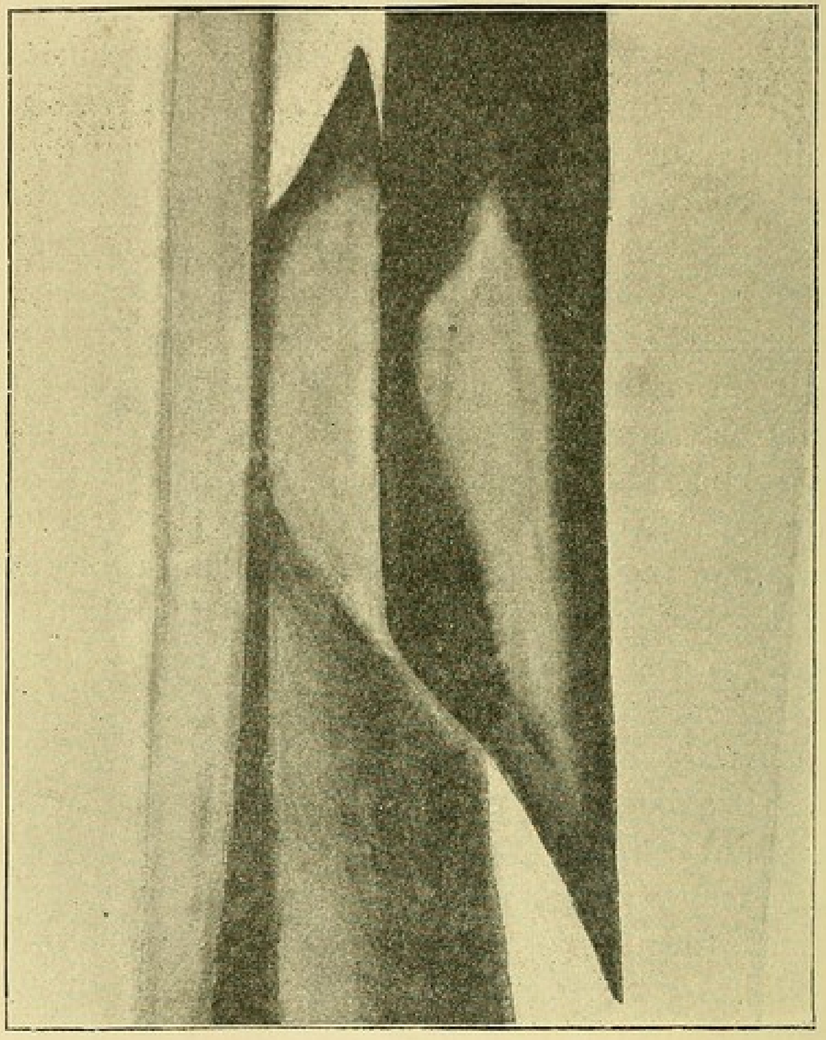


Fig. 109 is a skiagram made for me by Messrs. Watson and Sons, of High Holborn, and shows very well the spike-like extremities of the fragments, and the angular intervals in which they must be returned. The bones were placed in as good position as was possible, and were fastened securely on a splint. A careful study of this fracture will serve to convince one not only of the impossibility of restoring the bone to its normal form by manipulation and splints, but also of the *great difficulty* which is frequently experienced in doing so when the fragments are freely exposed by an operation. These fractures are practically *spiral.*

apposition, the surgeon must consider whether he can retain them best by screws or by wire. The wire is of virgin silver heated to a red heat, so that it is softened and can be bent more abruptly than the original wire. In this manner separation of surfaces due to the presence of a curve in the wire is avoided as much as possible. The screws I use are the ordinary carpenter's wood screws, as they are called. Their heads may be altered to remove the sharp prominent margin, and the screw silver-plated to prevent rusting Corresponding to the several sizes of screws are drills, rimers, counter-sinks, and screw-drivers, which are fitted to a universal handle. I used to use screws, drills, and rimers in two gauges only, but I now prefer those just described.

It should not be necessary for me to call attention to the importance of riming the aperture in the proximal plane of compact tissue carefully to avoid splitting of the bone, and consequent loss of approximating power, resulting from a lack of support at the point from which the head takes its bearing, except that I find many are unaware of this simple fact. Except in skilled hands it is safer to use wire than a screw in these fractures of the tibia, for the reason that unless the greatest care is taken in using a drill of suitable size, and in riming the proximal layer of compact tissue to fit the barrel of the particular screw, fissuring of the fragments may result. It would seem advisable, before the surgeon uses a screw for this purpose on the living subject, that he should make himself thoroughly familiar with its mechanics, and with its mode of application in the recent bone. In some cases the fragments are found to be fissured or comminuted, and in such application of the screw is often very difficult. The surgeon must remember that the screw is by far the best means by which the surfaces can be retained accurately and immovably in apposition; and that if there is a very great tendency to separation of the fragments he must make use of it if possible, either alone or in combination with wire. If he cannot use a screw, or if once apposition has been secured, there is little or no tendency to displacement owing to accuracy of fit, he should employ wire. The surgeon must not expect that any of what goes by the name of *callus* will form about the fracture of a bone treated successfully in this manner. It is not deposited about the broken ends when the bone is restored to its normal form, and the fractured surfaces are retained in firm and accurate apposition. The presence of callus indicates imperfect apposition or a want of complete fixation—both evidences of an unsatisfactory surgery. It is very useful in the savage and in the lower animal, but is a disadvantage in members of a civilised community, since it can only exist with unskilled work. Therefore, as far as we are concerned, *callus is a thing of the past* in the large majority of simple fractures treated scientifically.

I have made no reference to what is called "pegging" of fragments, as I know no circumstances under which such an unsatisfactory method can be applicable. It is evident that an ivory peg can have no approximating capacity, and very little ability to retain surfaces in apposition if there exists any force tending to separate them.

In the group of injuries comprised under the term

Pott's fractures the surgeon will find that unless the fracture runs through the attachment of the interosseous ligament the lower fragment cannot be materially influenced by such movements of adduction of the foot as are made use of for the purpose by surgeons generally, and the broken surfaces certainly cannot be brought into apposition by them. The fragments should be freely exposed, and by means of elevators and sequestrum forceps the surfaces are brought firmly and accurately together. The opposition to effecting this varies considerably with the length of the fracture, since the longer the fracture the more tedious the process of coaptation, though the reverse applies to the difficulty of retaining them once apposition is established. As in fractures elsewhere the difficulty is increased by time. In a case in which an interval of sixteen days had elapsed since the injury, I experienced very great resistance in bringing the fragments together. Screws are very rarely required for this form of fracture, since, the tibia being intact, the tension of the ties in the length of the bone is inconsiderable, so that there exists comparatively little force tending to produce overlapping of the fragments. The condition of the ends of the bone must determine the surgeon as to whether he perforates the fragments or encircles them with wire, or adopts both these measures. If the inner malleolus also be broken transversely its surfaces usually come into accurate apposition when the fibula is restored to its normal form. Any doubt on this point should be removed by wiring it on to the tibia. Sometimes the fracture traverses the base of the malleolus, a portion of the inferior articular surface of the tibia being included in this fragment. In such cases it is almost always necessary to cut down on the fracture, in order to restore the fragments to their normal position if they are displaced. Whether in this case a screw or wire will serve the purpose of the surgeon best must depend on the mobility of the fragments and the character of the fracture.

In fracture of the femur the surgeon must be guided by the same mechanical principles as in the case of the fractures of the tibia and fibula.

There is one form of fracture for which a screw is alone suitable, and that is a fracture of the olecranon. Here a screw driven into the base of this process secures perfect apposition, and restores to the joint its normal functions. Care must be taken to embed the head of the screw, otherwise it may have to be removed months afterwards. This can, however, be effected through an incision whose length equals the diameter of the head of the screw. I have not found it possible to secure perfect apposition of these fragments by wire. In fractures of the clavicle, acromion, radius, and ulna, wire affords an efficient means. I have not operated on a simple fracture of the humerus, but in the case of ununited fractures I have succeeded in obtaining bony union by means of the screw when others had failed with wire on more than one occasion. This is due to the difficulty of preventing movement of the ends of this bone on one another by means of wire when the fracture is nearly transverse. It is probable that the screw would do best for this bone. For fractures of the lower jaw, which are almost always compound, I have usually used wire, but have on several occasions found a screw of service when wire had failed.

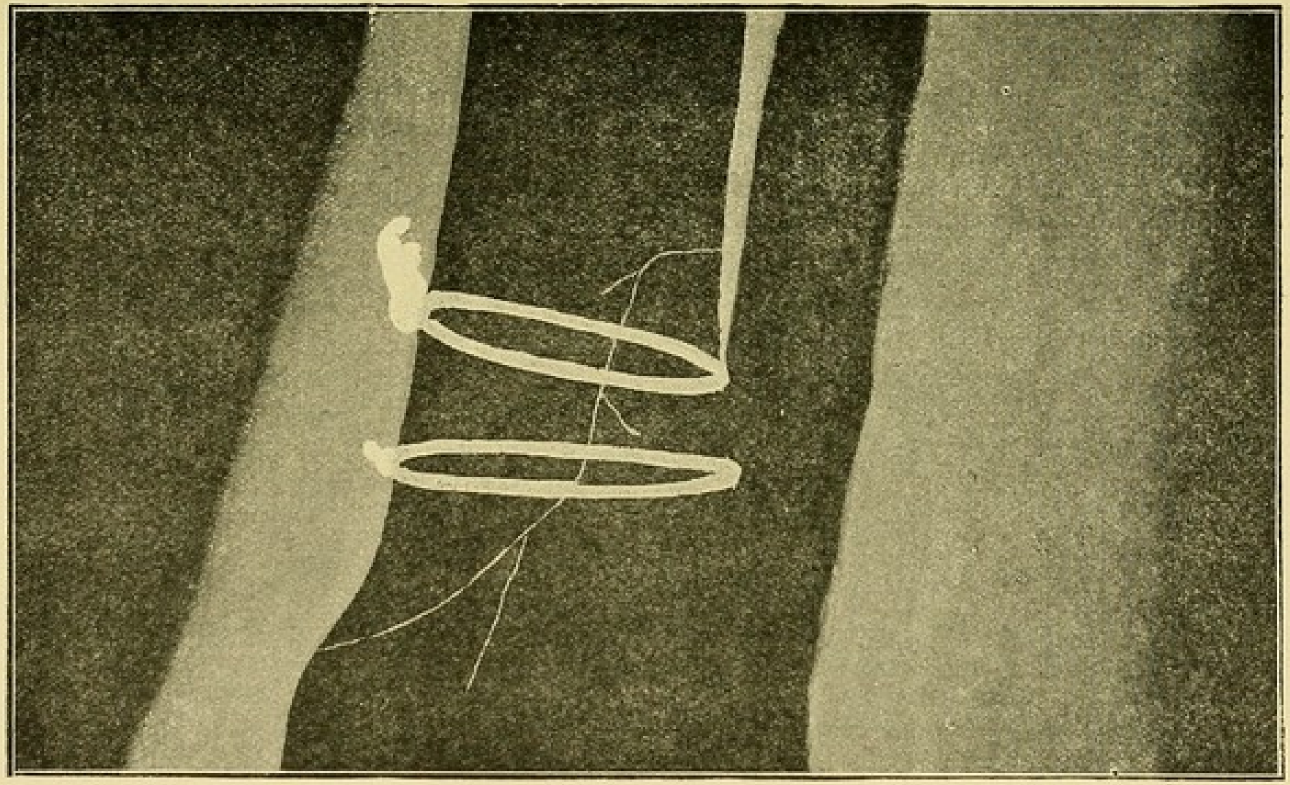


Fig. 110 represents a recent oblique fracture through the tibia, produced by direct violence. There was considerable displacement of the fragments upon one another; but when the broken surfaces were brought into accurate apposition, their irregularities opposed upward displacement, and rendered it possible to connect them securely with a couple of silver wires. In such a fracture as is represented in Fig. 109, owing to the strain exerted by the ties in the length of the limb, and the absence of any irregularity of the outline of the margins of the fragments, the use of the screw for forcible and accurate apposition of fragments and their subsequent retention is as a rule absolutely necessary.

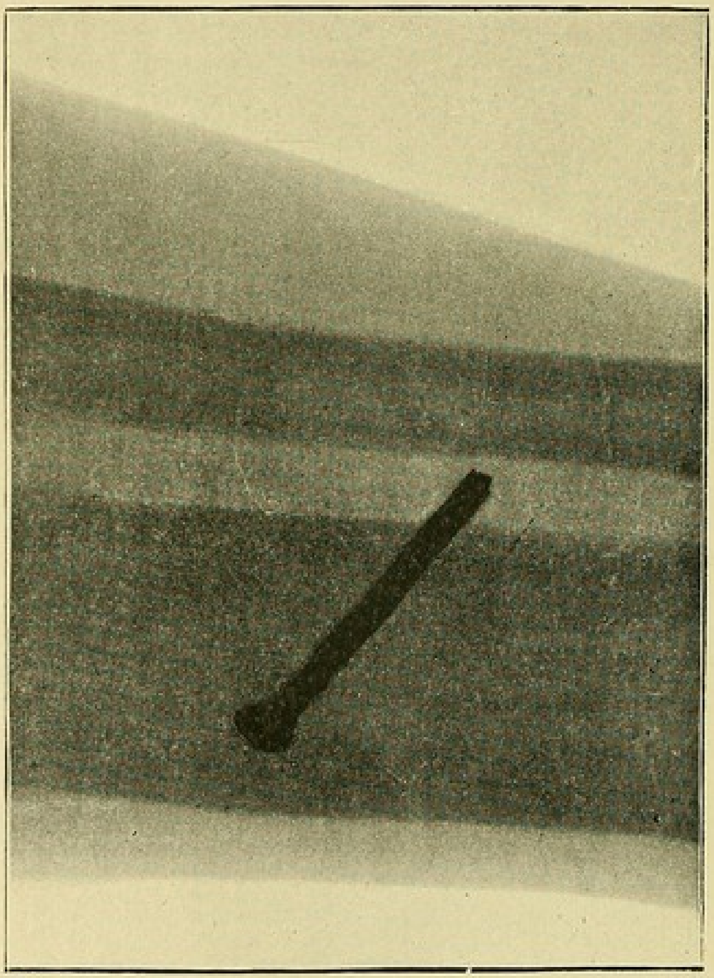


Fig. 111 represents a very oblique or practically spiral fracture of the tibia, and presumably an equally oblique fracture of the fibula at a higher level, resulting from indirect violence. The patient was a coal-heaver, and the injury was sustained more than two years ago. The tibial fragments were got into accurate apposition, and were retained there by means of the screw which is represented in position. Although it has been there for so long it shows no obvious change. He has suffered no pain or discomfort whatever, and he carries his load of two hundredweight as well as ever.

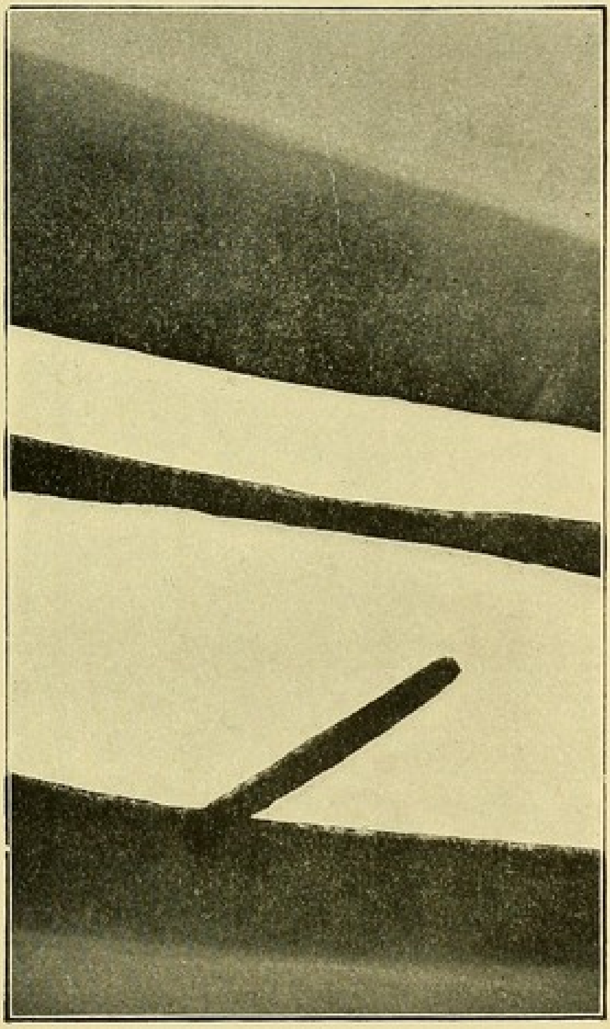


Fig. 112 was a similar case that was operated on about the same time as the preceding, and gave me great trouble in effecting perfect apposition.

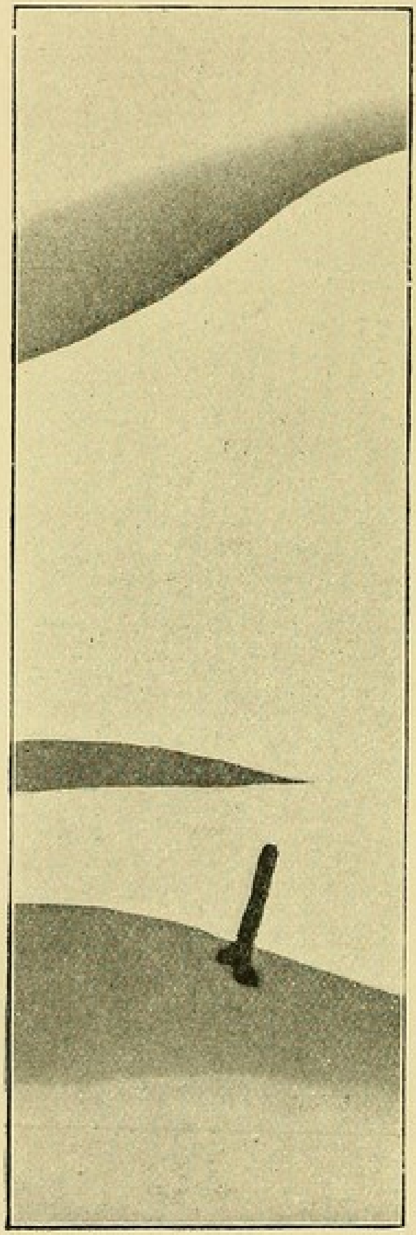


Fig. 113 shows a case of Pott's fracture in which the fibula was restored to its normal form, the fragments being secured firmly by silver wire.

This was particularly the case when the operation was done for non-union some weeks after the fracture had been sustained. This is due to the body of the bone softening at the seat of fracture, and then readily breaking or crumbling when perforated with the drill. In cases of fracture through the epiphysial line in which it is not possible by manipulation to restore the fragment to its normal position, and to retain it there, it is necessary for the surgeon to interfere promptly if he desires to do so at all. In some situations the fragment can often be replaced and retained in position with ease, as, for instance, in fracture through the lower epiphysial line of the femur; but in others, as in separation of the head of the femur in the young subject, it is probable that the head could not be restored to and retained in its normal position.

The reason that action must be taken without delay is that *in fractures through a growing line the efforts at repair are extremely active, and very soon render it difficult, if not impossible, to separate the fragments from one another and to fit them accurately together.* I have never had an opportunity of treating this fracture of the neck within a sufficiently short period of its occurrence to have been able to separate the head from the neck, but if I had I would fix it accurately in position by means of a screw. I have cut down upon many of these cases with the object of detaching the head and restoring the bone to its original form, but have not succeeded in doing so. I have, however, improved the condition considerably in two ways. One is by chiselling off any projecting portion of the neck should it interfere with flexion by impinging against the ilium. The other is by the removal of the outward rotation of the thigh, which is sometimes its most incapacitating and deforming feature. This rotation is clearly dependent upon a shortening up of the interval between the attachments of the ilio-femoral ligament consequent upon the fracture. When I have found it a very marked feature I have removed it altogether by shortening up the ligament by the introduction of stout silver wire loops till the degree of rotation of the limbs equals on both sides. This can be readily measured by the angle formed by the inner margins of the feet when the patient occupies the supine posture.

By these means the most objectionable complications of this fracture are removed and the normal functions of the joint are restored as far as possible. In simple fractures I always try and keep any loose fragments, fixing them securely and carefully into position. I feel that I cannot condemn too strongly the mutilation of the fragments suggested by Mr. Christopher Heath when he says, "In compound fractures also you will be able to thoroughly investigate the presence of a spiculum of bone preventing accurate apposition, and no one would hesitate to push the bone out of the wound and saw off such a projecting spiculum." It has been my misfortune to have seen this advice followed, to the very serious detriment of the patient. The fracture should be freely exposed, and the spiculum placed accurately in its corresponding recess in the other fragment and retained there.

In operations for ununited fractures the use of the screw is absolutely essential in securing forcible and accurate apposition of bony surfaces, and in retaining them immovably on one another. I need

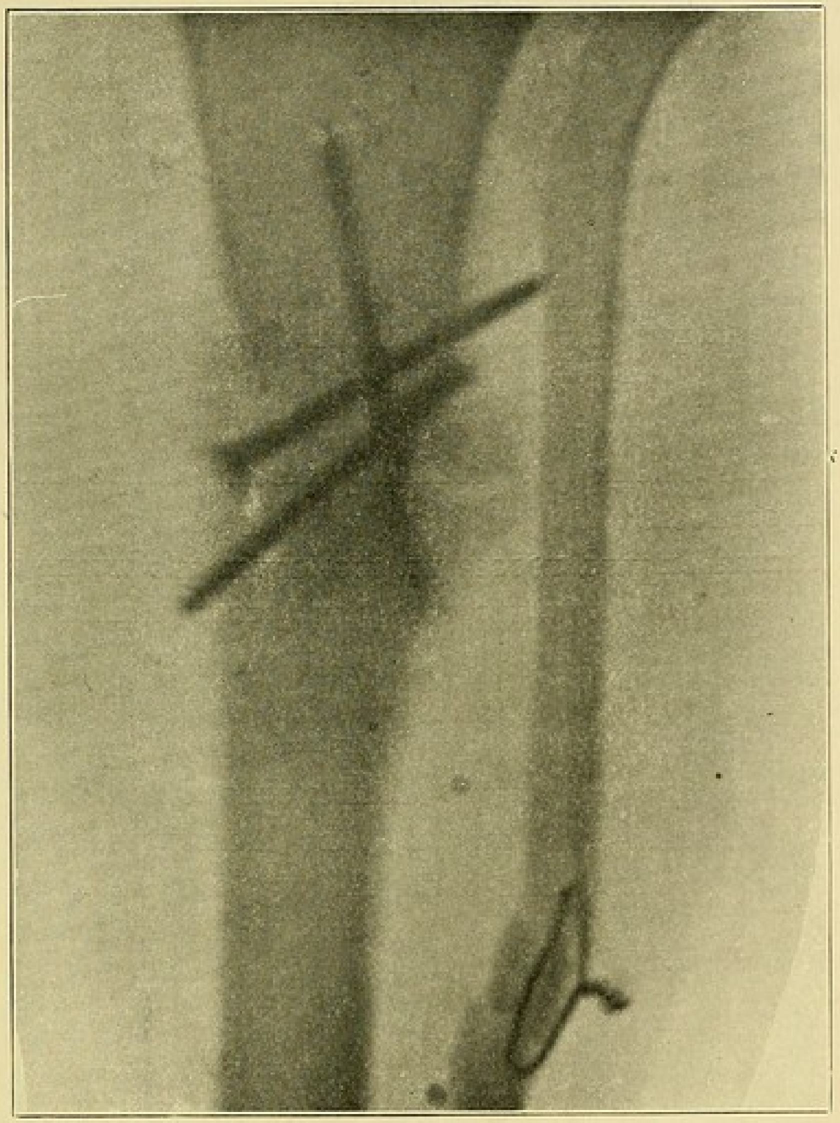


Fig. 114, which represents a radiograph taken for me by Messrs. W. Watson and Sons, is an excellent illustration of the result of the operative procedure in such a fracture. The man had broken his leg more than a year before. At the time he came under my care the fragments moved freely on one another on an axis at right angles to the plane of the fracture, which was very oblique in direction, and the patient was altogether unable to bear his weight on the limb. In this case it was necessary to use three long steel screws passed in different directions in order to secure perfect apposition and complete immobility of the fragments. Two loops of silver wire were found lying loose in the bone, and afforded the only evidence of a previous operation. A little too much of the fibula was removed, and, as is seen in the illustration, a portion of it was replaced. The radiograph was taken about three months after the operation, the result of which was perfect, the patient being able to bear his weight securely on the damaged leg.

hardly insist on the absolute necessity of doing this if a successful result is to be obtained. Such fractures often offer great difficulties to the surgeon.

Now as to the treatment of separate pieces of bone in a comminuted simple fracture, or of a fracture in which one of the fragments is very small. There can, I think, be no doubt as to the advisability of placing the fragments in apposition and securing them there in most cases.

Fig. 110 represents a comminuted fracture of the tibia in which there was considerable displacement of fragments. The fibular fracture, which was higher up, is not shown in this radiograph. The outline of the several fragments is indicated clearly in the illustration.

As a rule, small fragments are best restored when the two portions of the shaft have been fastened together. In some cases, however, it is necessary to attach the small pieces to one or to both extremities of the shaft before they themselves can be connected together. How best to retain them in their proper position must vary largely with their form and texture, as well as with the forces tending to displace them.

They may (as in Fig. 110) be perforated and sewn to adjacent bone by silver wire, or they may be retained in position by a wire which encircles them and the shaft, or the forcible approximation which is afforded by screw pressure may be requisite. Again, at other times a combination of these may be necessary to serve the purpose.

I have not as yet found it necessary to introduce bone obtained from other sources than the patient into a recent fracture, but have used it with the greatest advantage in ununited fractures which could not have been treated without it. The following case, though not one of fracture, illustrates very well the advantages which such a bony support would afford :

A child had suffered from birth from a progressive deformity, with loss of power of the forearm, apparently consequent on an undeveloped condition of the ulna. This bone consisted (see Fig. 115) of two parts, which were not continuous in direction with one another. The ulna was in consequence shorter than the radius, the head of which was being displaced outwards and upwards, while its lower extremity projected beyond the ulna to an abnormal amount. I cut down on the shaft of the ulna, freed the fragments for a considerable distance, and brought their axes into continuity with one another. By exerting traction on them I was enabled to lengthen the bone to what appeared to be its normal extent. In order to retain the fragments in this position a rabbit's femur was split in two and laced with wire to the fragments. The whole arm was then fixed immovably.

Fig. 116 represents the condition of the parts several months afterwards. It requires no explanation. The advantages which the patient gained from this operation were very considerable, both in the functional capacity and appearance of the part, the parents being delighted with the result.

It is easy to see, therefore, that in the event of considerable comminution of such a bone as the ulna, radius, or fibula, the additional security which the use of such bony supports can afford may make all the difference between a good and a bad result.

Fig. 117 represents the radiograph of a case very similar in character to the last. It was taken many months after the operation. The shaft of the ulna

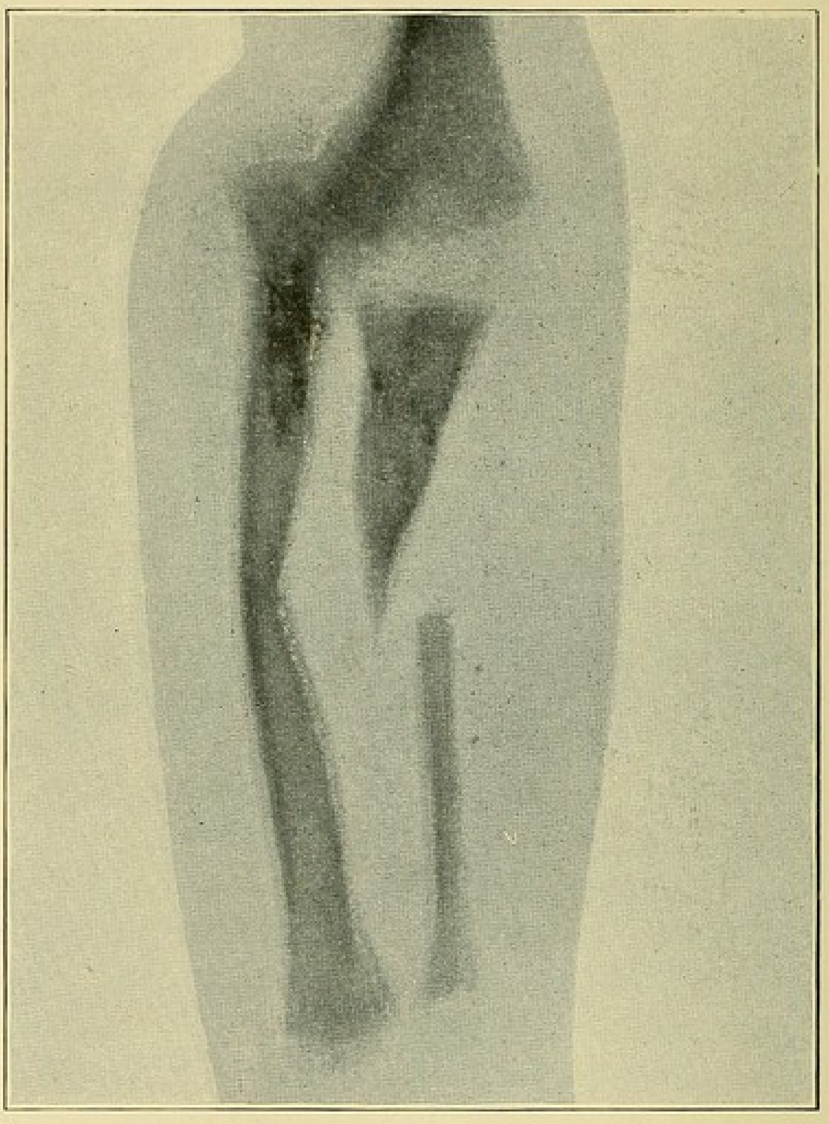


Fig. 115. Before operation.

had necrosed in consequence of an acute infective process. Though every means was employed to obtain a sheath of callus in its place by the introduction of a glass rod, and later of decalcified cancellous tissue, the fragments ended in two delicate spikes of bone separated by a considerable interval. The femur of a large rabbit was intro-

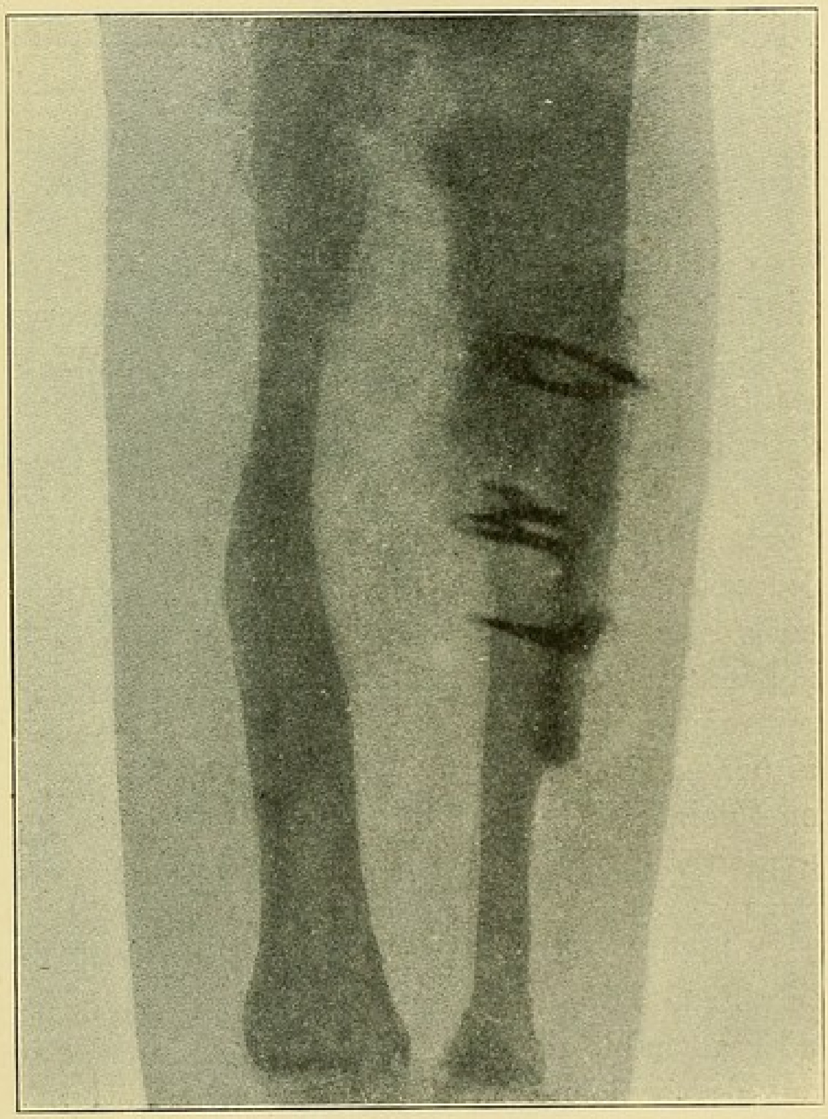


Fig. 116. After operation.

duced and fixed in position by loops of silver wire, its extremities having been filed down to fit the surfaces of bone to which they were attached. An excellent result was obtained, and the whole shaft of the ulna is now firm, strong, and efficient.

I would impress on you the necessity of fixing such bones *sufficiently firmly to prevent any movement in order to ensure their living.* Then I determined to go a step further, and introduce an articulation. This I did not long since, when I resected an ankylosed elbow-joint and put in its stead the radio-carpal and metacarpal joints of a sheep. This animal was killed in the immediate vicinity of the hospital, and the part came into my hands a minute after its death. Every precaution was taken against infection of the wound. The opposing surfaces of the sheep's and of the human bones were fastened together as securely as possible by means of screws and loops of silver wire, when the new elbow-joint permitted of a range of movement around a transverse axis which was quite as extensive as in the normal arm. After the bone had been in position for about ten days some suspicion arose as to whether the wound, which was quite healed, was sterile; consequently it was opened at one point, and some of the fluid which escaped was cultivated. This was found to contain *Staphylococcus aureus.* Fearing to expose my patient to any avoidable risk I exposed the bone, which was clearly dead. It was removed at once. There can be no reasonable doubt that the infection took place through some loophole in our precautions, and I can see no reason why the operation should not succeed if we render our precautions against infection more perfect.

In one case of fracture-dislocation of the spine I employed wire to retain the bodies of the vertebræ

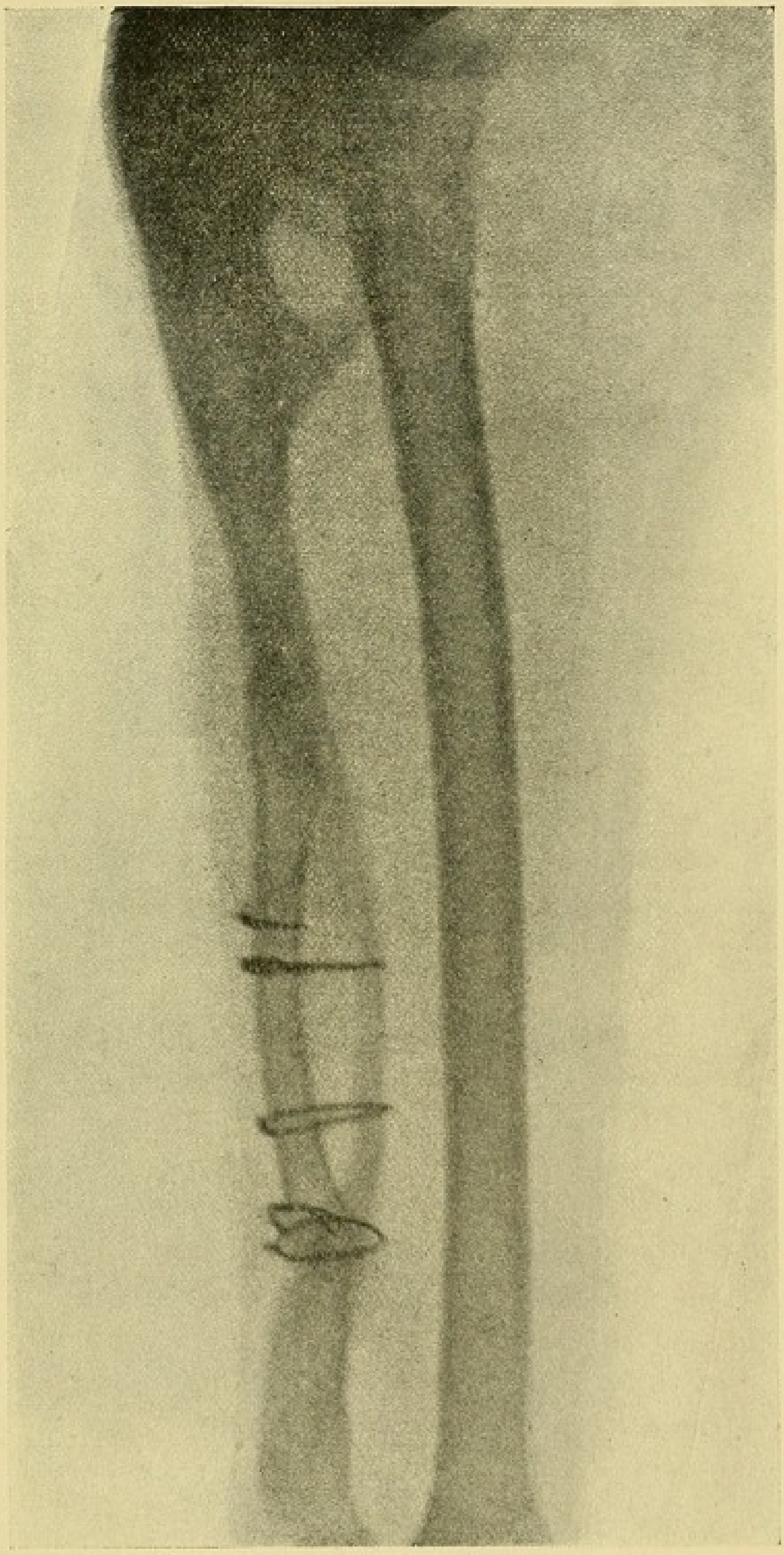


Fig. 117.

in their normal position, having reduced the dislocation.* The wire was passed round the adjacent spinous process, and this succeeded for a time, but the wound having become foul owing to some carelessness, the wire got loose and ceased to serve its purpose. In another case of this sort I should perforate the bases of the spinous processes to prevent the possibility of the wire slipping.

If there is any suspicion that the patient is alcoholic I postpone operating till an interval of three or four days has elapsed since the receipt of the injury. This is done to obviate the splintering and damaging of fragments that would probably ensue in broken bones wired or screwed together from the struggles of the patient should he be affected by delirium tremens. I think you will agree with me that from the surgeon's standpoint this precaution is a wise one, especially among hospital patients, whose injuries are too often brought about by alcohol.

Risk of infection of the wound in competent hands is small, while the benefit which the patient derives from the operation is enormous. Even if the wound does become infected, it may be necessary to remove the screw or wire, perhaps even with a small sequestrum, after they have served the purpose of retaining the fragments in apposition for a length of time sufficient to allow of their union. This happened to me in a very difficult case of fracture of the tibia and fibula; the patient, however, recovering with a perfectly useful limb.

It seems to me quite time that surgeons should

* "Fracture (Dislocation) of Spine; Reduction; Temporary Recovery," 'Lancet,' September 17th, 1892.

throw off their prejudices, and let their actions be guided by facts and reason instead of by tradition and superstition. If they are still under the impression that the statements and teaching of the present day are correct, they have ready at hand the cases they themselves have treated. These can be skiagraphed, and reliable evidence obtained both as to their condition and as to the mechanical well-being of the patient. Let them supplement their arguments and statements by the production of their own cases, and I shall always be pleased to place those I have operated on at the disposal of any one who is sufficiently interested. In this way we shall be more likely to arrive at the truth than by any amount of discussion. It is a curious thing that while a surgeon possessing any confidence in his methods will not hesitate to lay open the joint in the case of fracture of the patella, remove the blood effused, and bring the surfaces of the bone into accurate apposition by means of wire, yet the same man would entail great pain, distress, and financial depreciation on the unfortunate patient affected by the so-called Pott's fracture, because *he says it is unjustifiable to convert a simple fracture into what he incorrectly calls a compound one.* Why is this? The answer is an easy one. It is merely an example of the unreasoning imitative capacity of the human animal, which we inherit from our simian ancestors. Certainly, in my own experience, the depreciation resulting from Pott's fracture is usually much greater than that following a fracture of the patella treated by splints. Personally, I should have imagined that of all simple fractures the operative treatment of that of the patella is accompanied with more risk to life and limb than that of any other bone in the body.

Judging from the popularity of all kinds of unsatisfactory and unscientific compromises, undertaken with the intention of not exposing the joint in fracture of the patella, I am convinced that accidents are constantly happening owing to some want of precaution somewhere. These imperfect methods can only be suggested by "caution," which is often synonymous with "fear," gained by experience in the school of adversity.

The surgeon is, however, only too ready to attempt by means of operation to improve the mechanical condition of patients who have suffered from his want of energy, knowledge, and skill.

Take, for instance, the limited movements or the ankylosis of the elbow-joint which results so often from fracture about the lower epiphysis of the humerus in the young subject. To give such a patient a movable joint the surgeon does not hesitate to cut away large portions of the humerus, ulna, and radius, to expose the patient to considerable risk, and to the endurance of great pain for many weeks, in the hope of obtaining, after a considerable period of time, an arm much shorter than its fellow and as a mechanical arrangement almost invariably vastly inferior to it. Can anything be more brutal, illogical, and unscientific than all this? Fortunately, skiagraphy has placed in our hands, and in those of our patients, a means of determining the condition of parts at the time the injury is sustained, so that the surgeon has no longer any excuse for deluding himself into the belief that he has replaced the damaged structures in their normal position. In this particular fracture the bone *must* be restored to its original form if the elbow-joint is to perform its functions in a normal manner. To attack a difficult fracture of one or more bones may make a certain demand on the confidence of the operator in his manual dexterity and in his capacity to ensure asepsis, not only in himself,—a comparatively easy task,—but also in those who assist him. It is, however, no more than is called for in other important operations in which the skin is intact previous to the incision.

The difficulty experienced by those operating for the first time is that the method is a comparatively new one to the profession, and an accidental infection of the wound, which in other every-day operations might call for no comment, would do so in this case. A little familiarity with the procedure will, however, serve to remove this. The public will in future exert a powerful influence on the treatment of fractures. Curiously enough they, in common with the majority of the profession, share the belief that it is the duty of the surgeon to restore the broken bone to its original form, and in one way and another they have acquired a general knowledge of the form of bones. I feel sure that the law courts, aided by the skiagraph, will stimulate our action in this matter, obliging us to do our work efficiently and scientifically, as we are able to do with the abundant means at our disposal, and to discard our present methods, whose only claim to perpetuation is their extreme antiquity. It is now quite time they died a natural death.

Fractures produced by force acting through the Clavicle and Femur.

The following remarks refer to the causation and treatment of injuries produced by the leverage action of the clavicle and femur.

In short papers in the 'Transactions of the Pathological Society' for 1884 and 1885, entitled "One Mode of Fracture of the Sternum" and "Mode of Fracture of the First Rib alone," and more fully in a contribution to the 'Guy's Hospital Reports' for 1885, dealing with "The Changes produced by Pressure in the Skeleton of the Trunk and Shoulder Girdle," I explained clearly the mechanics of the shoulder girdle, and showed the manner in which the weight of the arm is transmitted through the clavicle, costal arches, and sternum to the spinal column, together with the way in which the sternum and costal arches can be fractured by an excessive force applied to the outer extremity of the clavicle through the leverage action exerted by it.

At that time the matter had received no attention whatever from anatomists as far as I was able to learn, and the surgeon was entirely unaware of the existence of fracture of the first rib alone, quite apart from possessing any knowledge of the mechanics of its production. Indeed, he went so far as to assert that "fracture of the first rib does not occur, *because it is sheltered by the clavicle.*" I demonstrated experimentally in the dead body that the first rib could be broken at any point in its length by the application of force to the outer extremity of the clavicle in a definite direction, varying from a directly downward one to one backwards and slightly downwards, and proved, both by instances of this fracture found after death as well as during lifetime, that it is an accident of comparatively common occurrence. It escaped notice because the shoulder girdle had no physiology in the text-books, and the surgeon therefore did not know that the clavicle exerted any leverage action on the costal arches. Curiously enough, the reverse of the teaching of the time is true, for the very reason given, namely, "the first rib is frequently broken *because it is sheltered by the clavicle.*"

I would point out that though the mechanics of the shoulder girdle were fully considered and explained in those papers, and though the knowledge of them is of immense importance to the surgeon, yet the anatomist has not thought it worth while to add anything to the very imperfect, insufficient, and unsatisfactory descriptions of the physiology of the articulations of the shoulder girdle which exist in the text-books on anatomy provided for the purpose of imparting useful and reasonably accurate information to students.

It therefore becomes necessary for me to recapitulate very briefly some of the points described at length in those papers.

The weight of the arm, with that of any additional burden borne by it, is transmitted to the spinal column chiefly through the clavicle, which in the erect position under these circumstances forms a lever of the second order. Its fulcrum corresponds to the sterno-clavicular articulation. The weight of the arm is represented as the power acting at the outer end of the clavicle in a direction vertically downwards, while the weight is transmitted to the costal arch at the point where the clavicle rests upon it, which is about the costo-chondral junction. The force applied to the end of the clavicle depresses

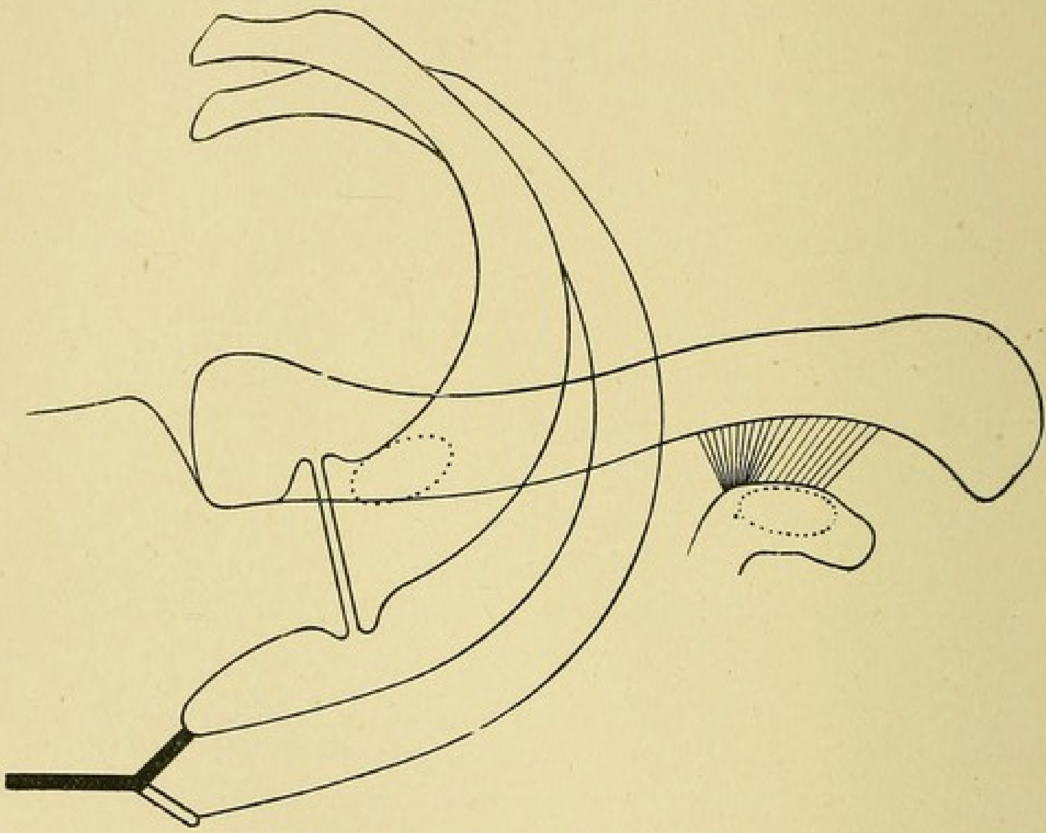


Fig. 118 represents the left first and second costal arches, with the manubrium, clavicle, and coracoid process, of a labourer. The manubrio-gladiolar joint is amphiarthrodial in character, while the joint which has developed in the ossified first costal cartilage is freely arthrodial. The position of the costo-clavicular articulation is indicated by the dotted outline on the first arch. On the upper surface of the coracoid process the facet which articulates with the clavicle forming the coraco-clavicular joint is similarly indicated.

the costal arch on the same side, rotates the manubrium around an antero-posterior axis should a manubrio-gladiolar joint exist, and raises the first costal arch on the opposite side. If a joint is not

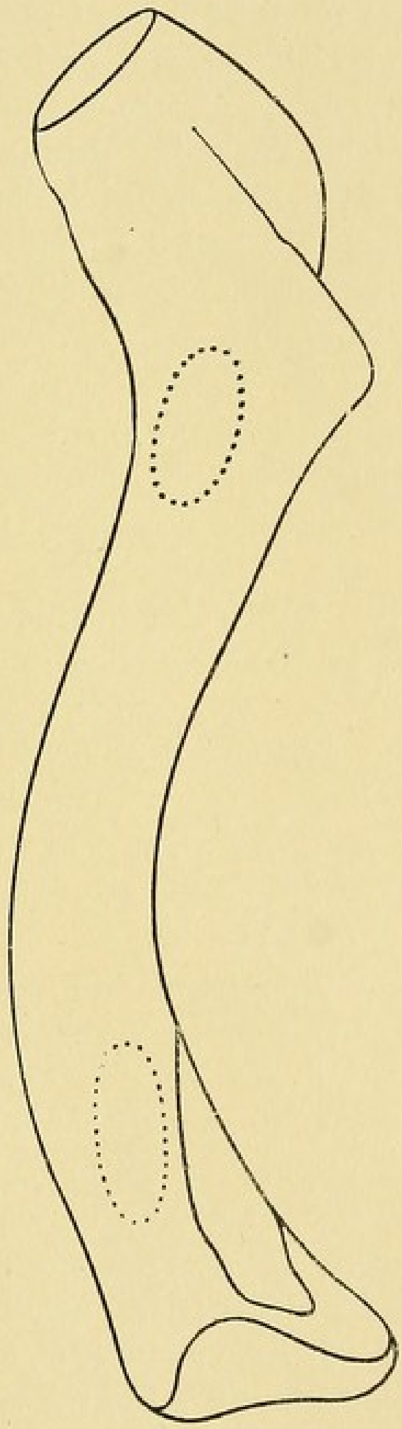


Fig. 119 represents the under surface of the clavicle with the articular facets which correspond with those on the costal arch and coracoid process.

present in the sternum the entire bone is rotated slightly around an axis passing through the manubrium. If sufficient force be applied suddenly to the outer end of the clavicle, should the lever itself not break or its fulcrum yield from dislocation, the costal arch fractures at the point of impact. If still greater force be used the second arch may be broken also in the same manner; and if a joint is not present in the sternum, this bone may be fractured about the manubrio-gladiolar junction.

If force be applied simultaneously to both clavicles both first arches may be broken, or the manubrium may be displaced backwards off the gladiolus at the joint, or if this is absent the bone may be broken in the same position.

If force be applied habitually in this direction, as in the case of the labourer who carries loads upon one or both shoulders, a new joint is developed between the clavicle and costal arch at the point of impact (see Figs. 118 and 119). The tendon of the subclavius muscle and the rhomboid ligament are in consequence displaced to some extent, while a complete capsule is formed about it. In most occupations the load is supported by the hands upon the back or shoulder, consequently the shoulder-joint is retained in a position of forcible and complete flexion. I showed that flexion of the shoulder-joint is limited by the impact of the coracoid process against the under surface of the clavicle, and that when sufficient force is applied abruptly in this manner the coracoid process is fractured by indirect violence, and not by direct violence, as was supposed by surgeons at that time.* In the case of the

* "Mode of Fixation of the Scapula suggested by the Movements of that Bone in Extreme Flexion of the Shoulder-joint; its bearing upon Fracture of the Coracoid Process," 'Brit. Med. Journ.,' May 19, 1888.

labourer the habitual forcible apposition of the clavicle and coracoid process results in the formation of a new joint between these bones, a complete

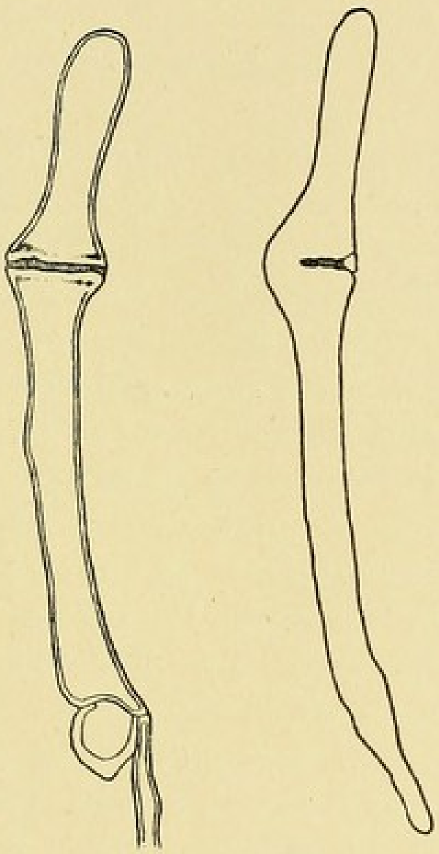


Fig. 120. Fig. 121.

Figs. 120 and 121 show the changes that take place in the manubrio-gladiolar joint in consequence of the transmission through it of great pressure. These specimens were obtained from the bodies of labourers who had been engaged in heavy porterage work at the Docks.

In Fig. 120 it is seen that the opposing surfaces of bone have been increased in area considerably, while the intervening ligamentous tissue has been rendered scant and dense. In Fig. 121 the joint has been almost completely obliterated by being bridged over in front, and by the formation of masses of bone in the ligament posteriorly.

capsule being formed about it. This I have indicated in Figs. 120 and 121.

If the load be carried on the back, as in the case of the coalheaver, the manubrio-gladiolar joint, should it exist, is altered in character, owing partly to the tendency to backward displacement of the manubrium off the gladiolus, and partly to the large amount of force transmitted through this joint.

As old age advances the first costal cartilage becomes converted into bone by a process of ossification which extends into it from the manubrium and first rib along its periphery into its centre. This ossification takes place comparatively early in life in the labourer under the influence of excessive strain, and in proportion to the weight of the load carried. Owing to this progressive rigidity of the arch an amphiarthrodial, and later an arthrodial joint is developed in the substance of the ossifying cartilage to enable it to perform its normal share in the mechanics of the shoulder girdle. This is shown in a well-developed state in Fig. 118.

If sufficient force is applied to the outer end of the clavicle in any direction from vertically downwards to almost directly backwards, it will transmit that force to some point in the length of the costal arch, and will break the bone at the point of impact. Should the patient who has sustained such a fracture continue to use the arm, a large quantity of callus will be thrown out because of the free movements of the fragments on one another, which of necessity result from the force exerted on the arch by the clavicle during the movements of the arm; and if the arch has yielded in its anterior half, the constant movement may result in the formation of an ununited fracture. When I was first interested in this matter

I found among the few bodies in the dissecting room at the time three first ribs fractured at different points. Those I preserved, and they are mounted in the Museum of Guy's Hospital, No. 1054[35]. They show a united fracture of the neck of the rib, with some displacement, an ununited fracture of the centre of the rib, and a united fracture of the anterior portion of the rib. A little consideration enables one to realise that displacements can only occur in fracture of the neck of the rib, because occurring inside the articulation of the tuberosity of the rib with the transverse process of the vertebra, the weight exerted through the clavicle raises the outer fragment.

I need hardly point out the inconvenience that must arise from the presence of a large mass of callus beneath the subclavian vessels and brachial plexus. Since surgeons were unaware of the existence of fracture of the first costal arch, if they found a bony tumour growing from the rib in this situation and producing symptoms of compression they probably regarded it as an exostosis, and I fancy I have read such cases described somewhere, but cannot remember the reference at the present moment. I can perhaps best illustrate this condition of the subclavian vessels and brachial plexus by a description of three typical cases which came under my observation.

The first was a middle-aged woman whom I was asked to see some years ago. She was supposed to be suffering from a traumatic aneurysm of the third part of the subclavian artery. The pulsating tumour appeared after a heavy fall on the shoulder sustained some little time before. She had used her arm freely since the injury. At first she complained of pain in the subclavian area, but this slowly subsided. Later she experienced some numbness in the arm and hand. An examination of the part showed that the artery was displaced forwards and upwards by a considerable elastic swelling beneath it, which was continuous with the rib. It was clear that the mass projecting from the surface of the rib was callus about a fracture. Placing the arm completely at rest resulted, after a time, in the progressive disappearance of the lump, the artery returning to its normal position.

The second case was that of a woman, A. B—, aged 37, who was recently under my care in Guy's Hospital. She was said to be suffering from an aneurysm of the left subclavian artery, associated with considerable pressure changes in the nerves of the arm. The history she gave was that about eight weeks before admission, while exerting herself greatly at work, which was very heavy and unaccustomed, she was seized with sudden pain in the neck, in the position of the present swelling, where she felt something give way. She continued to use her arm, following her employment. A week after this she suffered from pain in the distribution of the median nerve in the hand. This spread up the front of the forearm and then up to the shoulder. The fingers began to swell, when she soon lost all power over them. An examination showed the presence of a hard mass beneath the subclavian artery and brachial plexus, displacing them forwards. No pulsation could be detected in the vessels of the arm. The arm was blue and cold. The fingers were flexed and rigid, and movements at the wrist, elbow, and shoulder were very limited. She suffered very great pain in the whole upper extremity. On October 12th, 1898, an incision was made along the upper border of the clavicle over the lump, which was exposed after carefully turning the subclavian artery and the posterior cord of the plexus, which was much broken up and compressed, off it. The mass of bone was clearly defined as a formation of callus about what had evidently been a fracture of the rib in the situation of the subclavian groove. It was necessary to divide the clavicle over the tumour in order to expose and remove it completely. This bone was reconstituted afterwards by means of a wire. Pulsation was soon detected in the vessels of the arm, the pain gradually subsided, and the muscles and joints are regaining their normal freedom of movement.

The third case was that of a labouring man who was employed in carrying very heavy loads on his shoulder. He received a blow on the shoulder which produced a sharp pain in the left subclavian region. He continued his laborious occupation, though he felt for a time what he considered to be sharp rheumatic pains in this region. These gradually subsided, but were soon followed by pain which extended down his arm to the hand. Later there was definite loss of power and wasting, which, with the pain, quite prevented him from following his laborious occupation.

An examination of the part revealed the presence of a hard, smooth, bony, and fibrous swelling, surrounding the left first rib just outside the artery, and pressure on it increased the shooting pain down the arm. Rest of the arm in a sling was followed by some relief, but the pain returned whenever he resumed his occupation. In consequence of this he decided to have the mass of bone removed, and was admitted into Guy's Hospital for this purpose on October 31st.

On cutting down on it I found it to be an ununited fracture of the rib. The opposing articular surfaces were considerably increased in area, and produced a large, prominent lump upon its upper surface. Splayed out over this were the subclavian artery and the cords of the brachial plexus. These were displaced off it, and hooked to one side, when the large bulk of the mass about the upper part of the fracture was removed by means of a gouge forceps. He made an uninterrupted recovery.

I have come across several other cases of fracture of the first rib in which there was clear evidence of compression of the superjacent structures by callus, but in none of them was it necessary to interfere surgically. These, like the first case, were recent fractures, and the callus disappeared with support of the arm and the consequent removal of the pressure of the clavicle from the subjacent costal arch. In Cases 2 and 3 it was absolutely necessary to interfere actively, in Case 2 because the muscles and joints were becoming fixed, while the pain was hardly endurable, and delay in interfering would have resulted in permanent damage of the arm; in Case 3 because the patient could not afford to rest, and as the operation showed, the fracture was ununited, and without operative measures the lump would exist permanently as a considerable prominence, and continue to render the man incapable of following his laborious occupation.

Before leaving this subject I will give you briefly one or two other interesting instances from among very many of the advantages which the surgeon can derive from the study of the mechanics of the attitudes of activity as shown to perfection in a fixed condition in the skeleton of the labourer. You remember that the development of the costo-clavicular and the coraco-clavicular articulations resulted from the habitual retention of these bones in certain relative positions, while a very great amount of force was being transmitted through them. It is clear that the mechanical gain from the point of view of economy of expenditure of energy to the individual by the formation of these joints is very considerable. The chief function of a muscle is to retain bones in such a relationship to one another that force can be transmitted through them to the greatest mechanical advantage. The evolution of these new joints and the resulting limitation of the range of movements of these bones on one another, consequent on their development, save the expenditure of a large quantity of muscle energy which would otherwise be required to retain the bones in position. The same applies with equal force to the obliteration of joints from enormous pressure, as, for instance, in the ankylosed spine of the fully developed coalheaver. This explains the facility with which an aged labourer will perform an accustomed act which a young and stronger but untrained man is utterly incapable of doing. The great advantage accruing to the labourer from the fixation of a joint in an extreme position is also illustrated in a most interesting manner by the elbow-joint of the coal-trimmer.* While this man pursues his very laborious occupation the range of

* 'Journal of Anatomy and Physiology,' vol. xxi, p. 385.

movement of the elbow-joints during the constantly repeated sequence is within a limited angle, which varies somewhat in the two sides. In the fully developed coal-trimmer this range, both in the directions of flexion and of extension, is controlled and rendered extreme at its working limits by the formation of dense bone on the floors of the coronoid and olecranon fossæ, and upon the ends of the corresponding bony processes. In this manner both the flexor and extensor muscles of the arm are relieved of the enormous expenditure of energy which would otherwise be required to control the working limits in the powerful and heavily loaded movements of flexion and extension which are being constantly performed by this labourer. On the other hand, the range of movement in a joint may be increased enormously beyond the normal, as in the arthrodial joint between the bodies of the fourth and fifth lumbar vertebræ of this labourer, the lamina and pedicles of the fourth lumbar being separated from the body during its development.

I could further illustrate my point by innumerable instances of labour changes, but I will now confine myself to only one more, namely, to a condition which exists in the hip-joints of all labourers who carry heavy loads in such a manner that the trunk is at the time retained in a position of extreme flexion and slight adduction on the thigh bones. On picking up that very excellent text-book, 'Gray's Anatomy,' I find the following stated deliberately and without reservation of any sort:—"Flexion of the hip-joint is arrested by the soft parts of the thigh and abdomen being brought into contact." Now, gentlemen, this very definite and precise

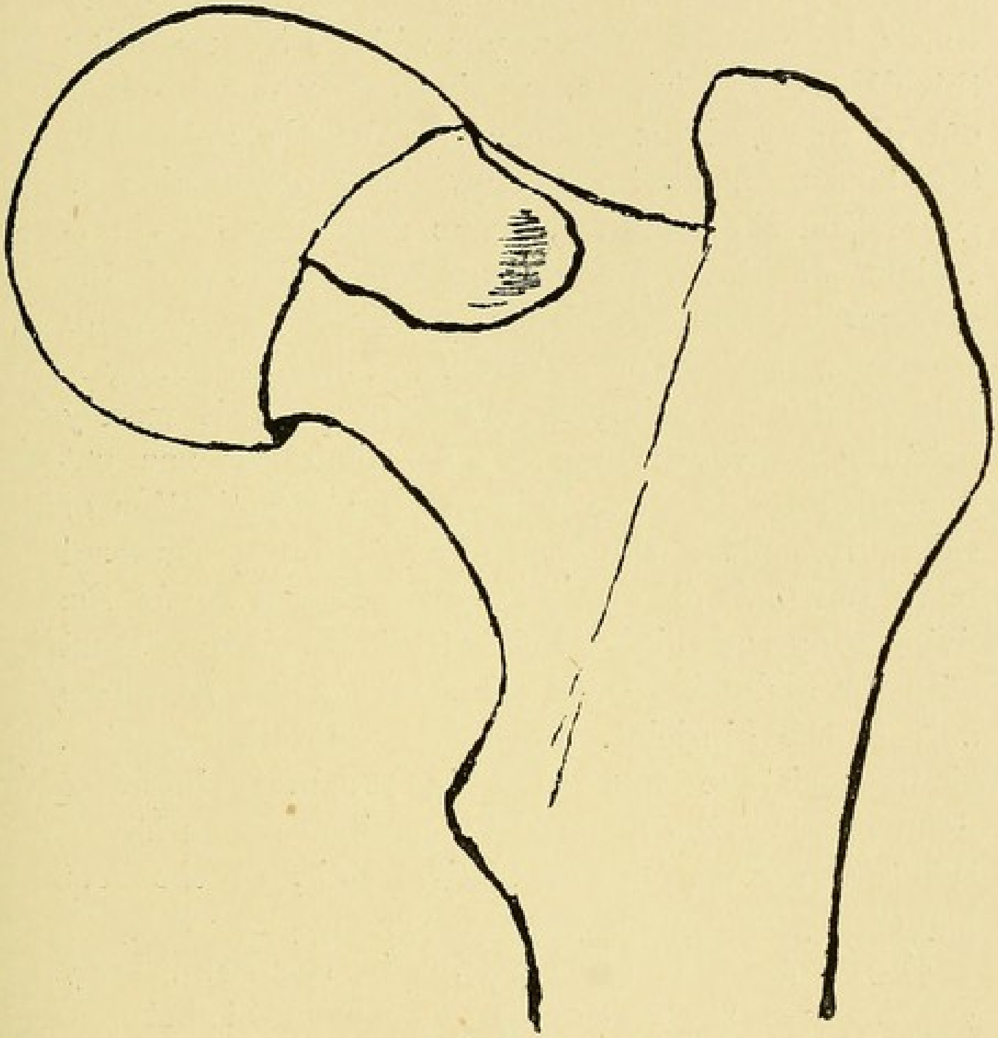


Fig. 122 represents the anterior surface of the femur of a man who has been engaged in carrying heavy loads upon his back. It shows an increase in the area of articular cartilage due to an extension outwards from its upper part on to the neck. Also the depression on the part of the neck which came habitually into contact with the margin of the acetabulum in extensive flexion and slight adduction. The upper surface of the head is on a lower level than normal, and is also flatter. On the under surface of the head an alteration described later is indicated diagrammatically.

statement is, except possibly in the case of obese people, absolutely without any foundation; in other words, it is utterly false, as you will see by examining this dissected specimen. This is only one instance out of many of the manner in which the authors of text-books on anatomy copy from generation to generation the carelessly made and incorrect observations of their predecessors on matters of the greatest importance without making any attempt whatever to verify their accuracy. How strong is this habit of mimicry amongst us! Is it merely because it saves trouble? The anatomist has not depended for his description on an examination of the movements of the head of the femur in the dead body, but has apparently assumed that when in the living body the thigh is flexed till it comes in contact with the abdominal wall this movement takes place only in the hip-joint. You may remember that a similar mistake was made in precisely the same manner when the anatomist described a rotation of the astragalus around a vertical axis, on the foot being fully extended by the flexor muscles.

If you examine the hip-joint in the dead body you see that the real range of movement between the limits of flexion and extension is small as compared to the apparent range, which includes the movements of the lumbar, lumbo-sacral, and sacro-iliac joints.

The movement of extension is controlled by the resistance offered by the almost vertically placed fibres of the anterior ligaments of this joint. Flexion is limited by the impact of the upper and anterior portion of the neck of the femur against the margin of the acetabulum, and any associated adduction limits the amount of flexion proportionately. A labourer, as the coalheaver, who carries any heavy load habitually on his back, walks with his hip-joints in a position of complete flexion, there being also a slight amount of adduction. The constant impact of the acetabular margin upon the same part of the neck of the femur, and the simultaneous transmission through it of great pressure, result in the formation in this part of the femur of an articular facet, which

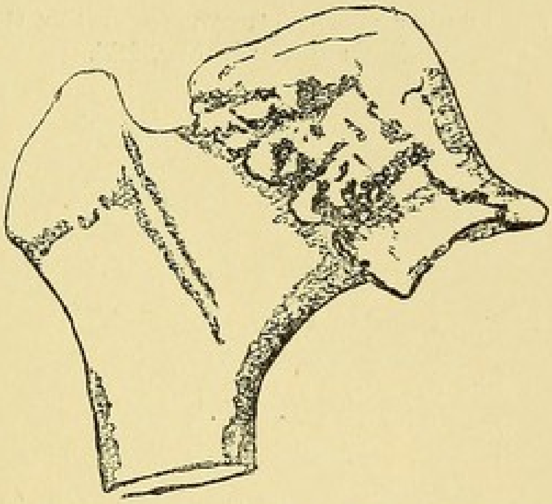


Fig. 123 shows the changes in the femur which result from the sudden transmission of excessive pressure through it in the manner described.

is covered by a thin layer of cartilage (see Fig. 122). The exact seat of this facet varies with the character of the load, and with the manner in which it is supported on the trunk. There is a corresponding surface in the innominate bone, though it is less defined. The advantage to this labourer of being able to secure the pelvis on the femur is clearly very great, since it removes the necessity of the muscles balancing these bones on one another while the heavy load is being carried, which would other-

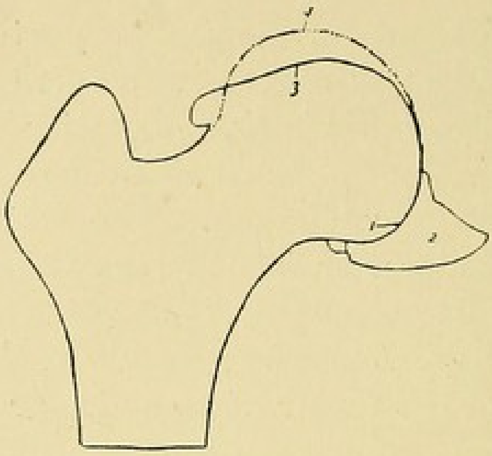


Fig. 124 represents a vertical transverse section through the specimen shown in Fig. 123.

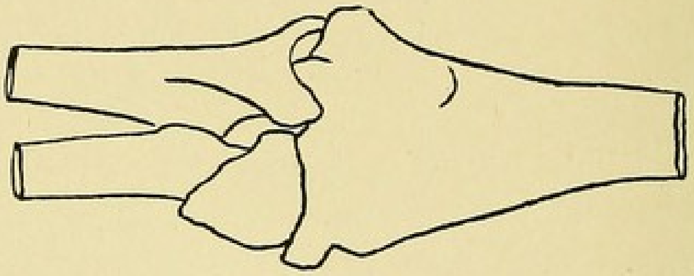


Fig. 125.

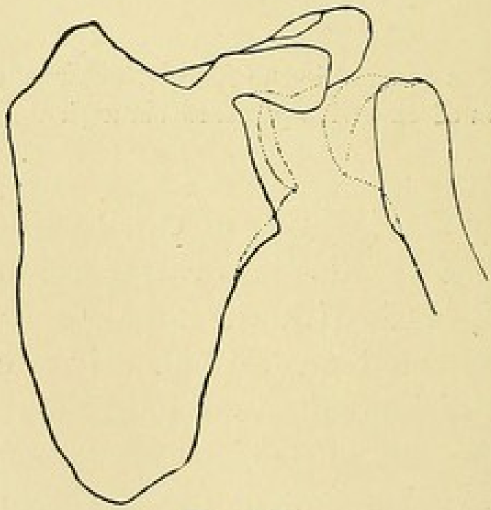


Fig. 126.

Figs. 125 and 126 show the changes which take place in the radio-humeral and shoulder-joints respectively in "traumatic arthritis," in consequence of the severe bruising of opposing articular surfaces in subjects past middle age.

wise be required. If the floor of the acetabulum be removed, and the ligamentum teres be exposed, you see that it is most tense in this position of flexion and slight adduction of the hip-joint. In extreme flexion the femur, and indeed the whole leg, performs the function of a lever of the first order, the fulcrum corresponding to the point of impact of the neck of the femur against the acetabular margin as represented by the facet described, and the short arm to the interval between it and the extremity of the head of this bone.

The head of the bone is retained in position partly by atmospheric pressure, partly by the resistance offered by the ligamentum teres, and partly by that afforded by the various muscles and fasciæ which surround the upper, posterior and lower aspects of the joint.

Fig. 127 represents the condition of the femur in the coal-trimmer, whose anatomy is of endless interest, and to which I have referred in previous lectures.

In the coalheaver and other labourers who carry in a similar manner, the ligamentum teres is enormously strong, presumably on account of the great strain to which it is habitually exposed. There is, I think, no doubt that the function of this ligament is to control extreme flexion, and the slight adduction which is associated with it in locomotion in this position in the manner I have just described. That other views are held about it the following quotation shows :*

"The security of the joint may be also provided for by the two bones being directly united through

* 'Gray's Anatomy,' p. 361, line 24.

the ligamentum teres; but it is doubtful whether this so-called ligament can have much influence upon the mechanism of the joint."

How can we apply the knowledge that we have obtained by the study of the fixation of the position of extreme flexion of the hip-joint in the body of the labourer? By it we learn that the immense leverage action exerted on a single occasion by the lower extremity in a position of extreme flexion and some adduction can produce a rupture of the ligamentum teres, and the displacement of the head

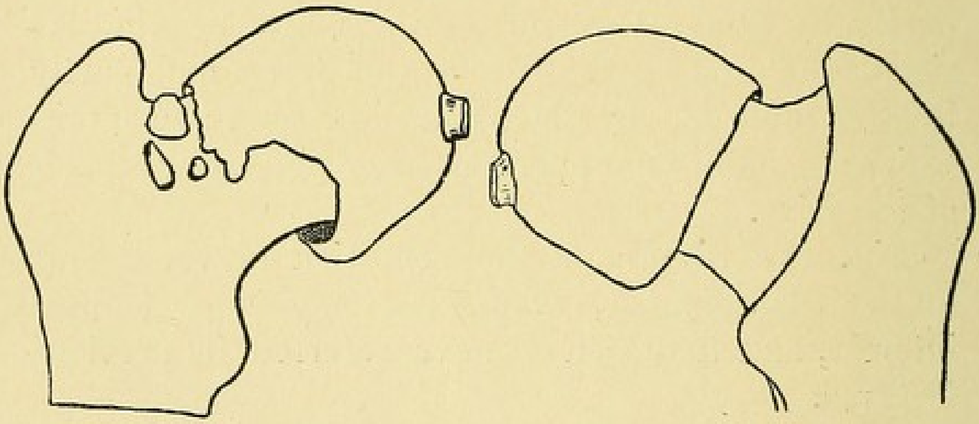


Fig. 127.

of the femur out of the acetabulum,—in other words, the first stage in all dislocations of the hip-joint—is effected in this manner. If the force be exerted gradually and over a long period of time, as in the uterus, the head of the femur is forced out of the acetabulum, and the ligamentum teres gradually yields and elongates, becoming also thicker at the same time because of the strain to which it is exposed. The head of the femur escaping from the acetabular cavity forms so-called "congenital dislocation of the hip-joint." During locomotion the hypertrophied round ligament assists very materially in transmitting the weight of the trunk to the extremity of the femur. If in the case of the feeble old subject or in the growing child force be applied suddenly through the long arm of the lever in the same extreme position of this joint, the ligamentum teres and the atmospheric pressure are more resistent than the lever itself, which yields in the situation of the fulcrum, a fracture of the neck resulting. This in the young subject corresponds to the junction of the neck of the bone with the epiphysial line, and is spoken of as a " separation of the epiphysis," and in those advanced in years the term " intracapsular fracture of the neck " is usually applied to it.

Returning to the hip-joint of the labourer, the habitual transmission of an enormous pressure through it while retained in a position of extreme flexion and very slight adduction results also in a removal of the upper surface of the convexity of the head of the femur, which is thus rendered less convex than before, while the opposing articular surfaces through which the force is transmitted are increased in area to a corresponding extent. This is increased still further by a formation of bone and articular cartilage in the immediately adjacent portion of the neck, the head altering in form considerably from the normal. If, as in some labourers, the load carried is still greater, the articular cartilage over this area is removed after a time, and highly polished, dense, eburnated surfaces of bone replace the original articular covering. In either case the upper surface of the head of the femur comes to occupy a lower level as compared to the trochanter.

As there is associated with the removal of the upper part of the head a compensatory deposit of bone on its under surface, the angle formed by the head and neck with the shaft in the fully developed labourer is decidedly smaller than it is in the subject who has not followed a laborious existence.

Mechanical changes on precisely similar lines take place very rapidly when these opposing surfaces are exposed to enormous pressure on a single occasion. In such a case the articular cartilage and subjacent bone are removed over this area, no attempt being made to restore the covering of articular cartilage, and abundance of bone is deposited below. I am of opinion that it was the alteration in the form of the bone which results from labour that induced the earlier observers to imagine that the neck of the femur yielded in old age. I may remind you that the pathologist was also led to regard the change in the head produced traumatically in the manner I have last described as being brought about by "interstitial absorption of the neck of the femur." Figs. 123 and 124 represent this condition of "mechanical or traumatic arthritis," as I have called it, in the head of the femur, and Figs. 125 and 126 precisely similar changes in the radio-humeral and shoulder joints. I think that I was able to satisfy myself from a careful examination of the bodies of infirm and aged people who had not followed a laborious existence that, owing to their transmitting their normal pressure through joints retained habitually in a position of considerable flexion with some adduction, a change similar to that to which I have called your attention in the labourer ensues in the very feeble and ill-nourished bones. That it takes place in other joints in the body I have shown beyond dispute. For further description and illustrations of these changes I would refer you to a paper " On Senile Changes " in the ' Transactions of the Pathological Society ' for 1886. In considering the variation in the angle of the femur in old age I am leaving out of consideration the yielding of the neck or of the other bones that results in the condition of imperfect nutrition called senile mollities ossium.

I ought perhaps to apologise for inflicting on you these details, which may at first sight appear to be solely of anatomical interest; but I feel sure that a little consideration will convince you that it is only by the careful observation and recognition of the general laws that govern these changes that we can hope to learn anything of the functions and mechanics of bones and joints, and to base our surgical procedures on some sound scientific foundation, which is at present singularly conspicuous by its absence.

SOME EXPERIENCES

IN THE

SURGICAL OUT-PATIENT ROOM OF A CHILDREN'S HOSPITAL.

There enters first a pale, worn-out woman, who tells you she is only twenty-two and looks at least ten years older. She brings you her infant, aged 4 months. Since it was a fortnight old it had attended the medical out-patient room, suffering from the wind and chronic constipation, varied by sharp attacks of diarrhœa, eczema, and chronic bronchitis. She says that she and her husband are quite worn out by the constant crying of the child. In desperation she occasionally yielded to the temptation and administered alcohol not only to herself but to her child. Nothing did the child more good. As an umbilical hernia has developed it is no longer regarded as medical, but is now considered to be surgical. The poor infant looks wasted and white; and as it commences to scream on your proceeding to examine it, the mother shoves into its mouth a rubber teat which is connected by a tube with a glass bottle, informing you at the same time that it is a very ravenous child and is never satisfied. The chest is small above, but below it is expanded by an enormously distended abdomen, which, when the child cries, bulges laterally, a protrusion appearing simultaneously along the middle line between the widely separated recti muscles.

In the position of the umbilicus is a thimble-shaped prominence whose size varies with the expulsive efforts of the child. The limbs are usually thin except about the joints, where the epiphysial lines are abnormally prominent, and some of the long bones are bent. The head is large, the forehead prominent, and the area of the fontanelles disproportionally great.

You ask the mother what is in the glass bottle, and she tells you it is a mixture of condensed milk and water, and that she uses condensed milk in preference to cow's milk as the latter readily becomes sour. She adds that she does not allow the child to depend on that alone, as she found it did not satisfy it, but that she gives it one of the many foods which are freely advertised with the sanction of the State, in the lay and medical papers, as being good for young infants, and if she is not in sufficiently affluent circumstances to buy such expensive articles of diet she feeds it on Robb's biscuits, rusks, or even boiled bread.

She was never able to suckle this child, and attributes it to the fact that her strength had been undermined by three preceding pregnancies which followed one another in rapid succession. You inquire about these children, and you learn that two died of consumptive bowels a few months after birth, and the first was born dead after a tedious labour in which she was attended by a midwife of sorts.

Why should all this distress have been inflicted so unnecessarily and so cruelly on this little family, and who is responsible for it? These people are the victims of circumstances over which they have no control, and the State is alone at fault, in that it has not provided her with such information as it should have done during the time when it was responsible for her education. The mother has certainly not neglected her child, but has attended to its every want with the self-sacrifice and unselfishness which are, I think, most admirable and wonderful qualities in nature. She has had to depend for her education in the diet and hygiene of her child upon information supplied by equally ignorant friends or relatives; and the very limited accommodation of her home renders it necessary that some means should be found to control the capacity of producing discomfort, which is possessed by an infant in a degree inversely proportionate to its age, with such consequences as those I have already related. Looking at the child you at once grasp the whole situation, and are able to consider the causation of the condition.

The child starts at its birth handicapped by an enfeebled vitality. What else could you expect from a young mother who has gone through the experiences this one has during her short married life. They are enough to break the spirit and undermine the health of the most robust. Not being able to supply the child with breast milk, she has had recourse to substitutes, with the awful results I have described to you. The frequent feeding produces a condition of discomfort, which is only relieved by the further introduction of food into the stomach. This produces constipation of such a nature that the child is poisoned by its own excretions. This monotony is relieved by the diarrhœa which results from irritating food or fæcal decomposition. The indigestion is associated with the production of much gas, which distends the abdomen and is popularly described as " wind." The great increase of the intra-abdominal tension, brought about by its presence, interferes with the normal function of the abdominal wall in violent expulsive efforts as in coughing, so that mucus readily collects in the bronchial tubes, and the child suffers more or less severely from bronchitis. Again, this tension interferes with the action of the diaphragm, so that the supply of oxygen obtained is insufficient to keep the child vigorous and active, consequently it readily falls a victim to any such depressing influence as chill, organisms readily obtaining a foothold in its tissues.

Besides over-distending, stretching and damaging the muscular wall, the tension results in a yielding of the weakest parts. At this age the umbilicus is the most yielding, and giving way, an umbilical hernia is produced. Associated with this enteric disturbance, there exists in the peritoneal cavity a quantity of serous effusion. This may be present in sufficient quantity to give a distinct thrill on the abdomen being tapped with the fingers or, better still, with a lead-pencil held lightly in the hand. This fluid being exposed to the same tension is in infancy driven through the more or less pervious processus vaginalis, or into the canal of Nuck, so as to form the hydrocele of infancy with which we are so familiar; and bowel may also be driven along the same canal, or may be forced into an acquired hernial sac.

Both these conditions you see remarkably well illustrated in the lad two years old who follows the last patient. He has bowel and fluid in the left tunica vaginalis, while on the right side the tunica vaginalis and much of the processus vaginalis are distended with fluid. The communication with the abdominal cavity is very small, and considerable and prolonged pressure on the hydrocele is requisite to influence its size. The mother tells us that when he awakes in the morning it is very small, and that it increases in size after he has stood for some time. On percussing the lower part of the abdomen with the handle of a pen while he is in the erect posture a distinct thrill is felt by the hand placed on its wall.

Returning to the infant, we know that the bones have yielded because they are abnormally soft, a sufficient quantity of lime salts, &c., not being obtainable because of the condition of disordered digestion ; nature makes every effort to meet as far as possible this unsatisfactory state of affairs, and a quantity of imperfectly developed bone is deposited upon the original skeleton. This is most abundant where its presence is most urgently demanded, namely, upon the surface of the vault of the skull, in order to secure intact from injury the brain, the most important organ in the body to the life of the individual. On the back of this skull you find the bone less resistent than elsewhere, in fact it yields to the pressure of the finger. This results from an absence of deposit of new bone upon the skull in consequence of the pressure exerted on the head by the pillow, which in some cases is sufficient to produce an absorption or thinning of the skull, because of its imperfect nutrition.

The hurry to do its best to maintain the normal mechanical relationship of the individual to its surroundings is also very well illustrated by the rapid and abundant formation of imperfect bone at the epiphysial lines, so producing the lumps in this position which are spoken of as beading. These are most conspicuous at the wrists, ankles, and costo-chondral junctions.

These children are not always thin; they are often covered with a thick layer of fat, and furnish excellent illustrations for advertisers of artificial foods.

Now it is quite apparent to any one that, because the parents of the two children we have considered have not been taught how to feed their children, they have brought upon them, and upon themselves, an immense amount of misery and distress. One feels inclined to blame them, but a very little consideration at once shows us the utter injustice of such action, and that they are all the victims of a vicious system of government.

Another child comes into the room. She is about eight years old, and her mother complains that her right shoulder is growing out, and her ankles are weak. You inquire of the mother as to the number of her family, and she tells you that she has had nine children in rapid sequence; and that though they are all alive, they are feeble and delicate. She says that up to her marriage she lived in the country, where she was healthy and robust; but that her frequent pregnancies, anxiety about her children's health, limited accommodation, and very small means, had reduced her to the wreck she now is. When asked if she takes any pleasure out of her children, she seems to regard them solely in the light of anxieties, and an infliction necessarily associated with matrimony. She has tried to make her eldest daughters servants, and then factory girls, for both of which occupations they proved themselves physically unfitted. Now they earn a precarious livelihood as sempstresses. All her children suffer from "weakness of the spine and ankles."

You look at the child, and notice that she is thin and frail, and that she occupies a listless position, supporting her weight almost entirely on the right leg. You examine her boots, and see that they are trodden down on the inner side, especially about the heel. They are pointed in the manner so attractive to members of the female sex as long as they pay any attention whatever to their appearance, and the worn-down heels are narrow, and so placed as to lie considerably anterior to the heel of the foot. This style of boot has produced in the child the form of foot which I have described to you as a typical or normal female variety. The great toe is forced outwards, and the head of the first metatarsal bone appears to project inwards. The second toe occupies a form described as hammer-toe, being jammed into this position by the outward displacement of the great toe and the inward displacement of the three outer ones. The high heel, placed as it is beneath the centre of the foot, has necessitated the transmission of almost all the weight of the body through the compressed and deformed anterior portion of the foot; and, as a natural consequence, the mechanically impaired foot readily wearies, and occupies the "*position of rest*" or of abduction—a posture described by the vulgar as "flat-foot."

What can be more tiring or more wearying than wearing such instruments of torture? How disinclined they must make the wearer to lead a vigorous, active existence. Only women who are able to drive everywhere can afford to wear them.

Unfortunately, the poor mimic the rich, forgetting that their mechanical relationships to their surroundings differ very widely indeed. Do these people receive any instruction on such a simple and yet how important a thing as the physiology of the foot? No; there is too much of no practical interest whatever that has got to be introduced into their brains to permit of time being utilised for such a valuable purpose.

As we already noticed, the patient possesses, in a condition of fixation, the resting posture which is assumed by the normal child when standing on the right leg; or, in other words, the "*asymmetrical resting posture of the trunk.*" It is usually described by the meaningless terms *lateral curvature* or *scoliosis*, which, like *flat-foot*, have no connection with the condition, and do not in any way suggest its causation.

The asymmetry of the trunk is largely dependent on the depreciating influence exerted upon the feet by the boots, but both come about chiefly in a manner to which I will now call your attention.

Let us expose the thorax and abdomen, when you notice that the chest is flattened from before backwards, and that it does not appear to move during respiration. Pass a tape around it at the level of the nipples, and you find that the variations of the measurements between inspiration and expiration do not exceed a sixteenth of an inch. Observe the abdomen, and you see that what breathing there is is rapid, of a most superficial character, and practically entirely diaphragmatic.

Inspiration, as carried on by the diaphragm, is a more perfect reflex, and makes much less demand upon the capital energy of the organism than does inspiration produced by the intercostal muscles; that for this reason during our resting positions and during sleep the oxygenation of the blood and the removal of the carbonic acid from the lungs is carried on by the unaided action of the diaphragm; that old people whose chests, like the rest of the skeleton, have become fixed in symmetrical attitudes of rest depend almost, if not entirely, on the action of the diaphragm; and that feeble children with very little energy and vitality only obtain such an interchange of gases as results from the more or less regular contraction of this muscle.

It is largely on this account that many teachers of voice-production, singing, and public speaking develop abdominal respiration as opposed to thoracic respiration. More attention and care can be expended on the movements of the larynx and tongue in this form of aëration, as it makes less demand on the energy of the individual.

I showed that, owing to the great differences in form that exist in the thorax in the two sexes, the diaphragm plays a much less important part in the male than in the female, and that a dependence on the diaphragm is also fraught with much more damage to the male child than to the female. Anatomists, with wonderful obtuseness, do not seem to have observed these important variations in the anatomy of the thorax in the sexes, with the most important points of physiological and hygienic interest which arise out of them, though they have called attention to the difference in the character of the respiratory processes without endeavouring to throw any light on their causation.

They have discussed for a long time the mode of action of the intercostal muscles, and many fallacies have arisen in what is practically a very simple matter, owing to a want of recognition of physical conditions.

Attempts have been made to induce you to believe that there is any similarity in the mechanism of respiration and the influence exerted by rubber bands sloping in the direction of the intercostal muscles on two parallel bars which represent the ribs, that move on pivots upon two other parallel rods which represent the spine and sternum respectively; and as the result of this experiment the internal intercostal muscles are said to be expiratory, and the external inspiratory.

I will confine myself to criticising this particular experiment only. The fallacy involved in it consists in assuming that the movement of the ribs and sternum is the only change that takes place in respiration, and that the spine is a rigid rod.

Now I will show you that the variations in the curves of the spinal column in the positions of extreme inspiration and expiration are much greater than the variations in the movements of the ribs upon the vertebræ, and that these movements are eventually dependent on one another. Observe a child in the active position of extreme inspiration, and you see that the dorsal spine is extended to its utmost, each vertebra moving upon that beneath it around a transverse axis, so that a vertical line dropped through that axis tends to get as far as possible in a vertical antero-posterior plane behind a vertical dropped through that of the vertebra below. Look at the same subject in the active position of extreme expiration, and you find the dorsal spine is flexed to its utmost, each vertebra moving on that beneath it around a transverse axis, so that a vertical line dropped through that axis tends to get as far as possible in a vertical antero-posterior plane in front of a vertical dropped through that of the vertebra below.

The variations in the position of the dorsal vertebræ absolutely as well as relatively to one another, in a vertical antero-posterior plane, are very great indeed. The pair of ribs attached to each vertebra follows its movement in the same plane, so that the point on one rib which lies immediately above that on the rib immediately below in complete inspiration lies considerably anterior to it in complete expiration, the reverse being true in the transition from the position of expiration to that of inspiration. As the internal intercostal muscles slope downwards and backwards their points of attachment are nearest in extreme inspiration, while those of the external which slope downwards and forwards are nearest in extreme expiration. *Therefore we see that the external intercostal muscles are muscles of expiration and most powerful flexors of the dorsal spine, while the internal intercostals are muscles of inspiration and the most powerful extensor muscles we have of the dorsal spine.* All this, I found, was borne out in a most interesting and lucid manner by the examination of the bodies of labourers. You know that excessive strain causes muscle fibre to be converted into tendon, and later into ligament.* I found that on the removal of the intercostal muscles from the first spaces a dense layer of aponeurosis or ligament was exposed. This was directly continuous with the internal intercostal muscle, and was clearly a conversion of it into ligamentous tissue. It was thickest about the centre of the space. The same structure existed in the second, third, and fourth spaces, approaching the spine gradually. These I called "intercostal ligaments." They are produced by the influence of strain exerted on the internal intercostals connected with the upper ribs and dorsal vertebræ, and represent and vary directly with the amount of the strain thrown on these muscles by the transmission of weight from the shoulder girdle.

I need hardly impress on you the importance of the knowledge that the internal intercostal muscles are by far the most powerful extensor muscles of the dorsal spine in the body, and that in the production of this extension of the spine they, by the associated movement of the ribs, increase the capacity of the thorax, and that the reverse is true also about the external intercostal muscles.

While the external intercostal muscles flex the spine and produce actively the position of the chest called extreme expiration, this position as one of rest is brought about solely by the inaction of the internal intercostal muscles. Therefore, during the assumption of this position the muscles and ribs exert no

* The results produced upon the muscles, bones, and ligaments by the habitual exercise of excessive strain. 'Brit. Med. Journ.,' Dec. 1888.

leverage action upon the vertebræ connected with them, nor oppose their rotating around an antero-posterior axis, as they do when the body is supported on only one limb. The asymmetrical posture of rest of the trunk is associated of necessity with the position of rest of the thorax, namely, that of expiration, and it is impossible to obtain any rotation of the bodies of the vertebræ and the consequent existence of any lateral curvature of the spinal column when the chest is in a position of extreme inspiration, or, in other words, when the spine is completely extended by the active contraction of the very powerful intercostal muscles. The knowledge of this important fact in the physiology of the normal skeleton supplies us with the clue to the measures we should adopt in the treatment of the fixed condition of the normal asymmetrical resting attitude of the trunk, which is commonly, and to my mind stupidly, described as lateral curvature, or, worse still, scoliosis.

The indications for treatment are as follows:

1. By making the child inspire forcibly to its utmost you exert upon the spine by means of the intercostal muscles and ribs such force as is exerted when the normal individual changes from the asymmetrical posture of rest of the trunk to the symmetrical active erect posture. Therefore, it is obvious that in attempting to overcome the fixation of the resting position we must adopt the same mechanism.

2. Prevent the child assuming the asymmetrical posture of rest of the trunk. The exercise for certain periods of the day of the muscles of inspiration and expiration to their utmost capacity not only brings into action the only mechanical arrange-

ment we possess for restoring the resting dorsal spine to the symmetrical active position, but supplies the organism with a very much larger quantity of oxygen than it has been in the habit of obtaining, and the carbonic acid is removed very thoroughly. In fact, by ventilating the lungs you are supplying the tissues of a body whose machinery has been worked on a minimum supply of the form of fuel which is infinitely of most importance to it with a larger proportion of oxygen, so enabling them to perform their functions normally. Beyond such attention to the respiratory function, by means of which the child is provided with energy as capital, avoid at first making any great demand upon that capital as expenditure. I mean that you must not tire your patient by making her perform exercises other than those she is easily fitted to perform. The tissues in the most feeble can have their nutrition improved by massage without wearying. To cause your patient to draw largely upon her small capital by going through muscular exertion as in gymnastic exercises without attending to the supply of oxygen is practically to starve the sufferer still further than is already the case. There is no branch of surgery in which quackery and humbug are more rampant than in the treatment of the asymmetrical and other resting postures, chiefly for the reason that the large majority of the members of our profession are unable to understand thoroughly the causation of these conditions. Once they have grasped the physiology of the normal resting posture, they will learn to treat their cases themselves on sound scientific principles.

This child presents another condition, of which you will see innumerable examples in the out-patient room. As you watch her breathe, you notice that her mouth remains open, and that the upper lip and teeth, which are but partly covered by the lip, project forwards considerably beyond the level of the lower. In her ears there are plugs of wool, and the mother tells you that earlier in life both ears discharged, and that at intervals when the child catches cold the discharge returns. On opening her mouth the palate is found to be very high, and the upper jaw narrowed very considerably in its transverse diameter. On inquiry you gather that this is a formation common to all the female members of this family. The children suffered early in life from colds, which became chronic, and left them depreciated in hearing capacity, that several had suffered from inflammation and discharge from the ears, that they snored at night-time, and were greatly troubled with their tonsils. Two had had operations for adenoids, and one had had the tonsils excised. These operations had afforded some temporary relief in one case, but in the other inflammation and discharge from both ears followed immediately after, and a considerable discharge from the nose. The older girls, she says, have grown out of it, and are only troubled when they catch cold, when they become deaf. One cannot breathe through her nose at all, and at times suffers from a profuse watery discharge. She attended a throat hospital, where she had had a bone, presumably the inferior turbinated, cut out of each nostril. She breathed a little better for a time, but soon relapsed. She is now being treated with the electric cautery. The mother speaks disparagingly of the treatment, and says that by the time she recovers from the pain and aggravated obstruction brought about by one application, it is time for her to undergo another, and she has to submit to the painful consequences over again. Her story, as she tells it, makes you wonder why she should come to you for advice, since her little family seems to have suffered much at the hands of surgeons. Surgery certainly does not seem to have impressed her very favourably, and she has all our sympathy. She and hers are victims of over-specialisation, but the chief sinner is again the State as represented by our miserably unsatisfactory and inefficient educational system.

Let us consider this last trouble, and examine into its causation and pathology. As I told you, the child—badly fed, both as regards the food put into its stomach, as well as into its lungs—suffers constantly from inroads of organisms, one evidence of which is the so-called cold in the head. There is situated, as you know, in the roof and posterior wall of the pharynx a diffused mass of lymphatic glandular matter covered by mucous membrane which pockets into its substance. In the faucial aperture are the tonsils, similar in structure, but thicker and more circumscribed. Again, in the neck there are a number of lymphatic glands which receive much of their supply from these pharyngeal and faucial glandular collections.

Now a child gets a cold in its head. This means that the mucous membrane with the pharyngeal lymphatic tissue become swollen and inflamed, probably owing to the presence of organisms and their products. The mucus present in the nasal and naso-pharyngeal cavities assists in blocking the passage, so that air is unable to pass readily through it.

When the catarrhal condition subsides, the enlargement of the pharyngeal lymphatic tissue interferes with the passage of mucus from the nose into the pharynx, consequently it accumulates. Organisms grow in it, and it sets up further irritative change in the pharyngeal tonsil. It often runs out of the anterior nares, and irritates and inflames the orifice. The Eustachian apertures are often blocked, mucus being dammed back in the middle ear and antrum, and if the membrana tympani be already perforated, the discharge from the middle ear escapes into the meatus instead of into the pharynx. The occlusion of the orifice of the Eustachian tube frequently produces an acute inflammation of the middle ear, followed by perforation of the membrane, and probably a chronic purulent otitis, or worse still, a more chronic inflammation which leaves the membrane forcibly retracted, and the hearing capacity impaired to a degree usually largely in excess of that which exists in the chronic purulent variety, and without the same possibilities of improvement.

The faucial tonsils are frequently infected secondarily, and in the same manner. They become large, and help to impede the passage of air through the only portal remaining. The lymphatic glands in the neck become swollen and inflamed, and if they do not subside very shortly, tubercular organisms too frequently find in them an area of depreciated vitality, in which they readily establish themselves, and from which they are often difficult to expel.

A considerable proportion of the cases of tubercular glands in the neck which abound in our out-patient room owe their origin primarily to a nasal catarrh. Since the enlargement of the pharyngeal lymphatic tissue has been observed by surgeons, it seems to have been regarded as the primary source of trouble in these cases, and a bloody and unpleasant operation for its partial removal has become very prevalent indeed. That this operation, like excision of the pharyngeal tonsils, is frequently of service one would not pretend to deny, especially in the case of poor people, who are unable to pay such attention to their children as is necessary, and who are unable to place them under favourable conditions, and in very young children. The patient derives frequently a temporary alleviation from the operation, but in the majority of cases the cause not having been removed the effect again reappears. In not a small proportion of cases the patient suffers from, instead of benefiting by the operation.

This treatment is clearly unscientific. Certainly in private practice it is but very rarely necessary in my experience, and by itself comparatively useless. The obvious indication is :

1. To educate the child to change habitually a reasonable quantity of air, improving the general health and affording a greater resisting capacity to the entry of organisms, and to their expulsion if they have already obtained a foothold.

2. To insure the passage of all the inspired and expired air through the naso-pharynx. By ventilating this cavity the evacuation of the organisms and of their products is completed, and the mucous membrane and the lymphatic tissue is rendered healthy instead of being in a condition of fulness and vascular dilatation, evidences of chronic infection. The glands in the neck, if not already infected by tubercle, are also restored to their normal state. By this

means you also restore to the naso-pharynx *the mechanical pressure exerted by the air* in its forcible passage through it. This is the factor upon which the naso-pharynx, maxillary antrum, frontal sinuses, the upper jaw, malar bones, palate, teeth, and, indeed, even the lower jaw, are chiefly dependent for their complete development. Further, I believe that the only other force which influences materially the form of the face is the pressure exerted by the teeth on one another, and upon the intervening food, and that is limited almost entirely to the jaws.

The only circumstances under which I can understand the surgeon being warranted in attacking the pharyngeal tonsil are—(1) when the condition has been so thoroughly neglected that the child is unable to drive air through the naso-pharynx, whose development has been long in abeyance, until the enlarged pharyngeal tonsil has been effectually removed; (2) when for some reason or another, such as considerable difficulty in forcing air through the nose, ear trouble, important school or other engagements, peculiar circumstances, &c., it is necessary or advisable to telescope the duration of the treatment; and (3) when the child is too young to do what it is told. In private practice the first condition should not exist, and it only exists because medical men pay absolutely no attention to the manner in which the child performs by far its most important function, namely, respiration, by means of which the oxygen, the prime factor of life, is distributed to the several tissues in the body. Many inquiries will be made as to the manner in which the intestines perform their functions, and if, because of an imperfect supply of oxygen, and owing to the constant assumption of sedentary and resting habits, these viscera are not fit to perform the work they should do in a healthy subject, they are stimulated in an unnatural manner by drugs. Let medical men treat their patients in a common-sense manner, regarding them simply as machines, recognising that they bear only a mechanical relationship to their surroundings, and we will soon observe a rapid improvement in their physique. All such conditions consequent on imperfect development of the naso-pharynx, the constant assumption of resting postures, and any number of troubles associated with and produced by them, will disappear. When difficulty is experienced in inducing the patient to pursue such respiratory exercises as increase the vital capacity, it is well to place a trained nurse in charge, when progress is generally rapidly made even in very young children. This can be done by patiently teaching the child to make such deep inspiratory and expiratory efforts through the nose, the mouth being closed, as already described when considering the asymmetrical resting posture of the trunk, care being taken that the vital capacity is steadily increased.

As the mucous membrane of the nasal cavities becomes more healthy, so the pharyngeal and faucial masses of lymphatic tissue regain their normal condition and size. We should look upon the operation as removing one effect only of a general condition, and not as a radical measure.

As much exception has been taken to the statement I have made that the condition popularly called *adenoids* can be treated completely satisfactorily without operative interference, I would point out to objectors that these cases are exceedingly numerous, and that it is quite possible to attempt to disprove the accuracy of my views by producing a single case of a child affected in this manner, in whom the vital capacity has been increased steadily by systematic exercises carried out during a sufficient period of time, all air being passed through the nose, without the naso-pharynx having been developed, and the so-called adenoids cured. It is a mystery to me how physicians have so readily handed over to the surgeon cases whose treatment is, I believe, purely medical. I can only explain it on two grounds :—Firstly, that physicians usually pay no attention whatever to the manner in which the respiration of children is carried on ; and secondly, because one portion of the sequence unfortunately attracted the attention of Wilhelm Meyer, and it was dubbed with the name "adenoids," and an operation was suggested and practised. Once a name is given to a condition the profession ceases to consider its causation, but wallows in its nomenclature, deriving complete satisfaction from doing so, and thinks only of the accepted form of treatment. Just as a fracture suggests a splint, so a chronic cold in a child suggests an onslaught on the pharyngeal tonsil, not because it is enlarged in consequence of it, but because it is called *adenoids*.

Adenoids, like the fixation of the resting postures, are primarily dependent on deficient oxygenation.

Figs. 128 and 129 illustrate a very ordinary instance of the above condition in a boy, none of the features being excessively exaggerated.

Observe the "flexion" of the dorsal spine, the prominence of the scapulæ, the flattening of the front of the chest, the forward projection of the head, the

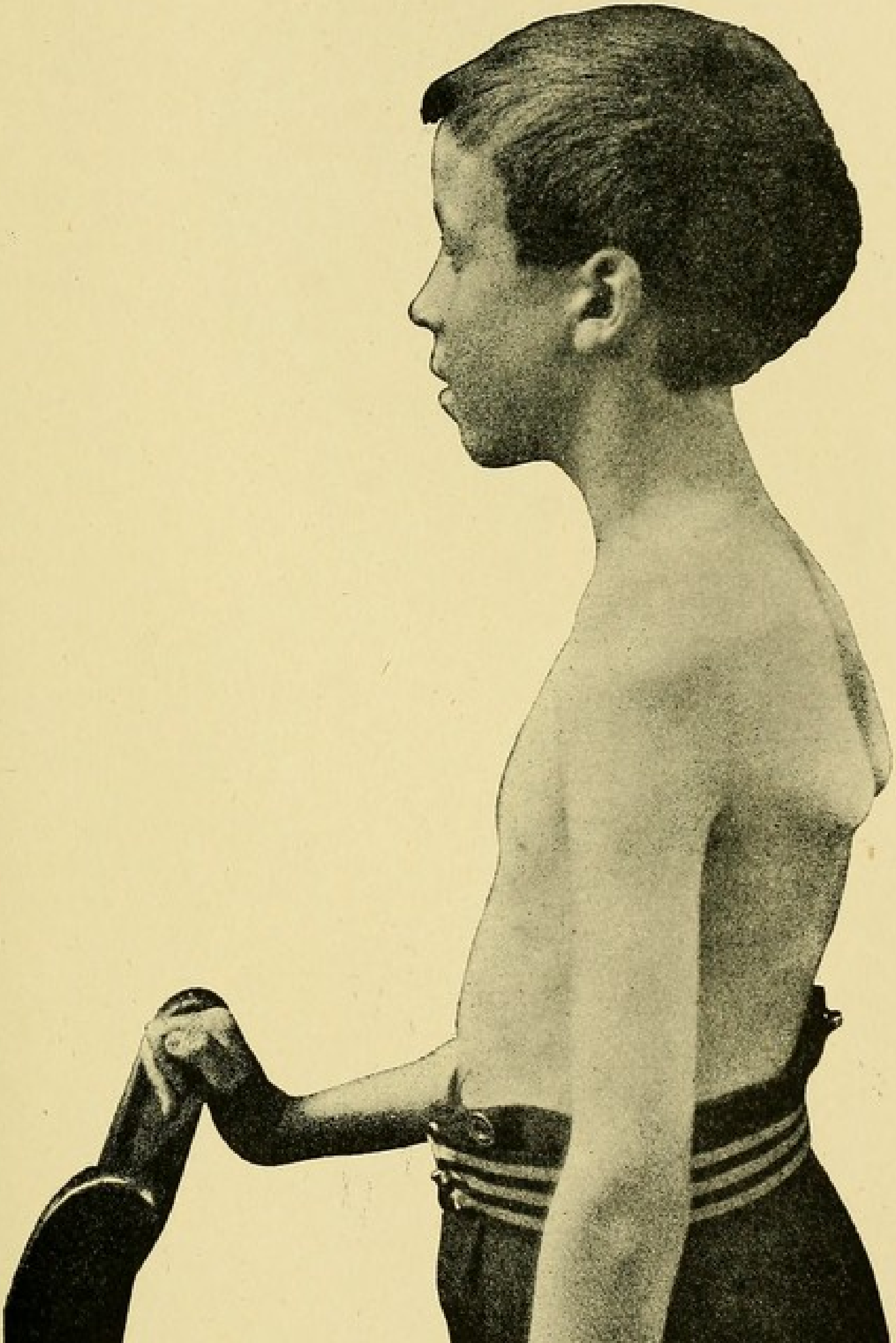


Fig. 128.

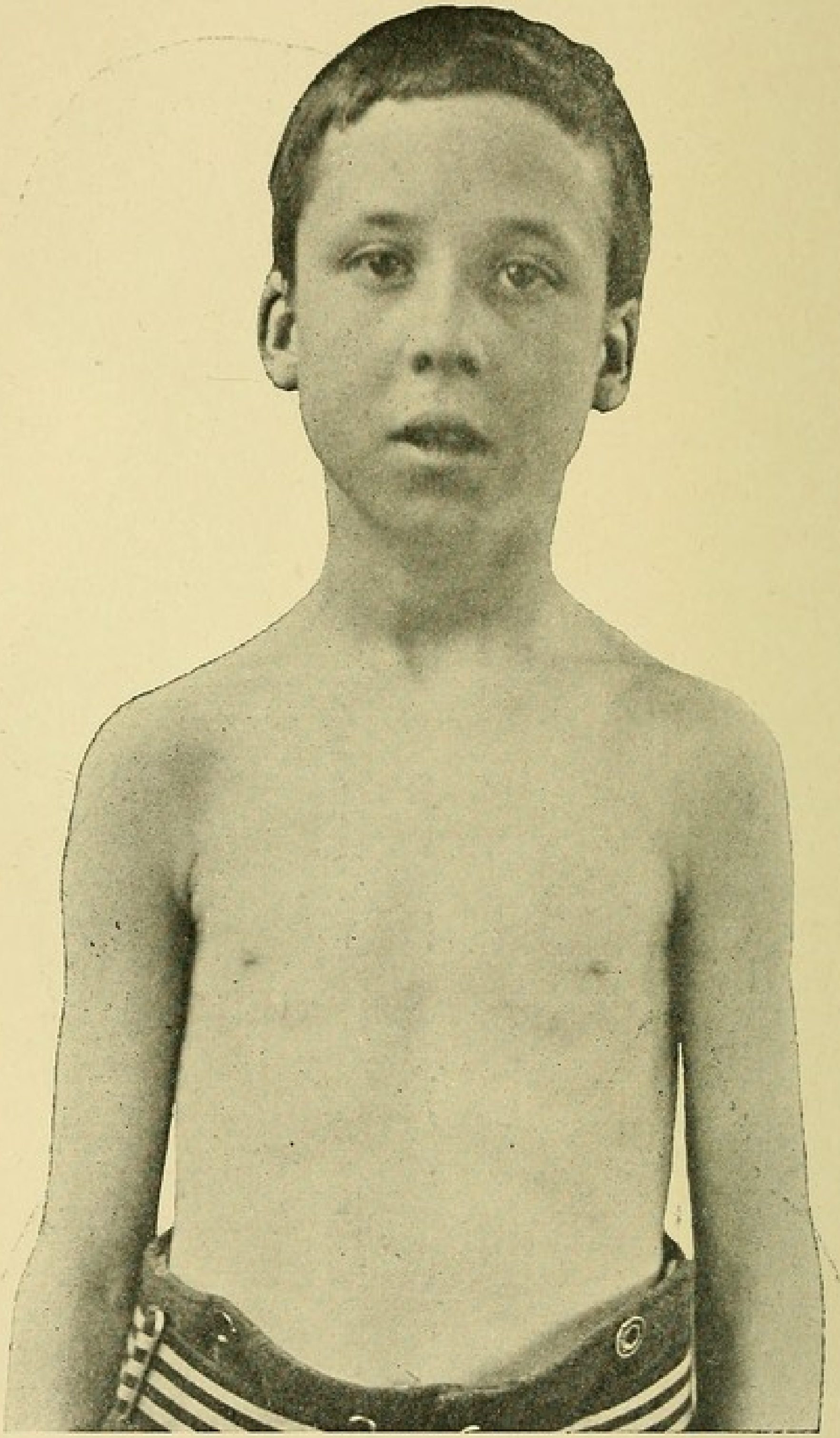


Fig. 129.—Facial deformity in greater detail.

rounded shoulders, all of which are necessarily associated with the posture of expiration; also the open mouth through which the incisors are partly seen, the lateral compression of the nose, the small size of the anterior nares, the hollowing of the face below the orbit and the flattening of the cheeks, both of which are due to the imperfect development of the antrum and the consequent diminution in the prominence of the malar bones.

ON THE TREATMENT OF INGUINAL HERNIA.

Gentlemen,—If we hope to arrive at scientific methods of treatment of this condition we must consider the anatomy and physiology of the part, and the manner in which a hernia is produced.

By inguinal hernia is meant the escape from the abdominal cavity of some of its contents into or through the inguinal canal.

The arrangement of the inguinal canal is such that the cord passes out from the abdomen obliquely, its points of entry and exit being spoken of as the internal and external abdominal rings respectively. In the interval the cord lies between opposing layers of muscle and tendon, which constitute the abdominal wall.

It is the obliquity of this channel of exit of the cord from the abdomen that ensures the security of the wall. Even in infancy, when the peritoneal cavity is in direct communication with the tunica vaginalis, such sudden increase in intra-abdominal tension as occurs in the normal abdomen from crying, &c., acting at right angles upon the inner aspect of the abdominal wall, forces the planes of muscle into apposition, and prevents the intrusion of the viscera along the track of the cord. If, however, the intra-abdominal tension be increased very greatly, the muscles forming the wall are stretched and over-strained, and cease to perform their function normally.

Owing to a diminution of tonic contraction in the muscles, the alteration in the form of the abdomen consequent on the stretching of the several components of its wall, and the continued presence of an excessive intra-abdominal tension, the obliquity of the canal is diminished, and the contents of the abdomen are forced along it.

I would refer to a short paper on "The Causation and Treatment of Hydrocele and Hernia in Young Infants," which was communicated to the Section of Diseases of Children at the Annual Meeting of the British Medical Association held in Newcastle-on-Tyne in August, 1893, since in it was described, I believe for the first time, *the manner in which hernia and hydrocele are produced in infancy by the increase in intra-abdominal tension produced by flatulence and indigestion, the irritation of the intestines causing a variable amount of peritoneal effusion;* the latter percolating through the processus vaginalis produces the hydrocele of young life with which we are so familiar, and which the surgeon imagines he can treat by what he calls discutient lotions applied to the scrotum, and by aspirating the contents for the time being of the tunica vaginalis. Of course, this treatment is based on no principle whatever.

The presence of such fluid in the peritoneal cavity of young children suffering from hydrocele can be readily detected by placing the child in the erect posture, when it may be sufficiently abundant to give very deficient resonance, if not dulness, in the lower part of the abdomen. By carefully tapping with the finger or spatula a distinct thrill can usually be detected in the lower portion of the abdomen. In attempting to obtain a thrill you must remember that *the facility with which this is detected varies inversely with the degree of tension of the fluid.* This you can prove at once by means of one of the large hydroceles that abound in our out-patient rooms. Choose a loose one, and holding it lightly in the left hand, tap the mass lightly with a penholder. The thrill transmitted by the fluid is felt most distinctly by the hand grasping it. Constrict the upper limit of the hydrocele by means of a bandage, so as to gradually increase the tension in the sac, when you will find that the thrill becomes less and less obvious till it cannot be obtained at all ; or you may demonstrate the same on a rubber bag under varying conditions of distension with water.

I mention this, as when showing this thrill in a subject standing erect, and in such a position that the abdominal wall is as lax as possible, I have been met by the statement that the thrill is not that of fluid, but is a movement transmitted along the abdominal wall, and this objection has been supported by the fact that a book or bed-card placed vertically and driven into the abdomen in the middle line reduces its distinctness. This it certainly does, and you will find that the loss of distinctness will vary directly with the increase of intra-abdominal tension which results from the pressure exerted. To put such a child on its back and to attempt to obtain an indication of the presence of fluid in the abdomen by percussion or by a thrill will very rarely afford any result; since the amount of fluid is usually small, and in this posture is distributed over a very much larger area.

In some cases of hydrocele, when the processus vaginalis is large, the fluid in the hydrocele may be diminished gradually in quantity as the child is brought slowly from the vertical to the horizontal posture, and the reverse is true in bringing the child from the horizontal to the erect posture. As a matter of fact, I have verified these conditions on the operating table, and it was from such observations that I arrived at the conclusions contained in the paper just referred to.

It is a remarkable thing that up to the time I demonstrated that hernia in young life was dependent solely on an increase in the intra-abdominal tension beyond what the abdominal wall was capable of controlling without yielding, surgeons had not recognised this mechanical relationship as a factor in the development of hernia, and had therefore paid no attention to the dietary of the infant in this connection. In the adult other factors beyond diet modify the normal mechanical relationship of the wall to the contents of the abdomen, but these from various circumstances are not so readily controlled as in the case of the badly-fed child.

It seems to me that in the examination of the abdomen, we are not sufficiently familiar with the advantages to be gained by examining patients in various positions, and that we confine ourselves almost entirely to the supine. For instance, I might mention the method suggested by Mr. Alfred

Parkin of Hull.* He found out that in the easy sedentary position, the abdominal wall being thoroughly relaxed, owing to the descent of the anterior part of the liver for a considerable distance, it is possible to feel its edge, its under surface as far back as the transverse fissure, and any coarse lesion of the gall-bladder and bile-ducts, together with a larger area of the upper surface of the liver than in the recumbent posture.

It would be difficult to exaggerate the advantages which are sometimes gained by the use of this posture. But at the same time, while in a loose flaccid abdomen one's fingers quickly become thoroughly accustomed to the feel of the liver, gall-bladder, &c., in a fat, tense abdomen one may spend a good deal of time in acquiring very little information. It is well to bear in mind that if you do not succeed in defining as much as you would like on your first attempt, half an hour spent in familiarising yourself with the feel of the several parts will probably enable you to do so.

Returning to our subject. In infancy, as in adult life, the presence of a quantity of fluid in the tunica vaginalis assists in bringing about the escape of bowel and omentum from the abdomen by the strain exerted by its weight through the cord upon the outer limit of the posterior wall of the canal, namely, upon the conjoined tendon. The obliquity of the canal upon which its security depends is lessened and the internal ring is approximated to and finally brought immediately

* A remarkable hepatic case illustrating a mode of examination of the liver suggested by Mr. Alfred Parkin; recovery; remarks. 'Lancet,' October 7th, 1893.

behind the external abdominal ring. This is also increased by the pressure exerted by bowel or omentum in an existing hernia.

While the track is yet oblique, the pressure exerted by a truss on the inguinal canal forces its walls together, and, assisted by the intra-abdominal pressure, prevents their separation by bowel; a very moderate amount of pressure upon the outer wall of the canal seems to effect this, providing its posterior wall is normal.

When the internal ring is so placed as to lie immediately behind the external, the difficulty of retaining the intra-abdominal contents is tremendous, since it is only by the pressure of the pad upon a bung-hole orifice that they can be prevented from escaping. Movement of the pad in any direction freeing a portion of the aperture from considerable pressure allows of the escape of bowel, &c., from beneath the margin of the pad of the truss. The amount of pressure which is requisite to close this orifice is often so great as to become unendurable.

It also depreciates still further the mechanical disabilities of the patient, in that it increases the size of the aperture and so adds to the difficulty of preventing the escape of bowel or omentum. Between the extremes of a canal of almost normal obliquity and that in which all obliquity has been lost there is, of course, every intermediate variety. It is therefore necessary that our treatment of cases of inguinal hernia shall vary with the particular mechanical conditions present.

The general feeling of the present day in the face of the comparative safety of surgical interference, even when in the hands of an operator possessed of little skill and less cleanliness, has tempted surgeons to resort very readily to such active measures as are comprised under the comprehensive term "radical cure."

This may mean almost anything, and I will not attempt to define it, nor describe to you the innumerable methods and modifications of methods that have been devised to meet the difficulty.

Very often some endeavour is made to improve on nature, and almost always the operation is regarded as producing a mechanical condition of such a character as to render it impossible for the contents of the abdomen to escape again in the same situation, although it continues to be exposed to the same factors that determined the formation of a hernia in the first instance.

I have read a great many accounts of the success of various operations, and of the ability of the patient to discard the use of a truss after operations. I have also performed for many years the duties of surgeon to the National Truss Society, and I have seen a large number of patients who have been operated on and in whom a hernia has again formed. In our technical language such are described as "relapses."

I have asked these patients why they had not returned to the surgeons who had operated on them, if only for the reason of helping them to correct their statistics, and have been invariably met by an answer to the effect that they did not intend to be cut about any more. Many asserted that the operation has not only not done them much good, but harm.

I am not venturing to criticise any particular operation, but it seems to me unreasonable to expect that, however skilful the operator, he can produce in the working man a mechanical condition better than the normal.

This canal was presumably normal before the hernia developed, and even if rendered as good as it was before it yielded, if exposed unaided to the same forces it is likely to give way again.

Certainly my experience of the patients of this Society impressed me with the idea that it is not wise to rely too much on statistics, however carefully they have been prepared, and however conscientious the compiler may be.

The principle that has guided me in operating on cases of inguinal hernia is to restore the mechanics of the canal as far as possible to the normal, since I cannot conceive any better arrangement by which the cord can pass through the abdominal wall. To do this it is necessary to fully expose the cord by splitting up the outer boundary of the canal, namely, the aponeurosis of the external oblique along the length of its fibres. The cord is drawn outwards and the conjoined tendon exposed and defined. Its free margin is stitched to Poupart's ligament so as to re-constitute the posterior boundary of the canal in its entirety. The neck of the sac is ligatured, and the sac removed. To utilise the sac as a plug is based upon the false assumption that this structure retains its character after the factors which determined its form, &c., have ceased to exist. The incision in the external oblique is closed, and if necessary any slack taken in.

The patient is kept absolutely at rest in the recumbent posture for five or six weeks in order to allow the sewn parts to unite firmly, every precaution being taken to avoid the exercise of tension upon them.

All that I calculate on from operative interference is that I put back the hands of the clock as regards the hernia, restoring the anatomy and mechanics of the part as far as possible to the normal; so that if the patient is of necessity exposed to the same forces that originally developed a hernia, he is ordered to wear a suitable truss to assist his abdominal wall in performing a function in excess of the normal requirements, which it failed in carrying out without some corresponding additional mechanical support.

We are sometimes inclined to forget that the human frame is only adapted to perform a combination of movements of activity and rest without undergoing change. Any deviation from this results, as I have shown, in a definite alteration of the anatomy of the part, whether it be the constant assumption of a resting posture resulting in its fixation and exaggeration, as in the feeble young subject, or the constant assumption of a posture or sequence of postures of activity resulting in their fixation and exaggeration, as in the powerful coal-heaver and coal-trimmer. In other words, the anatomy of a subject deviates from the normal in proportion as its physiology or mechanics are varied or specialised. In many occupations the abdominal wall, especially the inguinal canals, are exposed to a greater strain than they unaided are able to bear, and hernia is commonly produced. With such labourers it is wise to apply a suitable truss on the earliest indication of the intra-abdominal pressure being excessive.

In advanced life, when there is only a single aperture in the abdominal wall, the tissues are much stretched and wasted, and the hernia is large and a hydrocele possibly present, I prefer to remove the testis together with the sac, to sew up the aperture in the wall, and perform the only operation for inguinal hernia to which the term "radical" can be applied with any accuracy. I have found this procedure give the greatest satisfaction to the patient.

Returning to the infant and young child, we recognise that *the most important factor in the treatment of the case is to reduce the intra-abdominal tension to normal by feeding the child at regular and suitable intervals.* In many cases the hernia ceases to appear when this is effected.

If the child is old enough to wear a washable truss it should be worn constantly, and when removed for purposes of cleanliness the child should be kept on its back, and firm pressure exerted on the part in order to prevent the entry of bowel or even of peritoneal fluid into the sac.

The processus vaginalis being deprived of the pressure exerted upon it by the intrusion through it of bowel, omentum, or peritoneal fluid, undergoes its normal contraction and obliteration, which have been delayed by the presence of an abnormal force, and the hernia ceases to exist.

If, however, the posterior wall of the canal has been much displaced, and the abdominal wall is very lax, an operation similar to that in the adult must be performed.

In cases where there is no displacement of the posterior wall, but in which a truss for some reason cannot be worn, the canal may be split up, and a ligature put round the neck of the sac at the internal ring, telescoping in this way the more tedious and uncertain treatment by pressure. This applies chiefly to the treatment of the children of the poor, or of those who must enter a service, as the naval, at an early age.

There is a general consensus of opinion that while in the young subject it is possible to cure an inguinal hernia by the pressure of a truss, in the adult all that can be done by a truss is to prevent the entry of viscera into or their passage through the canal. So much so is this the case that the patient is directed to remove the truss on going to bed, and to replace it before assuming the erect posture.

As I have already told you, except in old-standing cases in which the aperture in the abdominal wall is a single one, the pad of the truss pressing backwards, inwards, and upwards, tends to increase or re-establish obliquity of the track occupied by the cord.

By means of a well-fitting truss worn continuously, it is often possible to prevent the entry of any structure into the neck of the hernial sac, and consequently to deprive its peritoneal surface of the pressure which in the first instance determined its existence, and without the continued action of which it shrinks up and ceases to exist. It is upon the possibly unconscious knowledge of this, that many irregular practitioners trade. They apply a truss that will effectually retain the contents of the abdomen, and they insist on the truss being worn continuously for a sufficiently long period of time to allow of this shrinkage taking place, because of loss of function. The difficulty the surgeon experiences is in getting the patient properly and accurately fitted with a truss, since the work is of the most difficult character, and has to be done by some one other than himself. The competition among instrument makers to reduce the prices of trusses, the value of their time, and the desire of the patient to obtain a cheap article, all conspire to defeat the aim of the surgeon. I have known large hernial protrusions of considerable standing disappear, and the inguinal canal restored to its normal function, by the constant use of a perfectly fitting truss for a sufficient length of time.

The patient requires treatment other than local, and *the special factors that determined the formation of the hernia must be recognised,* and met as fully as circumstances permit. For instance, cough, constipation, excessive fat, flatulence, stricture, piles, strain from occupation, &c., must, if present, be treated.

A LECTURE

ON

MECHANICAL OR TRAUMATIC ARTHRITIS.

Now, gentlemen, that we have plodded conscientiously through the anatomy and physiology of most of the typical attitudes of activity and of rest which we have been able to study as progressive actualities in great perfection and in the minutest detail in the skeletons of vigorous labourers, and of such feeble subjects as have habitually assumed attitudes of rest, the tendencies to change which exist during the assumption of any single posture of activity or of rest, I propose to consider separately the alterations that take place in the joints of these skeletons, and to contrast with them other articular conditions which are produced mechanically, and which bear to them a certain similarity. The mode of production of the latter differs from the former in that it is due to force applied usually on only one occasion.

To you, who have carefully followed me through the varying changes which the several bones and joints undergo when the functions they are called on to perform differ from the normal, I feel that I owe an apology for reconsidering, however briefly, material we have thoroughly threshed out, but I do so for two reasons. One is that, owing to a want of familiarity with pressure changes, and consequently with the normal physiology of the skeleton, you will constantly find surgeons describing the structural changes which you have seen to result from an altered physiology, and which are perfectly normal to the individual in his peculiar mechanical relationship to his surroundings, as being the products of disease. This I think due largely to the fact that the presence of any deviation from what is considered in anatomical works to be the normal form and type of bones and joints (in other words, the average or common type), such as partial or complete ankylosis of amphiarthrodial joints, the conversion of amphiarthrodial into arthrodial types, the eburnation and limitation of the range of movements of moveable joints, the development of completely new joints, &c., invariably suggest to their minds the necessary presence at some antecedent period of some inflammatory condition, and they will talk glibly of their having been produced by tubercular or other form of inflammation; while occasionally, when such suppositions are too manifestly absurd, they will fall back on the term "congenital," and speak of the appearance presented as an "abnormality." Gentlemen, I would warn you to avoid as far as possible this feeble mode of trying to avoid the careful consideration of a mechanical problem. The less keen the observer, the more readily does he support himself with this prop. I need only mention this to you, since you are already thoroughly familiar with the very definite changes in bones and in the intervening soft parts which of necessity follow upon variations in the manner in which pressure is transmitted through any part of the skeleton.

The chief blame for this want of knowledge on the part of the surgeon rests with the anatomist, who ignores almost completely the physiology of the skeleton in his irregularly distributed treatises upon its structure. As I have shown you, it is exceedingly difficult to arrive at a knowledge of the functions of the skeleton by confining one's observation to the study of the so-called normal skeleton; and that it is only by the careful examination of the fixed and exaggerated *attitudes of activity* and *of rest* that it can be done with comparative facility, perfect certainty, and scientific exactitude. Each attitude admits of accurate examination and explanation.

The second reason is that changes in joints somewhat similar in appearance to those you recognise as being produced by the habitual assumption of attitudes of activity or of rest may result from the sudden transmission through them of considerable pressure, as in the case of a forcible impact being sustained by the part. These changes, as you see from an examination of these specimens, possess only a most superficial resemblance to those we have previously examined; yet to the surgeon who is unaware of the manner in which the latter are brought about they are practically indistinguishable. As you are aware, the term rheumatoid arthritis is that which is almost universally applied to the majority of these conditions. Since it is one that your examiners will insist on your using, you must sacrifice your common sense and knowledge till you have passed beyond their control.

Of the pathology of true rheumatoid arthritis we know at the present moment little more than enough to say that it resembles in no manner the pathological conditions to which the term is applied almost universally. I do not propose considering it here.

In the 'Transactions of the Pathological Society,' 1886, I communicated a paper entitled the "Causation and Pathology of the So-called Disease Rheumatoid Arthritis, and of Senile Changes," in which I pointed out that all the conditions which were described pathologically as being produced by the presence of this disease rheumatoid arthritis were produced mechanically; and I could not find in our museums any specimens of so-called rheumatoid arthritis which was not caused in this manner, and had obviously no causal relationship whatever with the disease rheumatoid arthritis as we know it clinically in the present day. I showed that precisely similar changes occur in the skeletons of animals, brought about in the same manner. My subsequent experience has served to strengthen the position which I took up at that time, and I have in previous lectures endeavoured, as far as possible, to familiarise you with the details of the facts and arguments upon which it was built up. The term which I applied to these mechanical changes in the skeleton was one which suggested the mode of their causation, namely, "*mechanical or traumatic arthritis*;" and you will, I think, agree with me that, being fully descriptive, it is a very serviceable and scientific one. At the same time I do not for one moment use the term arthritis as suggesting any inflammatory causation.

I am very pleased to find that my keenly observant and critical friend Mr. Bland-Sutton has been able to confirm my statements as to the development of mechanical arthritis in domestic animals due to a laborious occupation.

I will now formulate a few statements regarding pressure changes in bones and joints other than those brought about by the exercise of considerable force abruptly to the part on a single occasion, and with each I will give you one or more references to conditions already fully described, and which serve as ample evidence or proofs of each.

1. That the so-called normal anatomy of a joint, of whatever form, remains normal only as long as it is called on to perform a usual combination of attitudes of activity and of rest.

2. That the habitual or frequent adoption of an attitude of activity or of rest produces a fixation of the attitude, which becomes exaggerated later. This results from changes in the joints, and in the growing subject it is modified largely by the consequences of unequal pressure exerted on the epiphysial lines in obedience to the general law which I formulated, viz. that *the rate of growth of bone in the several parts of an epiphysial line varies inversely as the amount of pressure transmitted.*

The joint changes consist in the gradual compression, absorption, and, finally, the complete removal of the soft parts in places through which an excessive pressure is transmitted, and in advanced cases the opposing bony surfaces may unite to one another by bone. On the margin of the bones which are compressed lips of dense osseous tissue are formed, and such adjoining growths readily unite.

The behaviour of any particular joint varies with its character and the peculiar function it carries out. While amphiarthrodial joints readily ankylose, in enarthrodial joints areas of articular cartilage are removed, the exposed bony surfaces are eburnated, and the form of the articulation is changed by the marginal deposit of new bone. For examples of these changes I would refer you to the joints of the porters, coal-heavers, coal-trimmers, shoemakers, sailors, charwomen, and other labourers, together with those of cases of lateral curvature, dorsal excurvation, knock-knee, and flat-foot which we have examined. These diagrams illustrate some of the conditions referred to.

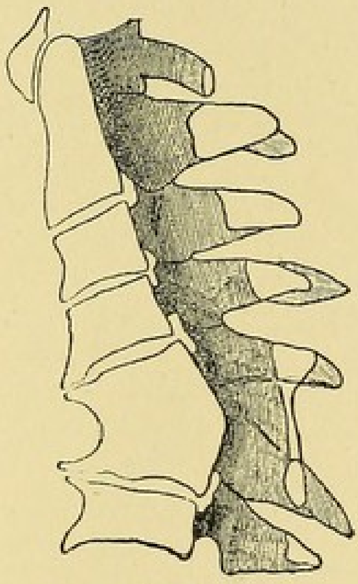


Fig. 130.

Fig. 130 represents a vertical median section through the cervical spine of a labourer. It shows very well the destruction of the soft parts between several of the bodies of the vertebræ resulting in complete ankylosis of the fifth and sixth, with ossification of the ligamenta subflava, under the influence of excessive pressure in the one case and excessive strain in the other. The bodies of some of the other vertebræ are also altered in form.

Fig. 131 shows the fourth to the ninth dorsal vertebræ in vertical median section. This was obtained from the body of a labourer. The function performed by the dense supporting callus in enabling the spine to support its load is so obvious in the drawing that I need not explain it further.

Figs. 132 and 133 represent vertical transverse sections through the acetabular cavities of a charwoman

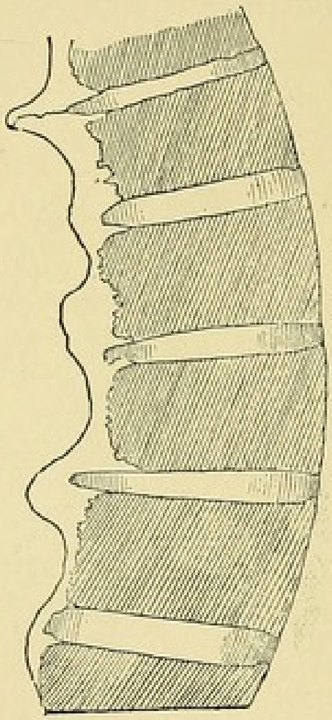


Fig. 131.

whose anatomy I described in the 'Guy's Hospital Reports,' 1886–1887: "Some changes in the form of the acetabular cavities, spinal column, and joints of the hand, illustrated by the anatomy of the charwoman."

In Fig. 132 the bony and cartilaginous articular surfaces have been extended downwards, so as to encroach to a very considerable extent upon the area of the original non-articular cavity in the floor of the acetabulum.

In Fig. 133 the non-articular area is normal in form and extent. The upper portion of the cavity has been extended outwards by a deposit on its margin, while the upper concave aspect of the acetabulum is deprived of its articular cartilage, the exposed bone being somewhat eburnated.

3. That pressure exerted directly upon bones alters

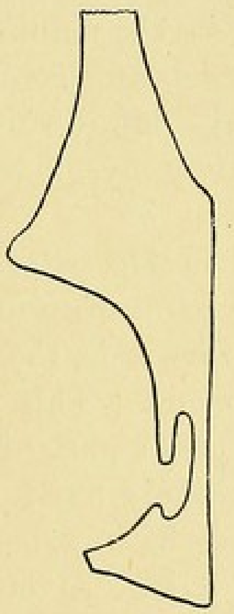


Fig. 132.

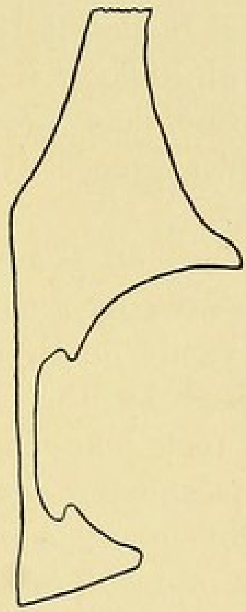


Fig. 133.

their form in a manner varying with the character of the pressure is shown by the sternum of the shoemaker, and the progressive section of the lamina of the fifth lumbar vertebra in the spondylolisthetic condition of the coal-heaver, and by the divided fourth lumbar lamina in the fully developed coal-trimmer, &c.

4. That excessive movement readily alters a joint from the amphiarthrodial to the arthrodial type.

This is shown exceedingly well by the arthrodial joint which develops between the bodies of the lumbar vertebræ in the coal-trimmer, the developing joint in the ossifying cartilage of the first rib, &c.

Perhaps, to those who have neither the time nor inclination to plod through all this detail, the following description of the normal anatomy of a case of torticollis will explain a great deal. It was obtained from the body of an aged female which I dissected; I published the case in the 'Transactions of the Pathological Society,' 1884. As the manner in which a varying physiology regarded as an altered mechanical condition has produced definite changes is obvious and simple, I will satisfy myself with a mere description.

Woman æt. 60 years. The left sterno-mastoid was represented by a narrow band of tendon. The face could easily be directed forwards, the chin being a little raised by the movement. This movement apparently took place in the lower part of the neck, the upper part being comparatively fixed. It was a gliding movement, combined with some rotation around an antero-posterior axis. A large curve, with its convexity to the right, occupied the lower cervical and the dorsal spine. The normal convexity of the dorsal curve was increased considerably, and that of the cervical curve slightly.

The upper three cervical vertebræ were normal. The fibro-cartilage between the fourth and fifth cervical vertebræ was wedge-shaped, the apex of the wedge being to the left. Over it the left margins of the bodies of the vertebræ had fused by an osseous deposit. Union to a greater extent had taken place between the fifth and sixth vertebræ on the left side. The left articular processes and the halves of the laminæ had fused together, forming one deep lamina.

The body of the seventh cervical was much diminished in depth, and there was much osteophytic growth at its margins. The anterior ligament which connected it originally to adjacent vertebræ was absent.

Lying on this and on the adjacent vertebræ, and behind the œsophagus, was a loose synovial cavity, which communicated with synovial spaces formed by the partial, and in some cases complete, destruction of the fibro-cartilages above and below the body of the seventh cervical vertebra, so that, instead of the amphiarthrodial joints which exist normally in this situation, there were two of an arthrodial type, and allowing of very free movement indeed.* The margins of the dorsal vertebræ presented much bossing, and many were more or less completely ankylosed by this dense bony material, viz. the sixth, seventh, and eighth, and the ninth, tenth, and eleventh dorsal vertebræ. The deformity and inconvenience produced by the degenerated muscle was, to a very great extent, overcome by the formation of this very large curve, by the diminution in depth of some of the vertebræ and of the fibro-cartilages, by the alteration in the shape of the vertebræ, and by the formation of the remarkably complete arthrodial joints in connection with the body of the seventh cervical vertebra.

This case shows very well the effects of pressure

* I would remind you of the very similar condition in the lumbar region of the coal-trimmer described and illustrated in an earlier lecture.

alone in causing diminution in thickness of the fibro-cartilages, and later, if there be much movement, the formation of articular cavities, while, with a greater limitation of movement, pressure causes, as well as absorption of the cartilage, the formation of osteophytic growths from the margins of the vertebræ at the seat of greatest pressure, and later, partial or complete fusion of the bodies of the vertebræ.

I propose now to show you some specimens illustrating the condition of mechanical or traumatic arthritis as brought about by the sudden and abrupt transmission of a considerable amount of force through a joint or joints on a single occasion.

I would just remind you of a fact to which I called your attention when we were considering the influence exerted upon dependent joints by such alteration in the mode in which pressure was transmitted through them by the unsatisfactory union of fragments when one or more long bones are fractured, a condition which almost inevitably results in a greater or less degree from the very imperfect and utterly unscientific manner in which these injuries are treated in the present day. It is that *the changes which develop vary with the age and with the vigour of the subject.* Up to a certain age bone, cartilage, and synovial membrane are readily evolved, while later in life such compensatory changes in the form of bone do not result without destruction of articular cartilage, eburnation, and other frictional changes in the opposing bony surfaces, marginal deposit of bone, with increase in the bulk of the synovial membrane and of its secretion, &c., —all changes coming clearly under the head of mechanical or traumatic arthritis.

I will now proceed to illustrate, by clinical history and by pathological specimens, several typical examples of this variety of mechanical or traumatic arthritis.

1. An elderly woman trips over a piece of orange peel, and falls heavily upon the extended palm. The lower end of the radius resists the breaking strain which it sustains, and the whole of the force which is transmitted along the shaft of the radius is impacted upon the radial head of the humerus, bruising the opposing surfaces of articular cartilage severely. After the accident the elbow-joint becomes painful, the joint remaining more or less completely fixed in the position in which it sustained the injury. After a time the tenderness in the part subsides, and the patient acquires some degree of movement, chiefly in the direction of rotation of the shaft of the radius, the range of flexion of the elbow-joint continuing very limited. On examining the joint the head of the radius is found to be much altered in shape, and the radial head of the humerus presents much bony deposit upon its margins. The styloid process of the radius occupies an abnormal relationship to that of the styloid process of the ulna, being on a higher level than on the opposite side. The pathological condition shows a destruction of the articular cartilage covering the opposing surfaces of the radius and humerus with frictional changes and sclerosis of the exposed bones. A quantity of new bone is deposited around the head of the radius, and about the altered and limited facet on the humerus. A certain slight amount of change of a similar nature has taken place in the humero-ulnar and superior radio-ulnar joints, but

this is due to extension from the radio-humeral segment in a simple and mechanical manner. Fig. 134 represents diagrammatically the changes which such a joint undergoes. The part is looked at from the front.

This specimen illustrates very well the relative amount of force transmitted to the humerus directly through the radius, and indirectly through the interosseous membrane and ulna.

2. A man, past middle age, falls heavily upon his

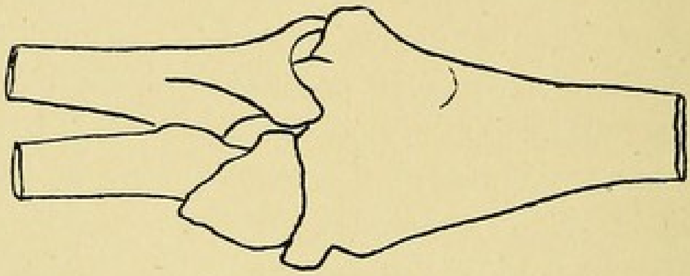


Fig. 134.

side, striking the great trochanter with much force. In consequence of this injury he experiences great local pain in the hip-joint, which is aggravated by movement of it. If the legs are measured, they are found to be of equal length. The patient finds that after the injury his leg is not so reliable as it was before—that the movement of complete flexion of the hip-joint is accompanied with discomfort at first, and later with pain, so much so that any movement of the joint is avoided as much as possible. He also suffers discomfort or pain in the joint in damp weather or during the cold east winds. I believe it is the similarity of this pain to that felt by rheumatic patients that has led clinical observers to include this traumatic condition among those classified under the old headings of "rheumatoid arthritis," &c. I need hardly point out that after an injury to a bone, such as fracture, &c., the sufferer often complains of the same kind of pain under the same atmospheric conditions. After a time the patient notices that the damaged leg has become shorter than its fellow, and actual measurement shows that this is the case. This shortening increases during the lifetime of the patient, if he continues to throw his weight upon the articulation. The joint becomes progressively less secure until at length the weight of the body cannot be supported by it at all in many cases. Soon after the receipt of the injury grating can be felt on flexion or extension, and this sensation becomes more marked as time goes on. If such a joint be examined after death, the head of the femur and the acetabulum are found to be completely altered in form and character. The opposing surfaces of the innominate bone and femur are rubbed down, sclerosed, and eburnated, while around these eburnated surfaces there is an abundant deposit of more or less dense bone, whose obvious function is to compensate for the alteration in the direction in which force is transmitted through the joint, and to render it as secure as possible under the circumstances. The capsule has become thin and lax, and has ceased to perform most of its normal functions. The synovial membrane in the joint is bulky, and contains an abnormal amount of synovia. Figs. 135 and 136 represent the condition and its mode of production from the normal state. The opposing surfaces of articular cartilage have been bruised sufficiently to interfere with their vitality, and there being no means of replacing the damaged tissue it is removed. The habitual transmission of force through the damaged joint results in the progressive destruction of the remainder of the articular cartilage, in the exposure, eburnation, and the gradual removal

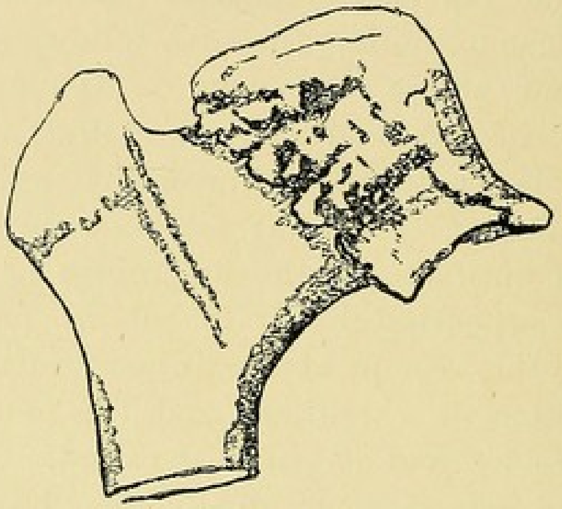


Fig. 135.

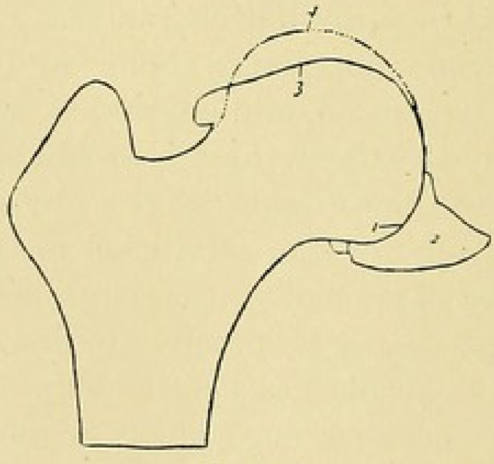


Fig. 136.

of the subjacent articular lamella of bone. These changes are followed by the others already described, the factors determining their evolution being solely mechanical. This all seems very simple and obvious to you. Yet at the time I wrote the paper already referred to in the 'Transactions' of the Pathological Society, this condition was, and, for all I know, may still be described in a well-known text-book of surgery as "interstitial absorption of the neck of the femur." Such a pathology is founded on imagination and not on fact.

3. The following serves as another instance of chronic traumatic arthritis. A man falls heavily on the outer surface of his shoulder. He suffers much pain at the time, and he can neither bear the shoulder-joint to be moved, nor can he perform any active movement himself, on account of the pain associated with it. If the shoulder be examined no fracture can be made out, and the outlines of the humerus and of the glenoid cavity are normal. The symptoms progress as in the case of the hip. The shoulder becoming flattened, the patient is unable to abduct the humerus, and the movements of the shoulder-joint become limited finally to a moderate amount of flexion and extension. On examining the joint after death, the opposing surfaces of the head of the humerus and of the glenoid cavity are found to be deprived of cartilage, the articular layer of bone is rubbed down and eburnated, and the surface of the humerus is rendered flat or but slightly convex, being much increased in breadth by the deposit of bone upon its margin. The articular surface of the scapula has undergone similar changes. The synovial membrane is bulky, and the muscles of the shoulder, especially the abductor muscles, are much wasted. Here, again, the causation is quite simple. Force is applied to the outer surface of the humerus in such a direction that its articular surface is driven forcibly against

that of the scapula, at right angles to the surface of the latter. Changes ensue in the manner already described in the hip.

Fig. 137 represents the shoulder-joint of a cabman who fell off his cab and pitched on the outer aspect of his shoulder. It exhibits the condition just described.

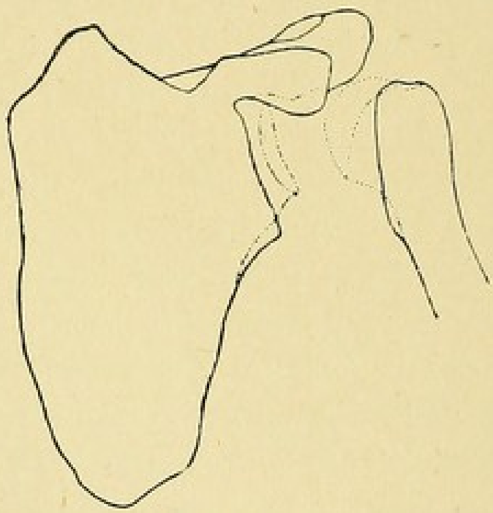


Fig. 137.

4. I would instance one more variety of traumatic arthritis in this joint. An elderly man receives a heavy blow, or pitches heavily on the point of his shoulder, breaking his acromion process, whose loose fragment is driven forcibly downwards upon the upper surface of the adducted humerus, bruising its articular surface severely, together with the intervening capsule and tendon of the supra-spinatus. Degenerative changes ensue in the contused portion

of the articular cartilage, and gradually extend to more or less of the remainder of the cartilage of the head of the humerus, and to that of the glenoid cavity. The upper portion of the capsule, with more or less of the tendon of the supra-spinatus, is gradually destroyed, and the humerus comes sooner or later into direct contact with the moveable fragment of the acromion. The constant movement of these bones upon one another results in further changes in both, the acromial portion becoming excavated, eburnated, and lipped. The intra-capsular portion of the biceps tendon is destroyed, the long head acquiring an attachment to the altered great tuberosity. Other changes develop at the same time in the synovial membrane. I would call particular attention to this last injury, as it bears in an important manner on the elucidation of the causation and pathology of chronic traumatic arthritis. I showed that fracture of the acromion is of very common occurrence, and that the supposed rarity of the fracture depends upon a want of skill in recognising its existence. Also, non-union is due to the fact that unless the accident is diagnosed, which it very rarely is, or unless it be accompanied by some more severe injury, as fracture of the upper end of the humerus, the shoulder is not kept at rest for a sufficient time to allow of the acromial fragments uniting by bone, and as a consequence a false joint forms. When the blow which produced the fracture was sufficiently severe to contuse the articular cartilage of the head of the humerus and the intervening soft parts, the changes I have just described follow.

Anatomists are largely responsible for the non-recognition of these fractures, since they have chosen to regard the resulting ununited conditions as examples of non-union of an epiphysis, and, so far as I can see, upon no reliable evidence whatever. Surgeons have readily accepted the explanation of the anatomists, apparently without investigating them. They have, however, observed the frequent association of this so-called ununited epiphysis with the presence of chronic rheumatoid changes in the shoulder-joint, and have explained the cause of their association in various ways. One has gone so far as to assert that in cases of chronic rheumatoid arthritis of the shoulder-joint, a disunion of the acromial epiphysis from the rest of the bone takes place. Such a statement hardly calls for criticism, and I only mention it to emphasise the frequency with which those changes which the pathologist regards as characteristic of the disease, rheumatoid arthritis of the shoulder-joint, are found associated with ununited fracture of the acromion. Can anything be more obvious and simple than the mode of development of an ununited fracture of this process of the bone, if one considers for one moment its position and muscular attachments, together with the difficulty of retaining the broken fragments at rest for any length of time, even if the fracture be recognised? The only two examples of bony union which I have observed in fracture of the acromion occurred in cases in which there existed in addition a severe comminuted fracture of the upper end of the humerus. Owing to the pain resulting from the presence of the latter fracture, the shoulder was kept at rest sufficiently to allow of bony union of the acromial fragment. Though I might multiply such instances of traumatic arthritis almost indefinitely, I think I have said enough to show that a severe injury to a joint is liable to be followed by the development of such pathological conditions as surgeons are still accustomed to regard as evidence of the presence of rheumatoid arthritis.

ANTRECTOMY AS A TREATMENT FOR CHRONIC PURULENT OTITIS MEDIA.*

As several years have elapsed since I first suggested and performed the operation which I called *antrectomy* for cases of chronic purulent middle-ear disease which did not yield to ordinary treatment, I feel that I should now make a general statement as to the subsequent career of these cases after operation, particularly in reference to the persistence of the very remarkable improvement in hearing capacity which follows within a very few days upon this treatment, and which was in many cases so complete as to defy the detection of any auditory imperfections in ordinary conversation by the lay observer.

By antrectomy I mean the complete obliteration of the antrum; or if that is impossible, owing to its having acquired considerable dimensions, the sufficient removal of its walls to prevent the formation of a cavity or sinus in the same position at any subsequent period.

The details of this operation differ from those adopted by Schwartze of Halle, the pioneer in this section of aural surgery, who exposed the antrum through an aperture in the mastoid process, the

* Reprinted, with slight alteration, from 'Archives of Otology,' vol. xxi, No. 2, 1892.

diameter of which did not measure more than 15 mm. across. From his description it seems to me that he merely opened and cleared out the antral cavity, and did not of necessity permanently obliterate it, performing an operation of antrotomy rather than of antrectomy. Practically antrectomy has very great advantages over the operation devised by Schwartze, to whom we are so greatly indebted, in that it is very much more thorough, certain, and effectual. It is also much easier to perform, which is an important matter in an operation that occasionally presents considerable difficulties.

I would briefly remind the reader of the several points in reference to this operation, to which I have directed attention in previous papers,* some of which I believe were more or less original.

I believe I was able to demonstrate—

1. That the antrum plays a very much more important part in the pathology and causation of chronic purulent otitis media than is generally recognised. It steadily enlarges, and becomes a progressively increasing obstacle to cure by treatment applied to the middle ear.

* 1. "Five Complicated Cases of Middle-Ear Disease," 'Trans. Clin. Soc.,' 1889.

2. "The Treatment of Suppurative Inflammation of the Mastoid Process associated with Disease of the Middle Ear," 'Brit. Med. Journ.,' March 29th, 1890.

3. "Two Cases of Subdural Abscess resulting from Disease of the Antrum and Middle Ear," 'Brit. Med. Journ.,' 1890.

4. "Treatment of Chronic Otitis Media," British Medical Association, 1890.

5. "The Treatment of Pyæmia consequent upon Disease of the Middle Ear and Unassociated with Thrombus of the Lateral Sinus," 'Brit. Med. Journ.,' June 28th, 1890.

6. "Abstract of Clinical Lectures on Inflammation of the Middle Ear and its Complications," 'Lancet,' September 26th, 1891.

2. That this cavity had only recently received from surgeons, anatomists, and physiologists the attention it deserves, being ignored by or unknown to some, while by others the term was applied to some of the irregular cavities, which are frequently present in the substance of the mastoid portion of the temporal bone. The antrum is often figured and described as the orifice by means of which the mastoid cells communicate with the back part of the tympanum. Very scanty allusion is made to the structure in anatomical works, nor can I find any description of the manner in which the mastoid cells establish, during their development, this supposed communication with the middle ear.

3. That the antrum has no anatomical or physiological relationship with the mastoid process or its cells, but that it is situated in the petrous bone, and is physiologically and anatomically a part of the middle ear.

4. That the chief if not the sole function of the antrum is to secrete and store up mucus with which to lubricate and moisten the middle ear and its contents, in a manner analogous to the purposes served by the sacculus in the larynx, the surplus finding an exit into the pharynx through the Eustachian tube. It varies somewhat in size in different subjects, but, as a rule, it measures about a quarter of an inch in length by an eighth of an inch in depth and breadth.

5. That a considerable number of mastoid processes consist throughout of very dense bone, or of bone containing but a few minute cancelli.

6. That a large number contain only in the apex of the process, and in its vicinity, cavities which

vary in size from minute cancelli to cells of considerable size.

7. That in only a comparatively small number does the mastoid bone contain the two groups of large spaces or cells described by anatomists. It has been pointed out by other observers besides myself that the older ideas as to the mastoid process being made up largely of cells were absolutely fallacious, and that the presence of dense bone free from any but the smallest cancelli is not the result of chronic inflammatory changes—a mistake I have known made very frequently by surgeons. What I think an anatomical and surgical fact of great importance is, that with chronic purulent otitis unassociated with attacks of tenderness and inflammation of the mastoid process (but accompanied by deep-seated pain in the same side of the head and perhaps also deep in the ear), in fact, just such cases as I am calling attention to in this paper,—you are sure or almost sure to find the mastoid process nearly free from cells, and probably also from cancelli; indeed, it is usually composed throughout of very hard dense bone.

8. That in the healthy subject the normal antrum may become continuous with the cells in the mastoid process, owing to their encroaching upon it in their subsequent development. This occasional occurrence probably accounts for the incorrect description of the anatomists.

9. That when a chronic purulent otitis media has existed for some time, the antrum has increased in size, its cavity being filled with decomposing and irritating caseating secretion, which by its presence causes the progressive absorption and destruction of the wall of the cavity. In this way the dura mater

of either fossa, with the lateral sinus, may be exposed, and form a portion of the boundary of the enlarged antral cavity.

10. That the antrum, as it increases in area, encroaches more or less upon the mastoid bone, and may establish communication with the mastoid cells if they exist in a high degree of development, these also becoming filled with a material similar to that which is present in the antrum. If, however, the antrum before it had become inflamed was in communication with mastoid cells, the latter of course would participate simultaneously in the inflammatory process.

11. That if the antral cavity be much enlarged, it is perfectly hopeless to attempt, with safety, to clear it of its foul, tenacious, thick contents by any process of irrigation or operation through the external auditory meatus; and even if it were possible to do this it would only be a matter of a few days or weeks before the antrum again becomes choked with decomposing secretion.

12. That while the enlarged antrum is filled with its irritating contents, aërial conduction may be partially or completely absent, and that within a few days after the operation of antrectomy and cleansing the middle ear, though the patient may have been absolutely deaf in that ear for more than twenty years, ordinary conversation will be heard readily. In such a condition it is just a little difficult to understand by what means the presence of the caseating material in the middle ear and antrum is able to keep the hearing capacity of the internal ear in abeyance, so that within a few days after its removal the acuteness of hearing becomes almost as keen as ever. It is pro-

bable that it acts partly mechanically as a buffer to sounds, and partly by keeping up inflammatory irritation, much as the dry crusts sometimes do in ozæna.

13. That the facial nerve bears a very important relationship to the aperture by means of which the antrum communicates with the middle ear, since it lies immediately to its inner side, and that any uncertain interference with this opening may result in permanent damage to the nerve.

14. That the chief function of the membrana tympani is to prevent evaporation of the secretions of the middle ear and antrum, and that its presence is not necessary in order to hear ordinary conversation with acuteness.

15. That after antrectomy, in order to retain the hearing capacity in the improved condition resulting from the operation, it is necessary to replace the functions of both the antrum and the membrana tympani. The former is done by daily irrigation, and by the introduction of some antiseptic, and evaporation is prevented by placing in the meatus a small plug of lamb's wool. This, should it become moistened by secretion, does not form a dense mass, as does cotton wool, but continues to allow the free passage of vibrations through it.

I have now performed antrectomy a very considerable number of times upon patients suffering from chronic purulent otitis media, and very often from pain, either more or less continuously, or at intervals, over the whole side of the head, or perhaps only over the mastoid process and above the ear; sometimes neuralgic in character, and at other times described as being boring, or throbbing, or like a deep-seated abscess, and very often preventing the patient from lying on that side of the head when in bed. In many of these cases the patient did not complain of pain or tenderness when the mastoid process was forcibly compressed with the thumb, or struck with a pleximeter. Such patients not uncommonly have a slight but distinct rise of temperature in the late afternoon or in the evening, showing that some absorption of septic products takes place constantly from the antrum, and produces a harmful influence on the health of the sufferer.

I need hardly point out to you how great a source of danger to the patient is this cavity filled with many varieties of organisms, which are capable of setting up mischief elsewhere, when the vitality of the individual is depreciated generally or locally. It seems to me that the profession generally are hardly sufficiently alive to the importance of this, and do not regard the diseased ear with the fear and suspicion it merits.

In all, or nearly all these cases, the antrum was enlarged—in most cases very considerably so,—and, what is a matter of the greatest importance, the mastoid bone hardly ever contained any but the most minute cancellous spaces; but, on the other hand, it was often so dense as to take a good hour's hard work or more, with gouges and a heavy mallet, to expose the antral cavity. I prefer these implements to the use of burrs driven by electric or other motors.

I do not suppose any surgeon of the present day would have the hardihood to attempt to expose an antrum by the process described and illustrated in most works on operative surgery. It is only right, however, to remember that the conditions for which we usually do antrectomy now-a-days were not recognised when the trephine was used for this purpose.

I am not, of course, considering the conditions that are so common in inflammation of and suppuration about the mastoid process. One has heard of mastoid cells distended with pus being readily opened by the use of even so clumsy, unsuitable, and dangerous an instrument as the small trephine, and then being cleared out with a sharp spoon; possibly, too, the antrum is also found and cleansed, especially if much enlarged and communicating with the cells by an aperture of any size.

I do not suppose that any surgeon in the present day would be sufficiently unfamiliar with the anatomy of the part as to venture to apply such a dangerous implement as a trephine for the purpose of exposing the antrum; but it is not so many years ago since it was recommended and made use of, not unfrequently with disastrous results.

It is at once obvious that the deep-seated inflamed antrum, covered almost always, in the cases I particularly wish to call attention to, by about three quarters of an inch of very dense bone, is infinitely more dangerous to the life of the individual than an antrum in immediate relationship, or in direct communication with large cells in the mastoid bone; since the latter, when inflamed, at once makes itself obvious to the most inexperienced surgeon, and even if he does not interfere, the pus usually escapes externally at last.

That the pain in the head from which the patient with the enlarged antrum suffers is in most cases due to an obvious chronic inflammation of the dura mater in immediate relation with the antrum, I have been able to demonstrate on very many occasions.

By exposing the antrum in such cases, by the careful use of the mallet and gouges, and by scraping the cavity with sharp spoons, and then by subsequent removal of overhanging bone, so as to make the gouged inner wall of the antrum the floor or apex of a cone, the base of which is rendered as broad as possible in order to remove the sides of the enlarged antral cavity, and by plugging the cavity for a considerable time with iodoform or other gauze till the skin forms a depression on the surface of the obliterated inner wall of the antrum, its cavity is permanently obliterated, and the floor of the cone becomes partially filled up with fibrous tissue. The duration of the operation in the case of very dense bone may be much curtailed, and the procedure itself facilitated by the use of an electric motor and burrs. If the middle ear is much diseased it is then thoroughly cleared of its contents, any relic of the membrana tympani being carefully removed, and, if it seems advisable, the aperture of communication with the antrum may be somewhat enlarged by the removal of portions of its outer boundary, the whole of the posterior boundary of the external auditory meatus having been left intact as far as possible when the mastoid process was cut away. In performing this last stage of the operation the greatest care must be taken to avoid injuring the facial nerve, and up to the present I have succeeded in doing so. On one occasion the muscles of the side of the face twitched distinctly, but no harm resulted. Though it has never been my misfortune to damage this structure, it is, I believe, the chief—I may say the only—risk of the operation; yet it is one that would be most distressing to the patient, and should therefore always be in the mind of the surgeon should he consider it advisable to enlarge the aperture into the middle ear.

If there is no perforation in the membrana tympani, or if with a perforation of small size there is no evidence of extensive disease of the middle ear, the membrane may be left untouched with advantage.

As regards the subsequent condition of the patient, months or years after the operation, when the simple daily routine of cleaning the ear and introducing a plug into the meatus is followed, the hearing capacity not only retains its improved condition, but often becomes more acute. If, however, the patient is dirty and careless, and pays no attention to the ear after he passes from observation, the hearing capacity gradually diminishes owing to the accumulation of dry secretions and inflammatory materials in the middle ear. My experience of the operation is that it is one of the most satisfactory and useful operations that we have in surgery. In skilful hands it is accompanied by practically no risk; it is followed by no pain worth talking of; it absolutely frees the patient from subsequent risk from intra-cranial complications if the simple directions as to cleansing, &c., are followed; it removes the foul discharge; the headache, neuralgic pain, and tenderness disappear; it very often cures any existing facial paralysis; it prevents the formation of aural polypi; and it gives the patient back almost perfect hearing, which remains in the same condition or improves if only such small trouble is taken as the ordinary cleanly person habitually devotes to his teeth.

I would point out, however, that by ventilating the naso-pharynx systematically and habitually, and in this manner diminishing largely the tendency to obstruction of the Eustachian tube, it is possible in many cases to relieve the patient sufficiently of the inflammation of the middle ear and antrum to obviate the necessity of performing antrectomy. I have also found these simple means of the greatest service in other conditions of the ear due to Eustachian obstruction.

Antrectomy should form a necessary portion of the operative procedure in any complication of middle-ear disease, whether it be cerebral or cerebellar abscess, extra-dural abscess, or infective thrombosis of the lateral sinus. In reference to the last complication, which is now treated so generally and effectually, the first case of aural pyæmia which was ever operated on by ligature of the internal jugular vein and removal of the thrombus, and in which I acted upon a suggestion made some little time before by Mr. Victor Horsley, now enjoys, after the lapse of twelve years, excellent health, unimpaired by the alteration in the circulation. This operation was performed in August, 1888.

In one case of aural pyæmia I was able to save my patient's life by removing the lower limit of a septic clot from the left innominate vein after I had eradicated practically the whole of the internal jugular vein on the same side.

ON THE PRINCIPLES THAT SHOULD GUIDE US IN THE OPERATIVE TREATMENT OF CANCER.

In the operative treatment of cancer our chief aim is the complete eradication of the disease, which should, if possible, be effected at all costs, for the reason that unless it is removed in its entirety it must in the ordinary course of events prove fatal. This should be made perfectly clear to the patient if any objection on the score of mechanical disability or deformity is urged against it. The extent of the operation must vary directly with that of the disease, and the more extensive and thorough the operative procedure for the removal of the growth the greater is the immediate risk to life from it. Of course, in a proportion of cases an operation is performed not so much with the object of removing the disease as of meeting complications consequent on its presence, as in intestinal obstruction due to growth. While the surgeon should be prepared to accept any risk that an extensive radical operation must involve, he should at the same time not omit to take infinite pains to render the condition of the patient such that a minimum of pain and discomfort shall result from his action. I think that we sometimes fail to bear this important point sufficiently in mind. I will illustrate my meaning by referring to certain operations on the larynx and tongue that have interested me. It was, I believe, the universal custom in excision of the larynx to leave the air passage in communication with the pharynx. While this state of affairs entailed of necessity upon the patient great pain and suffering, usually very much more than was experienced before the operation, it added very largely to the risks of surgical interference. It seemed to me that this method was clumsy and unscientific, and that the larynx could be removed quite as effectually and the discomfort and risk minimised by shutting off the communication between the air passage and pharynx. I applied this principle in an operation of excision of the larynx performed in February, 1891, upon a patient suffering from cancer of this organ, and in whom there were some infected glands which I feared could not be completely removed. The following is an extract from the report of the case in the 'British Medical Journal,' April 4th, 1891 :—"It was determined to make the rest of his life as comfortable as possible, and to save him from any of the inconvenience which so frequently follows excision of the larynx from the passage of food, saliva, or serous discharge into the trachea, as well as from the risks of pulmonary complications which result from the same. For these reasons the mucous membrane, which had been separated from the back of the larynx, was carefully sutured to the hyoid bone and along the middle line, so that the pharynx was no longer in communication with the trachea. On the day following the operation he wrote on a slate that he had experienced no pain whatever, and that he was very comfortable. During the several succeeding days he appeared to suffer even less pain and discomfort than is entailed by an ordinary tracheotomy. He had little or no cough, and only expectorated a small quantity of mucus, the Trendelenburg cannula (which was inserted at the time of the operation and retained for some days) being removed and cleaned twice daily. Within forty-eight hours of the operation he was able to swallow milk with relish, and none of it escaped from the wound in his neck. A small leak formed later immediately below the hyoid bone, owing to his suddenly tearing off the dressing when in a passion. This closed quickly under treatment."

It is clear from this that the application of the principle of the separation of the air passage from the pharynx robbed of most of its terror an operation which was otherwise accompanied by so much pain, distress, and risk, and I am pleased to see that surgeons are now generally adopting it.

Again, in operations for the removal of the tongue the surgeon amputates this organ in a manner that differs very little in its crudeness from that which used to be adopted by the executioner in past times. A large raw surface is left which must heal in the most tedious manner possible by a process of granulation and cicatrisation. The abundant discharge from this surface, mixing with the saliva, is swallowed with difficulty, and affords a very good medium for the cultivation of all sorts of organisms. They are a source of danger, and are depreciating to the vitality of the patient. It is difficult to grasp the principle that leads the surgeon to amputate one portion of the body in this manner, while his mode of removal of other parts is influenced by a very different one. For instance, it would never occur to anyone in amputating a limb to leave a large raw surface of muscle unprovided with any skin covering to heal in this way if it were possible to avoid doing so. It cannot be that in making suitable flaps he is afraid of leaving some structure already affected by the disease, since this can easily be avoided in any case in which the tongue can be removed with reasonable hope of the complete eradication of the growth from the body.

Recognising how much the patient would be relieved from pain, distress, and risk by the substitution of a carefully devised flap operation for the gaping raw surface, and knowing the rapidity with which union takes place between such tissues in this region when they are brought into accurate apposition, I always adopt this method in my practice. The first recorded cases in which I operated in this manner are published in the 'Lancet,' 1892, p. 1291, in a paper entitled "A modification of the operation of partial or complete excision of the tongue," and the cases described in it were operated on in June and December, 1890. Somehow or another with a very few exceptions this mode of treating the stump of the tongue does not seem to have appealed to surgeons of the present day. Curiously enough, the late Dr. Widenham Mansell, one of the most original surgeons I have ever met, read a paper at Dunedin at the New Zealand Medical Association in 1890 entitled "A new method of excising the tongue," in which he advocated the use of flaps to close accurately the gap left after the removal of this organ. Mr. Alfred Parkin, of

Hull, in a paper "On excision of the tongue," published in 'The Clinical Journal,' August 25th, 1897, gives his experience of the application of this principle which has proved most successful in his hands. I quote the following from his very interesting communication :—"I have invariably followed out this plan with the greatest benefit to the patient, in that there is much less soreness of the mouth, there is less risk of septic infection of the lungs, and in some cases it is possible to obtain healing by primary union along the whole length of the incision, and consequently a remarkably rapid recovery. The mucous membrane of the mouth is so movable when healthy that it is seldom that one cannot by a little careful manipulation, even when the whole tongue is removed, considerably minimise the amount of raw surface left; and this can be done without in any way cutting near the diseased part of the tongue itself. Some surgeons might argue that small details of this description are, to say the least, unnecessary; to these one might say that surgery ought to be (it often is anything but) the finest art, and that if I had to be operated on myself I would prefer a man who would, if it were possible, leave me half my tongue, who would prevent any blood whatever from trickling down my throat, and who would use all possible means to obtain a satisfactory healing of the resulting wound with the least risk of hæmorrhage or septic trouble, and with the least possible inconvenience to myself during the process."

Now, as to the importance of effecting a thorough removal of diseased structures, it is too often the habit of the surgeon to rely on statistics in order to illustrate the merit of any particular operation. This would be all very well if the extent of the growth were the same in all cases or in several groups of cases, when various methods could be applied. Again, there is a factor that cannot be eliminated in practice, and that is the varying skill, ingenuity, and cleanliness of different operators.

You must bear in mind that the wider the distribution of the growth the more extensive must be the operative procedure for its eradication, and also the greater the probability of the reappearance, or, as it is commonly called, the recurrence of the disease.

Therefore, it is absurd to argue against a big operation that it is more frequently followed by recurrence, and is accompanied by more immediate risks than a less extensive one, since the two operations are performed for quite different conditions.

Most surgeons will, I think, allow that *the more thorough and careful are the operative measures for the removal of a primary malignant growth and of its secondary foci of infection, together with the channels along which such infection is carried, the more likely is the patient to escape its reappearance, though the immediate risks from the operation vary directly with its extent.*

The surgeon should be guided in these operations by his sound common sense and by a knowledge of the behaviour of cancerous growths, and not attempt to follow slavishly usually accepted teaching and methods, his procedure being modified of necessity by the wishes of the patient.

For instance, in amputation of the breast it is evident that the complete removal of the diseased organ with any affected tissues in the vicinity, the infected glands, and the channels along which infection is carried, entails an extensive operative procedure, every step of which must be carried out skilfully, thoroughly, and patiently. I soon found that the removal of the infected lymphatic glands and channels could not be effected with anything approaching thoroughness through an incision made in the floor of the axilla. Consequently I adopted a method by means of which I was able to expose the entire axilla to its extreme upper limit, and to dissect out the whole of the fat with the lymphatic channels and glands contained in it. This I did by dividing the pectoral muscles and removing their fascial sheaths. If there was any suspicion of the muscles being involved they were cut away also. Otherwise their divided ends were brought into apposition after the axilla had been cleared of its contents. If there was anything to lead one to suspect the presence of infection in the glands above the clavicle, this region was cleared of its contents, and if it seemed advantageous the clavicle was drilled and then sawn across obliquely, so that part of the tract of the drill traversed either fragment. The sawn surfaces were forced apart, and the lymphatic structures beneath the clavicle were thoroughly removed. This having been done, the clavicle was restored to its original form by means of a strong silver suture. The surgeon should spare no pains in excising every suspicious structure, and he should never rely on his finger alone to decide on the presence of secondary infection, since it is clear that it can be no real test; besides, delicacy of touch varies within wide limits in different people. He should see everything, and *be inclined to regard any doubtful structure with the greatest suspicion,* knowing that the removal of a healthy lymphatic gland can do little harm, while the presence of a residual focus of infection may nullify the results of a very extensive operation. It is entirely owing to a want of thoroughness on the part of earlier operators that the surgical procedures for cancer of the breast obtained a very bad name, being regarded with well-merited suspicion not only by the public, but also by the profession. This reproach can only be removed by the adoption of improved and more efficient methods.

I described the measures referred to above in a paper published in the 'Transactions' of the Clinical Society, 1893, entitled "A case illustrating a more effectual method of removing a cancerous breast, lymphatics, and glands," and gave my reasons for the course I habitually pursued.

Perhaps the most serious difficulty which one experiences in operations on the breast is the provision of a satisfactory skin covering when there has been extensive skin infiltration. In most cases this can be met more or less satisfactorily by the formation of suitable flaps or by grafts; but there are others in which the surgeon must either hold his hand or adopt some more efficient means of obtaining a cutaneous covering. As an illustration of this difficulty and of the manner in which it can be met, I will quote the following from a short paper published in the 'Lancet,' October 12th, 1895, entitled "A Case illustrating a very effective method of treating extensive malignant disease of the breast."

"One comes across cases, however, in which the skin is so extensively infected that this last operation is unsatisfactory owing to the large raw surface which is necessarily left. In such cases I would urge what at first sight appears to be a heroic measure, namely, amputation of the arm at the shoulder in order to obtain enough skin to cover the raw surface and to give a nice soft covering to the part. The patient will certainly die if she is not operated on, and in all probability the arm will shortly become a source of distress to the sufferer owing to interference with the venous channels; therefore it is no great deprivation to remove it. Besides, it diminishes the risk of the operation, it ensures immediate union, and within a few days the patient is enabled to get about and enjoy an active existence. I cannot do better than illustrate the method I here advocate by the report of a case.

A woman aged twenty-nine years, single, of a remarkably youthful appearance, was admitted under my care into Guy's Hospital on September 9th, 1895, suffering from carcinoma of the right breast, which she had observed for the first time five months before. The mass was large, and involved almost the entire breast. The skin was adherent over it, and was ulcerated over a space as large as a five-shilling piece. All about the ulcer and over an area around the breast, the skin presented minute nodules of infection. There were enlarged glands in the axilla, and in the subcutaneous tissue over the coracoid process a gland could be felt. It had apparently been infected from some cutaneous nodules just below it. Nothing could be felt in the liver, and the patient's general health and weight were as good as ever they were. The advantage of removing the arm, the possible benefit she would derive from it, and the risks she ran, were fully explained to her, and she insisted on undergoing the operation. An incision was made along the length of the clavicle to the middle line, and the middle third or more of the clavicle was exposed and removed. The subclavian artery and vein were tied at the margin of the scalenus anticus, and all the areolar tissue and glands in the subclavian triangle carefully dissected out. There was no obvious infection of these glands, but beneath the clavicle the upper limit of the enlarged axillary glands was defined, and the glands were turned downwards. Great care was taken not to injure the suprascapular or other vessels crossing the subclavian triangle. From the inner limit of the horizontal incision another was carried down vertically along the middle line for about nine inches. It lay well outside the limit of skin infection. From its lower end another incision was carried backwards to the posterior folds of the axilla, at what seemed a safe distance from the growth, and then it was run upwards along the posterior fold to the axilla, when it ran across the arm to the outer end of the clavicle. A vertical incision was made from the upper limit of the posterior axillary fold to the elbow, where it crossed by a circular incision. The skin and subcutaneous tissue were dissected up off the deep fascia as far as the deltoid, out of which a large and sufficient flap was cut to ensure as much vascularity of the piece as possible. The inner part of the deltoid was removed, and the limb disarticulated. The skin and all the subjacent soft parts were dissected off the sternum, clavicle, ribs, cartilages, intercostal muscles, serratus magnus, and posterior

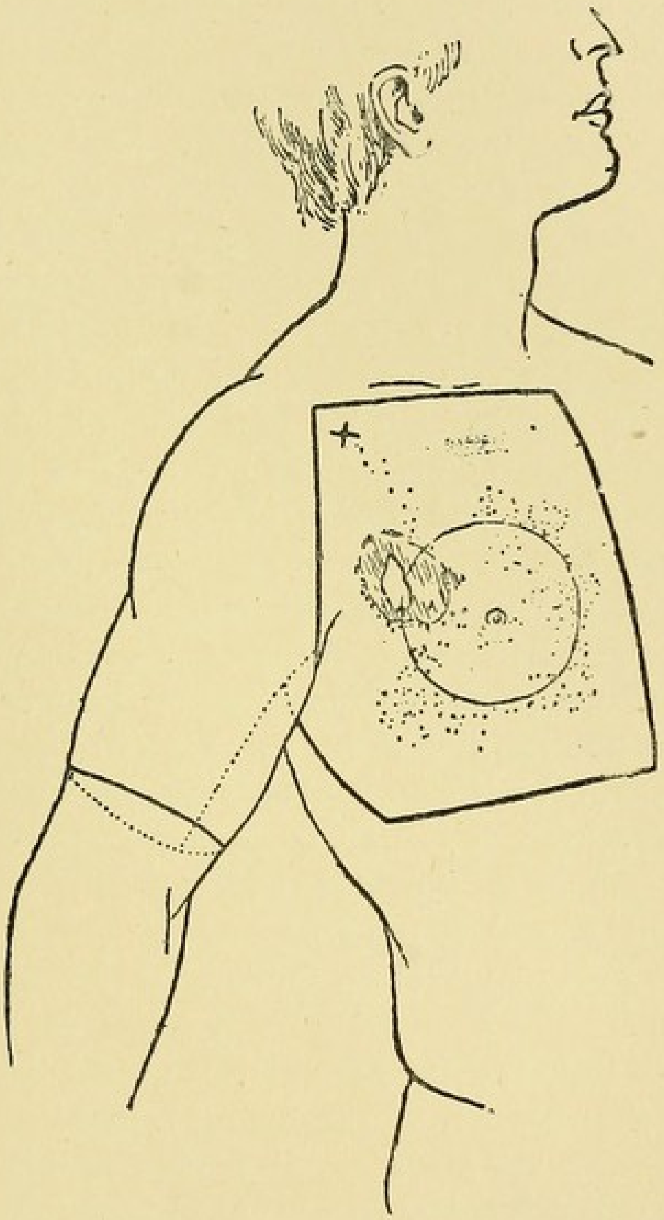


Fig. 138.—The above illustration shows the positions of the incisions with the ulcerated surface in the right and upper part of the breast. The × indicates the position of the gland in the subcutaneous tissue, and the dots show the approximate distribution of the points of infection of the skin by growth.

wall of the axilla, and the great square flap, which measured more than nine inches along each side, was fitted accurately and comfortably into the large exposed raw surface. The part that corresponded to the circular incision around the arm was united to the edge of the median or sternal incision, while the edges of the vertical incision in the arm were connected to the upper and lower horizontal incisions in the thorax. Very little blood was lost during the operation. The growth was found to involve the greater pectoral, but the most careful subsequent examination of the parts excised showed that the primary growth, the skin, and glands were very freely removed. The patient ran the usual course with an aseptic wound, experiencing no discomfort or pain in the part. The illustration represents diagrammatically the condition of the patient before the operation, and it shows very well the outline of the skin incisions in the chest and arm. Of course the area of the surface covered by the skin of the arm, after healing had taken place, was considerably smaller than when the operation was done, owing to a certain amount of shrinkage of the loose flap.

I would just point out that the excision of a considerable portion of the clavicle enabled me not only to remove all glandular and areolar tissue beneath and about it, and to tie the vessels securely, and with a minimum loss of time, but it also allowed the scapula to fall into such a position as to give a greater length of flap, and a less strain upon it than if the clavicle were left intact. Every operating surgeon of large experience is confronted too often with the results of very imperfect removal of the diseased structures, so much so that he sometimes cannot but think that the operator was influenced by a desire not so much to effect the thorough removal of the affected parts as to obtain a rapid recovery. It would seem obvious that such a course is not likely to reflect much credit on surgeons, and especially on operations for cancer of the breast.

In the last condition to which I will call your attention the question of subsequent comfort and effectual removal are both involved. I refer to cancer of that portion of the rectum that is covered by peritoneum, and which does not lend itself readily to resection in the majority of cases. In many of such cases surgeons appear to have obtained excellent results by the operative procedure which is commonly described as Kraske's operation. I am sorry to say that I have not been able to benefit my patients as much as I would like by the use of this method, and for the following reasons:

Firstly, I rarely succeeded in removing the infected glands in the mesentery with any feeling of certainty.

Secondly, if much bone was excised the discomfort experienced by the patient after the operation was often great and prolonged.

In my experience many of these cases are best treated by the performance of an inguinal colotomy in the first instance. In order to reduce some of the risk and unpleasantness of this operation I devised an apparatus by means of which the escape of fæces and gas about the attached bowel or into the bed or atmosphere is very largely reduced, and for a time completely avoided. (See Fig. 139.)

The appliance is composed of a proximal tube, consisting of a straight, short glass cylinder, with suitable round rims, to which is attached a piece of rubber tubing of a corresponding lumen, into the end of which is fitted a brass cylinder with a bayonet catch. The whole of this segment of the apparatus

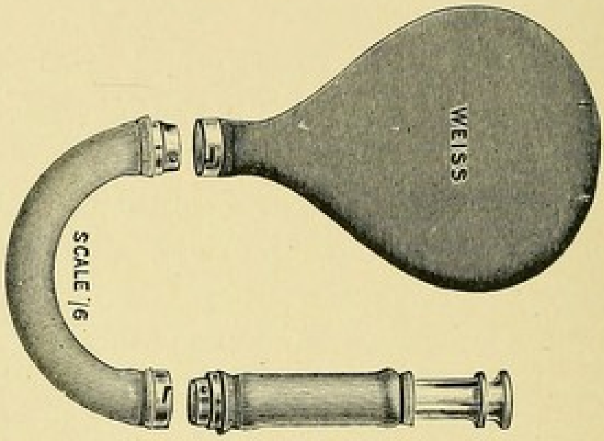


Fig. 139.

is of such a length as will permit of its being readily cleaned by the introduction of a rod of wood or metal into it. The second segment consists of rubber tubing of the same lumen, fitted at either end with a brass cylinder and bayonet catch. The third segment consists of a rubber bag, fitted also with brass cylinder and same catch. The bag may be connected directly to the first or proximal segment; or, if necessary, the interval between the bag and wound may be increased by the use of the second segment. In the manipulation a minimum of strain is exerted upon the connection of the tube to the muscle wall of the intestine, and no difficulty is experienced in emptying and replacing the bag. The several parts of the apparatus are connected with ease to one another. The connections being air-tight, the patient is unaffected by any unpleasant odour. The instrument is made in three sizes, two being of a size suitable for the large intestine, and the other for the small. In order to delay the separation of the tube from its connection with the bowel, I prefer to use silk tape rather than the ordinary silk ligature for tying the glass tube in position. In this manner the patient is exposed to less risk, since union with the bowel and abdominal wall is more secure before the tube is detached.

In the case of fluid-containing cavities as the stomach, gall-bladder, urinary bladder, and small intestine, I have used an apparatus based on the principle of the cup valve. Fig. 140 represents it.

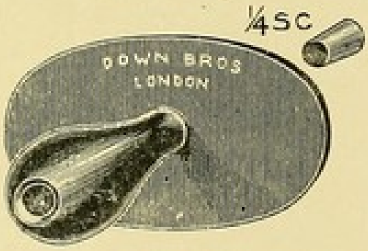


Fig. 140.

The great advantage of this mechanism is that the force exerted by the fluid upon the teat-like process of rubber is at right angles to the surface of the interior of this valve, and the greater the pressure the more closely is its periphery driven against the sides of the aperture, and the less possibility is there of any escape of fluid. The flat plate is adjusted after the cup has been introduced, and is fixed so as to help to retain it in position. I and others have used this instrument for months in the same patient without the escape of fluid, and the irritation of the skin which results in consequence of it. It has simplified gastrotomy in a wonderful manner, as the escape of the gastric contents was the chief objection to the operation. The same mechanical principle is of service in colotomy, but not to the same extent, for the reason that in it we have to deal largely with more or less solid contents. the character of which somewhat invalidates the working of the valve. Still a well-fitting cup valve is the most effectual means I know of controlling the escape of the contents of the larger bowel in a colotomy, and if well fitted and made of good rubber is of the greatest comfort to the patient. A satisfactory orifice into the bowel having been established, an effort should be made to remove not only the primary growth, but also the mesentery with the infected glands in it, should it seem possible to effect it at reasonable risks.

The varying conditions presented by these growths, by the secondary infections in the mesentery, and the different lengths of the meso-sigmoid, must influence the details of the procedure considerably, but the principle underlying our action must be the same in all cases, namely, the complete eradication of the primary growth, and of the infected glands. Perhaps I can best illustrate the methods I adopt by describing a case.

A woman aged fifty-six was admitted into Guy's Hospital on 27th April, 1891, under Dr. Perry, suffering from acute intestinal obstruction. She was in a very prostrate condition. A small hard growth could be felt high up in the rectum. The upper limit of the sigmoid was brought to the surface immediately above the internal abdominal ring, and an aperture made in it. Before this was done the pelvis was carefully examined, when the growth was found to involve the middle third of the rectum, in the mesentery of which large glands could be felt. The condition of the patient precluded any further interference at the time. After she had sufficiently regained her strength to bear a more prolonged operation I opened the abdomen in the middle line, with three methods in my mind by means of which I hoped to effect the complete removal of the growth.

One was to excise the growth and establish continuity by means of Murphy's buttons, which I have always found most satisfactory since I used them in January, 1894, the first time they were tried in England ('Lancet,' 1894, p. 1006). The second was to remove the whole or most of the bowel beyond the opening of the sigmoid in the groin; while the third was to excise the growth with its mesentery, together with the portion of the rectum below it, and to bring the lower end of the sigmoid, or rather its junction with the rectum, down to the anus.

The result of a careful examination of the mesentery of the rectum and sigmoid decided me on taking the third course, feeling that if I failed in it I could always fall back on the second.

The rectum and mesentery were separated from the sacrum, the mesenteric vessels being tied. The peritoneum of the meso-sigmoid was also divided in such a manner as to allow of its elongation. The patient was placed in the usual lithotomy position, when an incision was made around the anus, which was then sewn up. An incision was made backwards from the anus to the coccyx and the rectum was dissected from the vagina and sacrum. It was then possible to draw the whole of the rectum out through the wound in front of the coccyx. Owing to the vessels having been tied in the mesentery this portion of the operation was accompanied by very little loss of blood. The bowel and growth were removed, and the part above the growth fixed in the wound. The patient made an uninterrupted recovery. Some of the mucous membrane of the attached bowel sloughed, but it soon separated. All the fæcal matter escaped through the hole in the groin. The sinus in front of the coccyx gave her no discomfort whatever. It seems to me that by this method we applied our two principles as effectually as possible.

TUBERCULAR AFFECTION OF JOINTS.

Gentlemen,—I propose considering with you to-day the principles which should guide us in our treatment of tubercular affection of joints, and from a consideration of them to try and lay down rules for our guidance. I am constantly asked by friends, "How do you treat tubercular joints at Guy's Hospital or at the Hospital for Sick Children?" and I am obliged to say that I do not know. It is hard enough to state any definite method or methods which one adopts one's self without being aware of those views held, or methods adopted, by a number of one's colleagues.

Now let us consider the position. We have an individual usually possessed of a vitality depreciated by bad feeding or hygiene or both at one period or another of his existence, or by some debilitating illness, or who inherits from his ancestors a body which offers a resistance less than the average to the inroad of organisms. Such a subject sustains an injury to some portion of an articulation, which in the adult may be the bone or synovial membrane, and in the child the epiphysial line, synovial membrane, or bone. The tissue is damaged, and its vitality or its ability to oppose its colonisation by organisms so depreciated that they are able to secure a foothold and then to throw out settlements all round the primary focus. It does not follow that tubercle bacilli are always the first settlers.

The course of events depends upon the two factors—the virulence of the organism and the vitality of the individual. If the former is considerable and the latter small, the organisms will spread locally, the tissues doing their utmost to stay their progress and to confine them within certain limits, opposing as far as they can their dissemination throughout the body. This last is a very important capacity from a surgical point of view, and must be borne in mind. To put it more clearly, the organisms are isolated as far as possible by a process which is described as inflammatory, in what may roughly be regarded as a capsule, upon the completeness of which the body depends for its security from general infection by the entry of organisms into the comparatively unprotected tissues about.

From a consideration of these two facts it is clear that we must attempt two things:

1. To improve the vitality of the tissues of the patient, and so put them in the best position to isolate, and later to invade and destroy the army of organisms which have obtained a foothold.

2. To do anything to depreciate the vitality of the organisms and to assist the tissues locally at the seat of conflict.

Now it is quite obvious how these principles should be applied separately, yet, as you will see in your endeavours to apply one, your methods may act disadvantageously in the case of the other. In order to explain my meaning, I will consider the second principle first.

By keeping the affected parts at absolute rest the process of seclusion is rendered more perfect, and the inroad of organisms into the tissues driven back, so that their vitality is gradually depreciated in being deprived of a necessary supply of food. If the organisms are scattered scantily through a tissue—as, for instance, the synovial membrane, they are destroyed ; but if they, with the relics of their struggle with the tissues, are collected in a large quantity, the more fluid constituents are gradually absorbed, and a pasty and finally a cretaceous mass remains. I need hardly point out to you that free movement of the affected joint assists the disease as opposed to the patient, probably by damaging the inflammatory line and depreciating its capacity for resistance. Therefore absolute rest is one of the most important means we possess in fighting tubercular affections of joints ; at the same time such confinement as is necessary to secure this rest may be prejudicial to the general health of the individual, and it is often necessary to make some compromise, permitting a certain amount of mobility to secure a greater improvement in the general condition of the patient. To decide judiciously on this question is necessarily often very difficult, since so much depends on the surroundings of the patient.

Again, we are able to permeate the tissues of the individual with drugs whose action is powerfully germicidal, and which, in such quantities as we can safely introduce, possess the power, if not of destroying, at least of lowering the vitality of the invading organisms. I allude to mercury, arsenic, and the several iodides. In all tubercular affections I use these drugs in a systematic manner, giving in the adult a grain of blue pill three times a day, and a mixture containing liquor arsenicalis, iodide of potassium, iodide of sodium, and iodide of ammonium. The mixture of the several iodides enables one to give a larger quantity of iodine, and so to avoid the depressing effect of the potash salt. The iodides are given in about five-grain doses, the amount of which is not usually increased. The dose of liquor arsenicalis commences at about three minims, and is increased by a drop every week. It is raised till about fifteen minims are taken three times a day. Of course, owing to peculiar susceptibilities, this arrangement has occasionally to be modified, but in a considerable proportion of cases sooner or later this treatment can be enforced. These patients must be watched very carefully while taking the larger doses, as they are liable to lose flesh suddenly and rapidly without any warning, when the amount of arsenic administered must be stopped temporarily and cod-liver oil be freely administered. You would ask me on what grounds or on what evidence this treatment is based, since it is exceedingly difficult to prove its utility under such varying conditions as are presented by tubercular joints, and I would willingly acknowledge the wisdom and the strength of such criticisms. The conclusion must be arrived at from analogy. We have in the out-patient department a large number of adults suffering from tubercular affection of the glands of the neck. I purposely confine my remarks to adults, since the means by which the earlier use of these drugs was determined was experimental, and of necessity required the consent of the sufferer.

Finding that such a combination of powerful germicides appeared to benefit these patients, I obtained the permission of two of them who had enormous collections of glands affected by tubercle in their necks to remove a single gland. The greatest care was taken to shell out the gland entire, so as to prevent the entry of organisms into the surrounding undefended tissues. These glands were found to be in a state of acute tubercular infection. The necks were then carefully measured and the treatment by drugs commenced. This was pursued systematically till the dose of arsenic amounted to about forty or fifty minims in the twenty-four hours. By that time in neither case could anything but small hard masses be felt. In one of the patients I removed one of these relics, and found it composed of a mass of fibrous tissue, with a minute quantity of caseous material in its centre. Gentlemen, I do not wish you to assume that in every case of tubercular affection of glands of the neck you should confine your treatment solely to the administration of drugs; I merely adduce these cases as undeniable evidence of their capacity for assisting the tissues as against the organism. There are, attending my out-patient department, many patients suffering from tubercular affection of the glands of the neck, and you can watch for yourselves their progress under this treatment alone. We see, then, that we can increase the resisting capacity of the patient by improving his general health, by placing him in the best possible hygienic surroundings and by attending to his diet; and that locally, by keeping the affected parts at rest and by administering certain germicidal drugs, we can depreciate the vitality of the invading organisms.

Again, it is possible in many cases, by the withdrawal on one or more occasions of a varying proportion of the bulk of the invading organisms by some simple method, to render the task easier for the tissues. I refer to such treatment as the aspiration or the evacuation by means of an incision of a fluid tubercular collection, as for instance a psoas abscess, and you can readily understand the principle upon which such a treatment is based ; or one can introduce into the tubercular collection a material which, when acted upon by living tissues, is broken up into agents which exert a powerful germicidal or inhibitory action upon organisms. I refer to the drug which is most commonly used for this purpose, namely, iodoform. This material in the test-tube exerts little or no action on organisms, but when broken up by living tissues its products are most efficient in their destruction ; or it may be introduced after a proportion of the fluid contents of a so-called tubercular abscess has been more or less imperfectly evacuated by the aspirating needle, or more efficiently and thoroughly by incision and subsequent scraping.

We must bear in mind one very great objection to any method of treatment in which the invading organisms are not completely destroyed or removed, and I will illustrate my meaning by carrying you back to the cases of tubercular affection of the glands in the neck. In some of the cases which I subjected to a systematic treatment with drugs for a long period after the disease had apparently disappeared, I have occasionally been disappointed by seeing patients turn up, perhaps a year after, with a recurrence of the glandular trouble. They stated that it reappeared very rapidly after some very depressing illness, which was almost always influenza. Under treatment the condition subsided as before. We learn from this that these cases must be kept under treatment long after the disease has apparently subsided, that tubercular organisms will lie latent or dormant for very long periods of time, ready to burst into activity when the vitality of the surrounding tissues is depressed, and that the only perfectly satisfactory way of treating tubercular inroads is by their complete and perfect ablation from the body. Unless this is done, and done effectually, the patient is liable, not only to a local conflagration in the original spot or in some tissue damaged by injury or by the inroad of some other organism, but also to the dissemination of the organisms through the body generally, owing to some physical damage to the surrounding capsule.

With our present means of treating tubercular disease of the joints we must, then, recognise the fact that when a focus containing organisms—in a state however latent—must be left, the patient is exposed to possible trouble at any subsequent date of his existence. We also know that only in some joints is complete removal possible.

In a certain number of cases it is necessary to attack the seat of tubercular affection surgically, either because of the presence of a piece of dead bone, the rapid spread of the disease, or its appearance in other parts of the body. In the performance of all operations remember that you are exposing the patient to the risk of general infection, since the organisms may come in contact with recently incised parts, which possess no such obstacle to their entry as existed in the diseased part previous to operation. You must obviate this risk as far as you can either by effecting as complete a removal of the organisms as possible, or, if that cannot be guaranteed, or even in any case, it is wise to leave in a quantity of some such reagent as iodoform which shall influence prejudicially the vitality of those left behind. I cannot urge on you too strongly the importance of remembering this, especially when you are operating on the joints of young children. Those who have held resident surgical posts in children's hospitals are very much alive to this risk, which accompanies surgical interference on such a scale as is necessary in such operations as erasion or excision of a joint, particularly when the diseased structures are only imperfectly removed, as is unfortunately, owing to the anatomical conditions of the parts, too often the case, however skilful, painstaking, and experienced the surgeon.

I will now call your attention to a few general rules which may be of service to you.

1. In tubercular affections of joints, if recovery is made without operative interference, assuming that the joints are not permitted to become fixed in useless positions, and that the ends of the bones are not allowed to acquire abnormal relationships to one another, the mechanical results so obtained are usually much better than those that follow the removal of the disease by an operation. An illustration of the truth of this statement is afforded by tubercular disease of the knee-joint. If the patient

recover without operative interference, he will usually possess a much more useful joint than if the diseased tissues had been removed by an erasion, however perfect the operation and however young the child. Therefore, before having recourse to operative interference in tubercular disease of a joint, assuming that there are no symptoms which urgently demand it, it is obvious that every effort should be made to obtain a cure by such means as we possess. A considerable proportion of cases affected with tubercular joints will recover completely.

2. In young subjects, if operative interference becomes necessary, the tubercular material should be removed by erasion. The period at which active surgical measures should be adopted varies largely with the circumstances of the parents, the general health of the child, the presence of disease in other parts of the body, and the other conditions involved. In fact, each case must be treated with a full knowledge of its history, etc. I will apply the term erasion to any operation on a joint in which an attempt is made to remove more or less completely any tubercular material, whether in the synovial membrane alone, or also in the cartilage or bones, or structures about the joint, the articular surface of the bone not being removed by the saw. By excision I understand the sawing off of part or the whole of the articular ends of the bones entering into the formation of a joint, together with the removal of the affected synovial membrane.

3. In the young subject an excision should not be performed unless demanded by mechanical conditions, as the fixation of the joint in such a position that it cannot be brought into a useful one without the

removal of bone, or the dislocation of the articular surfaces on one another requiring for their replacement a removal of more or less of one or both bony surfaces.

4. When the disease is limited to the synovial membrane and the cartilage is only superficially eroded, a complete erasion of the diseased structures is almost always followed by a satisfactory result. In young subjects a moveable joint is frequently obtained, but as the age of the child increases the limit of the mobility decreases. The free removal of articular cartilage is not of necessity followed by the formation of fibrous ankylosis as surgeons used to imagine. During the operation the circulation through the limb should be controlled by an elastic band, so that the appearance of the parts is not obscured by blood, and the diseased structures can then be readily distinguished from the healthy tissues. This may also prevent the organisms being picked up and carried off in the blood stream by the divided vessels in the cut surfaces.

5. Where there is cavitation of one or both bones due to primary disease in the bone or to its infection by the diseased synovial membrane, such cavity should be thoroughly cleared of its tubercular contents and its wall scraped. It is then rendered quite dry and is packed firmly with finely powdered iodoform, which has been sterilised by being soaked for some considerable time in formalin lotion (1 in 500). The surface of the space filled with iodoform is rendered flush with that of the surrounding cartilage. In this way iodoform is used as a packing which occupies, with a solid material containing no organisms and in which organisms cannot grow, a

cavity in bone which must otherwise be filled with blood, in which organisms might very readily grow, especially if they are present in other parts of the body.

I published this method of treatment in the 'Lancet' of July 15th, 1893, under the heading "One of the best applications of iodoform in surgery." In it I described the earliest cases in which I applied it, and with complete success. One was a girl aged 10, who early in June, 1893, was suffering from a very extensive tubercular periostitis of the orbital, temporal, and zygomatic fossæ on the left side, and in the right knee-joint had a cavity in the lower end of the femur which occupied a great part of both condyles, though nowhere had it extended through the articular cartilage, which in some places formed its sole boundary. It was open anteriorly where it communicated with a collection of tubercular material which bulged the synovial membrane forward, producing a condition which, when regarded superficially, resembled very closely an ordinary tubercular synovitis. The tubercular contents of the bony cavity with the material beneath the synovial membrane were thoroughly removed, the cavity in the bone was firmly plugged with sterilised iodoform, the incision in the synovial membrane was carefully closed with a fine silk suture, the edges of the wound in the skin were accurately approximated, and a permanent dressing was applied under which perfect union took place. The condition about the base and side of the skull was also treated as effectually as possible by scraping and the introduction of glycerine and iodoform. Early in 1894 the girl again came under my care in order that I might improve the position of the eyelids, which had become displaced and deformed

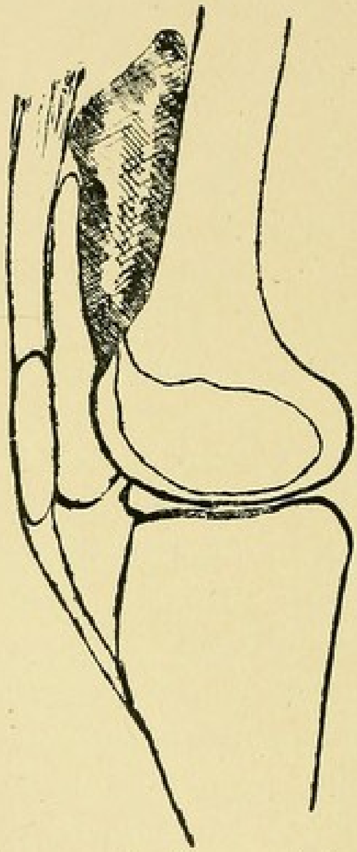


Fig. 141 illustrates diagrammatically a vertical antero-posterior section through the internal condyle. The shaded area represents the tubercular material behind the synovial membrane.

by the presence of a sinus in the outer part of the orbit. At that time the periosteal trouble in the head was much diminished in area, and was greatly benefited by the local use of sulphur. Except for the presence of an ill-defined cicatrix in the skin, the knee was to all appearances as good as its fellow. Movement was perfect, forcible pressure on the bone caused no pain or tenderness whatever, and there was no thickening or irregularity to be observed in the outline of the condyles.

The second case was a little boy on whom I operated early in April, 1893. He had very extensive disease of his ankle-joint, all the cartilage on the tibia being destroyed, together with that on the upper surface of the astragalus. Almost the whole of the interior of the astragalus was converted into a mass of caseous material with pieces of necrosed bone. This was all thoroughly scraped out, when it was found that the wall of the cavity in the astragalus was intact below and laterally. There was a little roll of pulpy synovial membrane in the posterior limit of the subastragaloid joint; but beyond this portion, which was removed, the articulation was apparently free from disease. The cavity in the

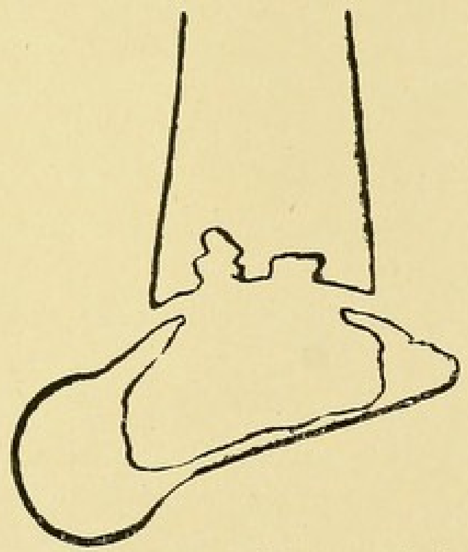


Fig. 142 illustrates diagrammatically a vertical antero-posterior section through the tibia and astragalus, showing the position of the large cavity in the astragalus and the smaller ones in the tibia.

astragalus, together with deep excavations in the lower end of the tibia, were firmly plugged with iodoform, the surface of which was in each case flattened and bevelled so as to resemble in form and outline the normal articular surface. The skin wound healed rapidly and firmly. The boy is still under observation. The foot feels perfectly normal, and I did not allow him to walk till two years had elapsed, and I felt certain that the thin-shelled very imperfect astragalus was sufficiently filled up by bone to permit of its transmitting the boy's weight.

This operation, which was of a very complete nature, was performed by a method described in the 'Trans. Clin. Soc.,' 1893, "Two cases illustrative of an operation of complete erasion of the ankle-joint." By the use of long skin flaps, the tendons being exposed for a considerable length, I have since been able by separating the tendons from their sheaths, to effect the same complete exposure of the joint and its erasion without the division of any tendon but the unimportant peroneus tertius. In this way I avoid the extension of the foot which will occasionally result from the separation of the divided extensor and peronei tendons, however carefully they are sutured together.*

I have since adopted this method of stopping cavities with solid iodoform habitually, and it has enabled me to erase a joint and to retain the limb in its full length, whereas I should otherwise have been obliged to excise it, leaving the patient disfigured by a thick boot and depreciated physically to a very considerable extent by the progressive shortening of the limb.

Recently, in suitable cases, I have substituted for the solid iodoform plugging, a stopping of decalcified

* This is described in the 'Transactions' of the Clinical Society, 1899.

cancellous tissue, suggested * by Dr. Robinson of Huddersfield, through which some iodoform has been diffused. It has been of the greatest service in these and similar conditions.

6. In extensive tubercular disease of such a joint as the hip, where there is much destruction of bone and extensive burrowing of abscesses into the pelvis, erasion or excision, however perfectly performed, too often fails to stay the spread of the condition, and it may become necessary to remove the limb to do it. This is also occasionally the case in disease of the spinal column, the sacro-iliac synchondrosis and the tarsal bones, and it is especially true where the wound has become fouled by the bursting of abscesses or by the knife of the surgeon. In such cases, after a variable proportion of the diseased tissues has been removed, there frequently remains enough to continue its growth, even though iodoform is freely used.

Feeling much dissatisfied with the result of the ordinary methods, I looked about for some non-poisonous drug, which, being acted upon by the living tissues, would produce more powerfully germicidal agents than those that result from the decomposition of iodoform. It seemed to me that sulphur was such a drug. The advantages I have obtained from its use largely exceeded anything I expected, and it has enabled me to save many limbs and many lives which I could not otherwise have done. In fact, since I have used sulphur I have hardly ever been called upon to amputate for tubercular disease of a joint or joints.

* "The Use of Decalcified Bone in the Treatment of Wounds," 'Lancet,' October 2nd, 1897.

Perhaps I cannot do better than follow out the same course I adopted in the case of plugging cavities in bone with solid iodoform, and relate the history of the first two cases in which I used sulphur. These were published in the 'Medical Week' of December 8th, 1893, in a paper entitled "How far is sulphur likely to be of service to the surgeon?"

Before doing so, I will state the conclusions at which I had arrived, which I summarised in that communication.

(*a*) Sulphur appears to exert no deleterious influence on the health of the patient.

(*b*) It gives rise to products which are powerfully caustic in their action, so that the drug must be used in small quantities and with discretion. The most active agent produced is apparently sulphuric acid.

(*c*) It destroys all organisms, whether free in a cavity, or invading the surrounding tissues.

(*d*) It acts more powerfully upon recently incised structures than upon granulating surfaces.

(*e*) Its action is rendered more uniform and general, and less violent, by mixing it with glycerine.

(*f*) If the drug be used in any quantity it must be removed within a very few days. Twenty-four hours is usually quite sufficiently long for the sulphur to produce its destructive action in a recent wound. In some cases it may be necessary to scrape away the sloughs together with the remaining sulphur, but as a rule packing the cavity with sterilised iodoform gauze is sufficient, the wound being subsequently retained in an aseptic state by suitable precautions.

Case 1 was a little girl æt. 10 years, who was operated on in the Hospital for Sick Children on September 9th, 1893. She was suffering from disease of the hip-joint with extensive destruction of the head of the femur, the acetabulum, and the bone in its vicinity, with much pocketing of pus and curdy material in the pelvis and about the joint. On October 11th the caseous material and the diseased bone were scraped freely away, and the abscess cavity cleared as thoroughly as possible. The disease was so extensive that, in my experience, it was most improbable that with or without the use of iodoform it would have subsided under this treatment alone. Consequently, after sterilising a quantity of sulphur and using it freely as one uses iodoform, I rubbed some into the scraped osseous surface where I feared that the carious bone had been imperfectly eradicated. More was also rubbed into the walls of the abscess cavities, both within and without the pelvis. A drainage-tube was introduced, and removed at the end of forty-eight hours. The thigh was fixed in a position of rest, the foot forming an angle of 45° with the vertical, so that the stump of the head, or rather of the neck of the femur rested on the anterior portion of the excavated acetabulum. When the tube was removed, a faint odour of sulphuretted hydrogen was perceived.

The case followed the usual course of an aseptic wound till October 25th, when the temperature rose to 100·5°. The wound was dressed on the 26th, when the same smell was perceived. The temperature varied till the 30th, when it was 99°. On dressing it on that day—eleven days after the operation—the edges of the skin were found to be sloughy, and the smell of sulphuretted hydrogen was very distinct. I therefore determined to observe the condition of the interior of the wound. On opening it up I found that the muscles, skin, fat, and bone had undergone a similar destructive process, the surface of the bone being blackened and evascular, the muscles and fat soft, dark, friable, and bloodless. Though the destructive process was very extensive, there was no external evidence of it, nor did the temperature afford any indication of its presence. The altered bone and soft parts were carefully removed together with any sulphur that remained, and the cavity was abundantly irrigated. This process was repeated daily, the wound progressing most satisfactorily. By November 15th, except for a very small superficial granulating patch, the wound had healed completely. Of course it is evident that in this case I did far more damage with the sulphur than the condition of the case necessitated, but I had no idea that such an extensive destructive process would result from the presence of the sulphur.

The girl came under my care again at the Hospital for Sick Children. In consequence of an injury, she developed extensive tubercular disease of the ankle, the subastragaloid joint, and the os calcis. Two discharging sinuses were found. With sharp spoons I cleared away as much of the diseased structures as I could after freely exposing the parts, and introduced sulphur and glycerine freely. The foot is now quite well.

Before passing on to the next case, I will call your attention to the great importance in destructive disease of the hip-joint or in surgical operations upon it, as well as in solutions of continuity of the lower extremity, of allowing the leg to rotate outward into its normal position of rest, in which the inner margin of the foot forms with the vertical an angle of 45° more or less, varying with the age, occupation, and habits of the individual. If I had followed the ordinary custom, and had in this case retained the thigh in such a position that the foot was vertically placed, a dorsal dislocation and a very imperfect mechanical condition would have resulted, very much to the disadvantage of the patient. This principle I described and discussed fully in a paper in the 'Transactions' of the Clinical Society in 1893, entitled "A New Method of treating old Unreduced Dorsal Dislocation of the Hip-joint," and in another read before the British Medical Association the same year, entitled "The Fallacy of the Vertical Foot-piece," and to these I would refer you for further details on the theory and mechanics of this very important point.

Case 2 was a child æt. 7 years, who was operated on at the Hospital for Sick Children on September 22nd, 1893, for advanced and rapidly progressive disease of the elbow-joint, the bones being affected very extensively indeed. After careful erasion of the synovial membrane and very free removal of the diseased bone by sharp spoons and gouges, sterilised sulphur was used, as in the first case. Swelling of the elbow ensued, and a distinct odour of sulphuretted hydrogen was observed. The same result occurred to a certain extent in this as in the former case, though in Case 2 I did not allow the sulphur to remain in the wound so long as in Case 1.

On the 30th of September—seven days after the operation—the joint was reopened and cleared of the sulphur and of the bone and soft parts, which had been altered very extensively by its decomposition. The subsequent progress of the case was most satisfactory, the wound healing rapidly and firmly. I intended, if sufficient movement were not obtained, to excise subsequently when recovery was perfect. I saw this boy some time after, and he had a thoroughly useful arm, the elbow-joint allowing a limited amount of movement. I do not propose doing anything further to it.

I need hardly point out that the powerfully germicidal action that follows upon the decomposition of sulphur by the tissues is not applicable solely to the treatment of tubercular disease, but that there are many analogous conditions in which it is quite as suitable. I will not do more than allude to them here, since you will find it used very freely in the hospital for such purposes.

7. In the adult affected with tubercular disease of a joint it is sometimes wiser to excise than to erase. This is particularly true in case of the knee-joint, and especially if the disease is extensive, since a firm limb is obtained within a short period of time, and the amount of shortening is only sufficient to permit of the limb being swung conveniently during walking. The chances of obtaining a moveable knee after an erasion in an adult must be very small, and an excised knee-joint causes less discomfort and affords a much more secure and reliable mechanism than a knee-joint in which ankylosis is incomplete and fibrous union has resulted.

A CONSIDERATION OF THE PRINCIPLES THAT SHOULD GUIDE US IN THE TREATMENT OF ABNORMAL MECHANICAL CONDITIONS OF THE HIP-JOINT.

Gentlemen,—I purpose considering with you to-day some points in the mechanics of the hip-joint and pelvis, in the hope that by the careful investigation of them we may be in a position to formulate some definite principles which should guide us in our treatment of disease or abnormality about the hip-joint, or in other words, of any deviation from the normal in the mechanical condition of the mode in which pressure is transmitted from the pelvis to the femur.

I think I will be able to show you at the present time that their treatment is purely empirical and founded upon our habits of imitation or mimicry of one another's surgical procedures, rather than upon any well-understood scientific mechanical basis.

We are inclined to copy more or less precisely the methods of others, occasionally going so far as to add to, or even to alter details. But we rarely study the principles which should govern surgical measures, and attempt to apply them for ourselves in our operative procedures.

We seem to dislike discussing mechanical principles, but are always ready to talk glibly and with satisfaction of our treatment and of our results. The latter are frequently unreliable, sometimes because the surgeon deceives himself, and sometimes for other reasons.

Unfortunately for us, the descriptions of the physiology of the skeleton as contained in the text-books on anatomy are, as you are well aware, not only very scanty indeed, but what little there is, is usually utterly incorrect and misleading. Consequently the surgical practice that is founded on such an unsatisfactory basis is insecure and empirical rather than scientific.

If you examine the skeleton you see that the whole of the superjacent weight of the trunk is transmitted through the sacrum. In the active erect posture the lumbo-sacral joint is in a position of partial extension, while in the resting or easy erect position it is in one of considerable flexion.

In a paper* treating of the position of activity as illustrated by the anatomy of labourers, I showed that in habitual over-extension of the lumbo-sacral joint much of the superjacent weight is transmitted through the spinous process of the fifth lumbar vertebra to that of the sacrum. This is evidenced by an excessive development of these processes, the formation of amphiarthrodial or arthrodial joints between them, and by the backward displacement of the body of the lumbar vertebra from that of the sacrum (see Fig. 143). This condition had never been recognised before by anyone.

Such habitual over-extension acting as an evolutionary factor in my opinion brings about the dis-

* 'Guy's Hospital Reports,' 1885 and 1886.

sociation of the first piece of the sacrum, as shown in Fig. 144, which is described fully in the paper in

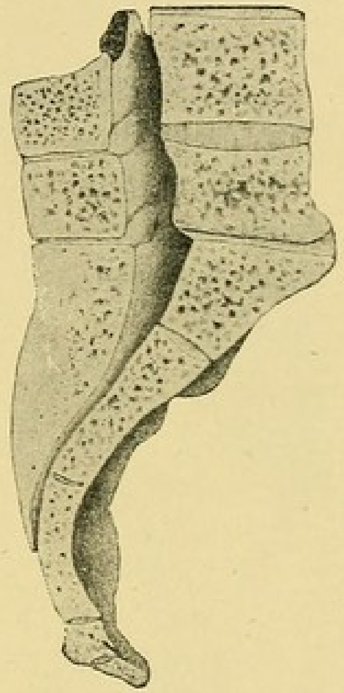


Fig. 143 presents a condition the reverse of spondylolisthesis, namely, a displacement of the straightened or even anteriorly concave lumbar spine backward upon the sacrum, and the consequent transmission of a large part of the superjacent weight through enormously developed dense lumbar and sacral spinous processes. This condition results from carrying on the head, or the load being habitually borne in front of the chest or trunk.

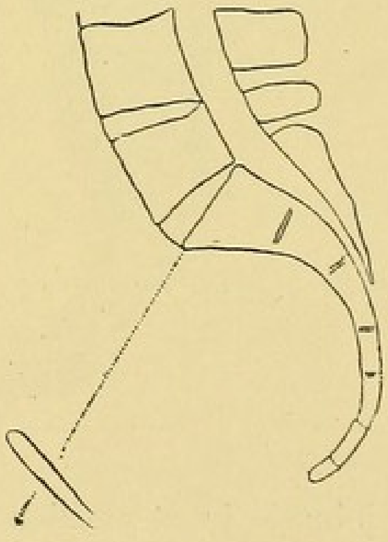


Fig. 144 represents a condition of the pelvis which at first sight closely simulates that associated with dorsal excurvation, namely, the diminution in the diameter of the conjugate of the brim of the pelvis, and the altered inclination of the facet on the first piece of the sacrum. This, however, is due to a separation or dissociation of the first piece of the sacrum to form one vertebra in excess above what are apparently the entire sacral series.

the 'Guy's Hospital Reports,' and which I have already referred to in this book.

In the resting attitude of the trunk, as represented in a more or less fixed condition by the skeleton of the inactive child and still more feeble old person, this

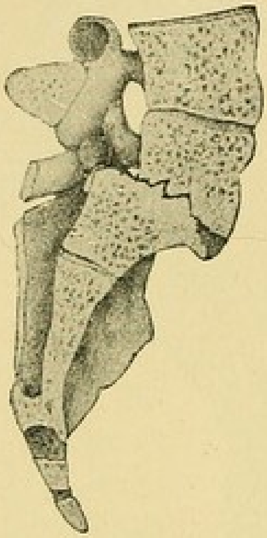


Fig. 145 represents the fourth and fifth lumbar vertebræ and the sacrum of the coal-heaver in vertical antero-posterior section, and illustrates the form of spondylolisthesis found in this class of labourer.

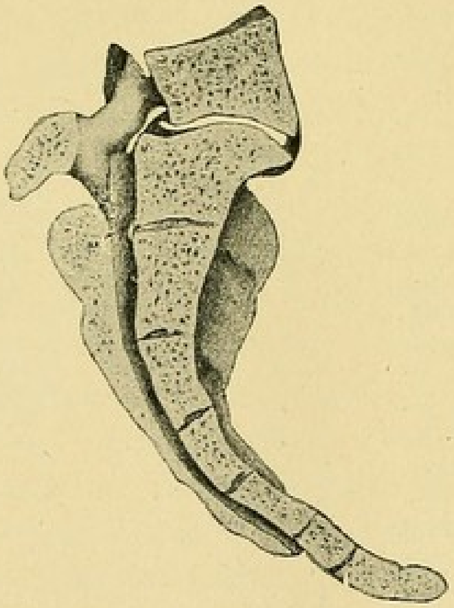


Fig. 146 shows the form of spondylolisthesis that occurs in such labourers as carry heavy loads on their backs less heavy than those borne by the coal-heaver, and who pick them off and replace them on the ground. The arthrodial joint seen between the fifth lumbar vertebra and altered upper piece of the sacrum is produced by this greater freedom of movement.

joint is in a position of considerable flexion. This results in the displacement of the body of the fifth lumbar vertebra downwards and forwards off the sacrum, or in a yielding of the sacrum around a transverse axis causing a similar alteration in the position of this joint as regards the hip-joints.

When flexion of this articulation is assumed habitually by the labourer as an attitude of activity, a somewhat similar displacement of the last lumbar vertebra as regards the pelvic axes takes place, and all the superjacent weight is transmitted through the body, and none through the sacral spinous process, which with that of the fifth lumbar vertebra consequently is very ill-developed.

Fig. 147 represents a vertical antero-posterior section through the spine in a position of activity, namely, the active erect posture; and Fig. 148 a similar section in a position of rest, which, when fixed by its habitual assumption, is called "dorsal excurvation of adult life" or "round shoulders."

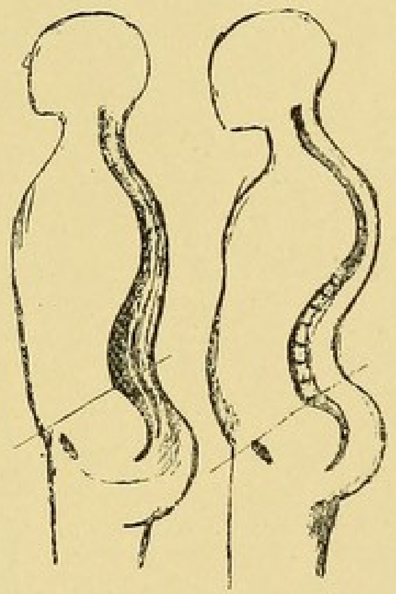


FIG. 147. FIG. 148.

Figs. 148 and 149 represent these changes in the feeble child and aged subject, and Figs. 145 and 146 those in the labourer.

Remember, then, that in over-extension of this joint there is a tendency for a considerable proportion of the superjacent weight to be transmitted through the spinous process, while in considerable flexion very little, if any, is borne by this portion of the sacrum.

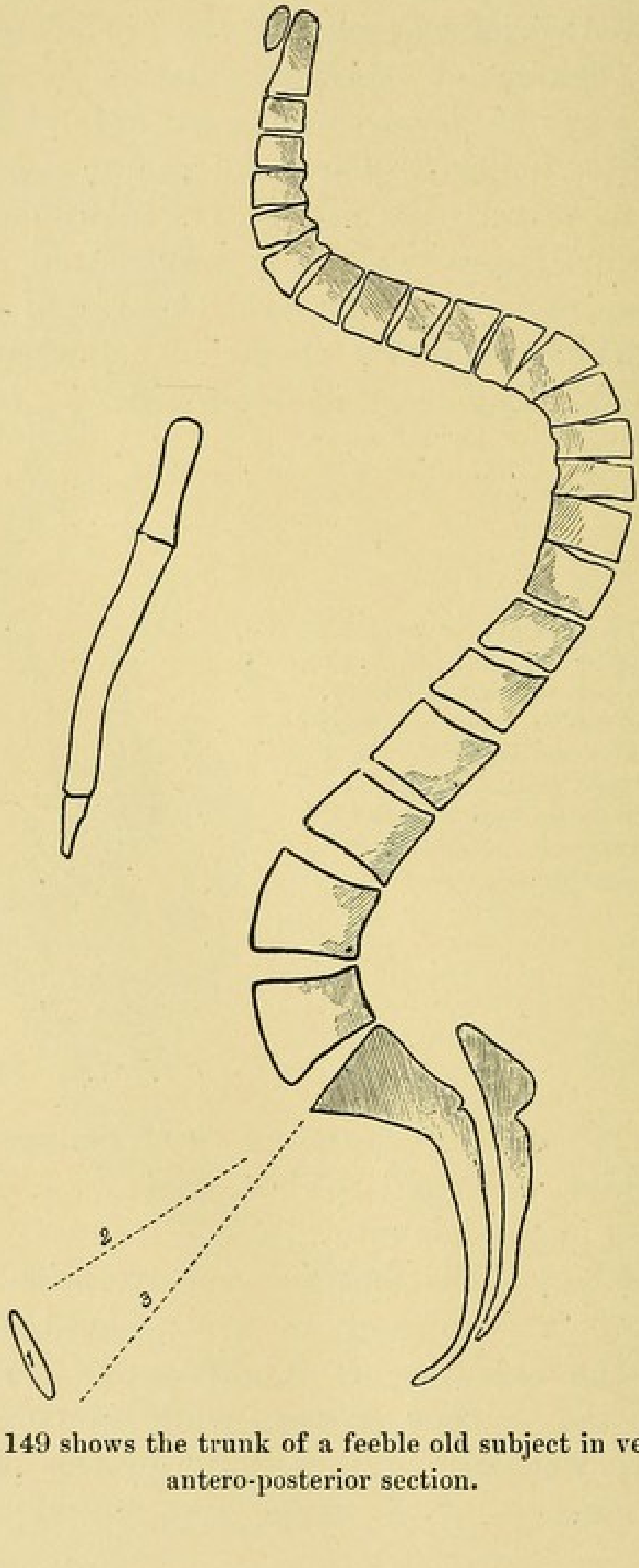


Fig. 149 shows the trunk of a feeble old subject in vertical antero-posterior section.

There is another joint which is closely allied in its movements with that of the lumbo-sacral, namely, the sacro-iliac. These joints are flexed or extended simultaneously.

The sacro-iliac joint is of great interest, since the mechanical principle which is made use of in its anatomy is, as far as I know, applied in only one other place in the body, and there in a modified form. I refer to the calcaneo-cuboid articulation. While it is one of very great power, it readily undergoes changes from the normal type under the influence of abnormal pressure or variation in the habitual range of movement.

Being curious to find out what had been done recently by anatomists to render more clear its mechanics, which, in spite of the work of Matthews Duncan and others, seemed to me to be but little understood, I obtained the last English text-book on anatomy, namely, Morris's, and looked it up. In it I found the following:

"The movements.—It is quite clear from the nature of the osseous surfaces, from the wedge shape of the sacrum, and the manner in which it is locked in between the hip-bones, as well as from the amphi-arthrodial character of the articulation, that *there can be no movement in the sacro-iliac joint.*"

"While the joint serves the useful purpose of breaking shocks, the cartilage is too thin and too firmly fixed to the bones to allow even of appreciable yielding, such as occurs in the intervertebral discs. The double wedge shape of the sacrum, with its broader surface at the base and at the front, prevents dislocation from above downwards and from before backwards. The sinuous character of the opposing surfaces of the sacrum and ilium, the forward and inward direction of the fibres of the posterior sacro-iliac ligament which passes from the ilium to the sacrum, as well as the ilio-lumbar and lumbo-sacral ligaments, prevent forward displacement of the base of the sacrum; while the sacro-sciatic ligaments prevent the tilting backwards of its apex. *Thus rotation forwards is entirely prevented.* The anterior and downward displacements of the sacrum are prevented by the interosseous and posterior sacro-iliac ligaments, which pass from the ilia to the sacrum and suspend the latter, acting somewhat in the same way as the chains of a suspension bridge. They also bind the two bones more tightly together, the greater the pressure the tighter the union. The suspension bridge arrangement of the sacro-iliac synchondrosis is admirably adapted to give strength to the pelvis."

Gentlemen, that represents the entire description of the physiology and mechanics of this joint as contained in this work under this heading. I presume you will be expected to understand, remember, and repeat it at the examination table.

I was pleased, however, to see that the editor does not consider the functions of the joints of such relative inferiority as to be put into very small print as is the case in 'Quain's Anatomy.'

Possibly, like myself, you may have failed to obtain a very clear grasp of the mechanical principles on which this interesting joint is constructed from the description I have just read to you from this anatomical text-book. To the ordinary observer it must appear very strange that such an elaborate and remarkable mechanical arrangement should have been evolved in order to *prevent the occurrence of any movement* between the sacrum and the iliac bones, when the same result could have been effected much more securely and simply by the fusion of these bones.

That the joint exists merely to serve the "useful purpose of breaking shocks," the writer himself, while asserting, seems to doubt, since he passes on to say that "the cartilage is too thin and too firmly fixed to allow even of appreciable yielding such as occurs in the intervertebral discs."

In the first place I will ask you to consider the mechanics of the sacro-iliac joint, since through it the whole of the superjacent weight of the body is transmitted. The principle involved in it consists in the apposition of concavo-convex surfaces retained in contact by means of the ligaments in front of and behind it, namely, the posterior sacro-iliac and the ligaments of the pubic symphysis. Roughly speaking, the articular surfaces are crescentic in form, the arc forming the concavity being part of a larger circle than that forming its convexity.

Force applied to the sacrum in such directions as to drive it directly downwards, or to cause it to rotate in a forward or backward direction around an axis passing through the attachment of the posterior sacro-iliac ligaments, brings about a separation of the corresponding articulating surfaces, since the prominence on one aspect emerges from the opposing concavity and travels along the inclined plane of an adjoining convexity. This movement of the sacrum upon the iliac bones is opposed and limited by the resistance offered by the very powerful ligaments already mentioned. The degree of movement permitted in a joint varies inversely with the age and vigour of the subject within wide limits.

In the active erect symmetrical posture the sacrum is forced directly downwards in the vertical transverse plane in which the acetabular cavities lie. Also in the rotation of the sacrum which occurs in flexion and extension of the sacro-iliac joints, the pelvis is rotated around a transverse axis passing through both acetabular cavities till that portion of the sacrum which transmits the superjacent weight is brought into the same vertical transverse plane. Under these circumstances the three joints of the pelvis are practically fixed. If, however, the subject is standing in the active erect posture on one leg, the whole of the superjacent weight of the body is transmitted through one sacro-iliac joint to the iliac bone, and through it to the head of the femur, the pelvis having rotated around an antero-posterior axis in order to facilitate this transmission. This it does by bringing the sacro-iliac joint into a nearer vertical relationship with the hip-joint, while it also enables the other leg to be swung forwards free of the ground.

During the assumption of this posture the sacro-iliac joint on the same side is fixed, while the opposite sacro-iliac and the pubic articulations are left comparatively loose. As a result of this, while the opposite leg is being carried forwards, the innominate bone rotates around the transverse axis of pelvic rotation, its anterior superior spine descending to meet the advancing leg. This movement can naturally be best observed in feeble-bodied children with loose joints, in whom all joint movements are exaggerated. In cases in which the hip or lumbar joints are fixed, or are much limited in their range of movement, and in some varieties of labour—as, for instance, that from which Fig. 145 was obtained—the freedom with which the iliac bones move on the sacrum is very great, the sacro-iliac joints having acquired an arthrodial type.

The surgeon may with advantage recognise and make use of the possibility of increasing by practice the amount of movement in these joints in certain cases where he is unable to have recourse to more radical measures. I have pointed out in a preceding lecture how anatomists have been in the habit of adding to the range of the movement of flexion in the hip-joint that which takes place in the lumbo-sacral and lumbar joints, and this added movement is very considerable. Additional evidence of this is afforded also by the fact that when one leg is shorter than its fellow, or is fixed at the hip-joint in a position of flexion, the sacro-iliac joint on the side of the shorter limb shows much more extensive pressure changes than that on the opposite side, and the consequent alteration in the lines of force produce those pelvic changes with which obstetric physicians are familiar.

Do not think for one moment that the information that is supplied in the text-books represents the knowledge of the present day or even of the last generation, or that it will satisfy your examiners in obstetric medicine, or even at the higher anatomical examinations. The obstetric physician has known and has taught for years that considerable movement takes place in the sacro-iliac joint of the adult, and he makes use of it largely in his practice to the advantage of his patients.

I fancy the anatomists must have drawn their conclusions from a study of the skeletons of labourers, which form the large proportion of the subjects in our dissecting rooms, but one would imagine that even they would afford more information. They certainly could not have studied the mechanics of this joint during youth, or under circumstances which show its variations to even greater advantage.

Many years ago Dr. Matthews Duncan described very fully this movement of the sacro-iliac joint as "nutation" of the sacrum. You will also find it figured in his most interesting works. If you look at Dr. Galabin's work on midwifery, a book with which you are very well familiar, you will find the following:

"In the adult woman, and especially in pregnancy, a synovial membrane exists between these surfaces, and a certain small degree of movement is permitted," &c.

In a paper* read before the Obstetrical Society I endeavoured to show that *the evolution of these joints during pregnancy was brought about in a simple mechanical manner by the presence of a temporary load in front of the lumbar spine.* This necessitates a considerable habitual extension of the lumbo-sacral joint, and a wide range in its limits of movement. The difference in the form of the sacrum in the two sexes is produced in this simple manner, as are also even more extensive variations in the thorax, which, probably for the reason that they are so very obvious, escaped the observation both of the anatomist and the physiologist.

* "What are the Chief Factors that determine the Differences which exist in the Form of the Male and Female Pelvis?" 'Trans. Obstet. Soc.,' 1888.

The knowledge of this movement is occasionally of great importance. In a paper by Dr. Fothergill, 'British Medical Journal' of October 31st, 1896, there is a description of what is called Walcher's position in parturition. Walcher found that he was able to obtain a variation of one centimetre, about one third of an inch, by bringing the pelvis from a position of extreme flexion to one of over-extension. This position of over-extension is obtained by placing the patient on the back and allowing the legs to hang freely down so that the feet do not touch the floor. By this means the innominate bones are fixed at the hip-joints by the over-extension of these articulations. This posture is now in use as a matter of routine in several German hospitals, where it is employed in all high forceps operations, in extractions after turning, and after perforation of the head,—all operations very materially assisted by any increase of the conjugate diameter of the brim of the pelvis.

Now what is the mechanical relationship of the pelvis to the femurs? In its movement upon the thighs the pelvis moves around two axes, a transverse one passing through the acetabular cavities, and around this axis the pelvis moves in opposite directions in the positions of extension and flexion, and an antero-posterior one.

In the *symmetrical position of rest of the trunk* the pelvis rotates in such a direction as to over-extend the hip-joints, this movement being chiefly controlled and limited by the strong anterior ligament of the joint.

The iliac bones pass backwards, the ischial forwards.

Associated with this movement of the hip-joint the sacro-iliac, lumbo-sacral, and superjacent joints of the spine are flexed, the thorax being also retained in a symmetrical position of rest, or of expiration. This position, when fixed and exaggerated, is spoken

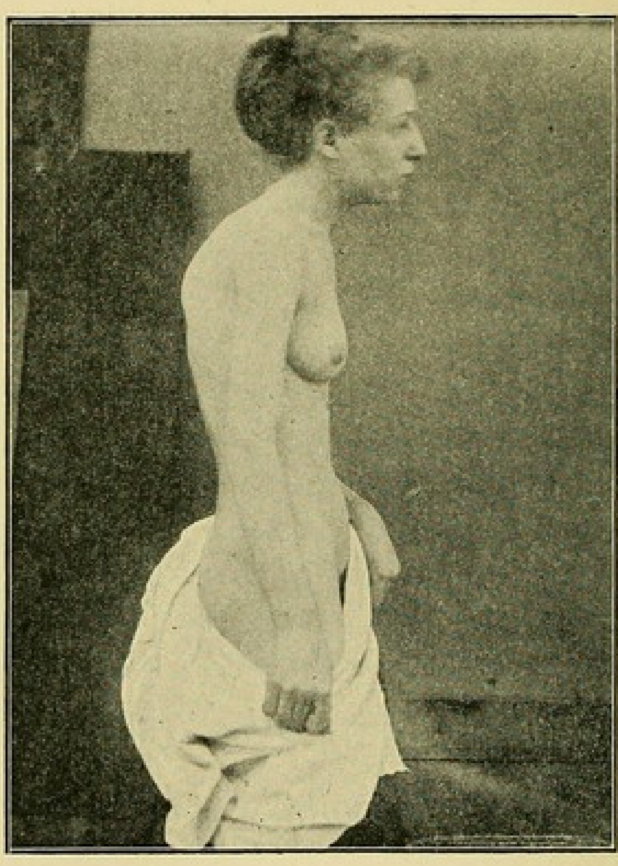


Fig. 150 shows a typical example of the fixation of the symmetrical posture of rest of the trunk.

of by the profession as "dorsal excurvation," and by the public as "round shoulders" (see Fig. 150).

As regards the pelvis, the superjacent weight of the trunk falls through the sacrum in a vertical transverse plane behind that occupied by the same axis of pelvic rotation, and so over-extends the hip-joint. It falls in front of the transverse axis, around which the lower end of the femur rotates at the knee, over-extending this joint also.

This I have endeavoured to indicate diagrammatically. A B represents the pelvis, C the lumbo-sacral, D the sacro-iliac, E the combined lumbar joints and the line above the superjacent spinal column, A H the anterior ligament of the hip-joint, which resists downward displacement of the end of the lever at D by the superjacent weight of the trunk falling through it (Fig. 151).

In order that this position of rest be assumed normally, *it is necessary that there be a secure joint allowing of no vertical play in front of the vertical transverse plane along which the weight of the upper part of the body is transmitted through the sacrum, together with an arrangement to control the movement of the iliac bones backward upon it, representing the anterior ligament of the hip-joint.*

In passing from the easy erect to the active erect posture the pelvis rotates around the same axis but in the opposite direction, until the transverse plane along which the superjacent weight of the trunk is transmitted through the sacrum corresponds to that occupied by the transverse axis of pelvic rotation. The sacro-iliac, lumbo-sacral, and superjacent joints of the spinal column are extended, and the chest is in a position of inspiration. This is brought about by the action of muscles which take a very much larger share in its production than they do in the position of rest. In the latter posture the transmission of force is controlled chiefly by ligaments, and by structures performing, for the time being at least, functions of ligaments. This position of activity is recognised by the soldier as "standing at attention."

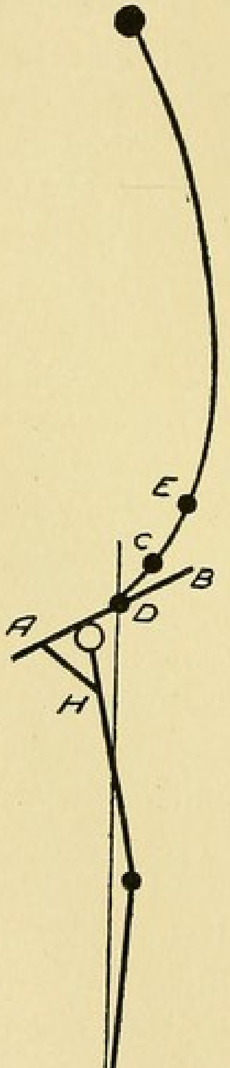


Fig. 151.

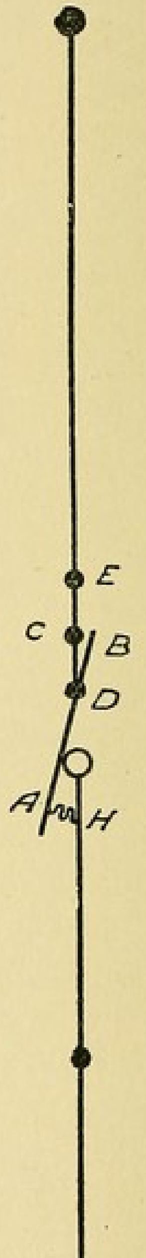


Fig. 152.

During locomotion in the erect posture this relationship is retained by a sequence of contractions of the muscles controlling the movements of the pelvis on the femur. That the positions of activity in the erect posture may be assumed satisfactorily it is necessary that it be possible to bring the point in the sacrum through which the superjacent weight of the trunk is transmitted into the same vertical transverse plane as that occupied by the hip-joint, which must be of such a nature as to permit no vertical play of opposing bony surfaces, but shall, on the other hand, allow of the direct transmission of force from the innominate bone to the upper end of the femur. It is also requisite that this joint shall permit of rotation of the pelvis around the transverse axis passing through it.

In Fig. 152 this attitude is illustrated diagrammatically. The ligament of the hip-joint, A H, is relaxed, and the several articulations are in a position of considerable extension.

When the individual passes from the symmetrical position of rest of the trunk to the asymmetrical resting posture, in addition to this rotation of the pelvis around the transverse axis of pelvic rotation which was associated with the former we have a rotation of it around an anterior posterior axis, the pelvis dropping on the side of the flexed limb. This rotation is controlled chiefly by the anterior ligaments of the hip-joint on which the body is supported, and by other structures performing the function of ligaments, the weight of the trunk falling in a vertical antero-posterior plane internal to that occupied by the centre of the head of the femur through which it is transmitted. The direction taken by the lever which is formed by the pelvis is therefore necessarily oblique, and not antero-posterior as in the symmetrical position.

If a limb is congenitally shorter than its fellow, —a by no means uncommon condition in a slight degree,—deviation of the spine from an antero-posterior vertical plane is obviated by the shape of the last interarticular fibro-cartilage, which is wedge-shaped, the base of the wedge being directed to the shorter limb. If such a subject carry loads from an early period of life, this fibro-cartilage is rendered thin and flat like the others, but the last lumbar body assumes the wedge shape in obedience to the law that *the rate of bone formation at the several portions of an epiphysial line varies inversely with the pressure transmitted.* In this manner the spinal column does not deviate from the vertical antero-posterior plane in spite of the abnormal obliquity of the facet on which it is placed. If, however, the shortening be acquired, the pelvis rotates around the transverse and antero-posterior axes referred to in proportion to the difference in the length of the limbs.

Upon the oblique plane of the facet on the sacrum the superjacent vertebræ of the vertical column form a curve at right angles to its surface. The joints of the lumbar spine and pelvis are over-extended, and the condition called *lordosis* exists. By compensating for the shortening the movements of the pelvis and spine are restored to their normal character.

"Lordosis" is a term used by surgeons to comprise various conditions of over-extension of the sacro-iliac, lumbo-sacral and lumbar joints produced either by an excessive rotation of the pelvis around the normal or other transverse axis in such a direction as to effect a symmetrical over-extension of the above-mentioned articulations, or asymmetrically having associated with it a rotation of the pelvis around an antero-posterior axis. It is one of those unscientific, unmeaning terms wanting in definition and precision like scoliosis, lateral curvature, kyphosis, flat-foot, and numbers of others which ought not to be used by a profession pretending to be scientific.

In the erect position the femur of the shorter limb occupies, as regards the pelvis, a position of flexion and abduction, the amount of rotation of the pelvis around the two axes varying directly with the differences in the length of the limb.

This extension of the lumbar, lumbo-sacral, and sacro-iliac joints, with the abduction of the lumbar and lumbo-sacral, if one might so describe the lateral movements of these structures on each other present in acquired inequality of the lengths of the legs, may be lessened in great part by compensating for the shortening.

When the head of the bone or the upper end of the femur is ankylosed to the dorsum ilii above and behind the transverse axis of pelvic rotation, the degree of over-extension and abduction is still greater than in the last case, and the incapacity is increased correspondingly.

In this it is not possible to lessen the curvature produced by over-extension of the joints by compensating for the shortening to anything like the extent that can be done when the head is fixed in the acetabulum.

Again, when the upper end of the femur moves upon the dorsum ilii in an arc limited only by the resistance offered by the fibres of the capsular ligament and the ligamentum teres, the pelvis rotates around its axes till the femoral attachment of the ligaments lie vertically along their insertion into the innominate bone.

When I was working at the changes in the skeleton that result in labourers from the pursuit of different occupations, or in other words the study of the fixation and exaggeration of various postures of activity, I examined several bodies in which fractures of the neck of the femur had been sustained, followed by non-union of the broken surfaces. I found two distinct varieties. The most common was that in which the stump of the neck was displaced on to the dorsum ilii above and behind the acetabulum, where it formed a joint, allowing an amount of mobility which was sometimes considerable. In these bodies it was obvious that considerable physical depreciation had followed the receipt of the injury, and that there was much deformity consequent upon the alteration in the mechanics of the part.

It appeared to me that the dorsal displacement of the upper end of the femur had resulted from the misplaced activity of the surgeon, who by the principle involved in the use of the vertical footpiece so rotated the femur inwards as necessarily to produce what was practically a dorsal dislocation. This I have explained fully to you in lectures on the treatment of fractures.

A few of these people appeared to have been sufficiently fortunate as to have escaped surgical treatment, or if they came under observation, were not subjected to the routine methods, and their legs were allowed to fall into a position of external rotation, so that the foot rested by its outer aspect on the bed. In these cases the stump of the neck formed with the ilium immediately beneath the anterior inferior spinous process a secure joint which allowed of no vertical movement of the bones on one another.

The condition of their bones and soft parts showed that the interference with the mechanics brought about by the formation of this new joint in front of and above the normal one was very much less than in the other case, and that the individual was able to continue some arduous and laborious pursuits in spite of it, more or less satisfactorily.

When the shortening was compensated for by the use of a thick sole, there was very slight alteration in the form of the lumbar spine and pelvic joints.

I have described these conditions briefly in a paper in the 'Medico-Chirurgical Transactions,' 1888, entitled "An undescribed method by which the superjacent weight of the body is transmitted in fracture of the neck of the femur through an acquired ilio-femoral articulation, and the bearing of the principle involved on the surgery of the hip-joint."

Since this new joint is situated immediately in front of and slightly above the acetabular cavity, or the situation of the normal transverse axis of pelvic rotation, when the patient stands the pelvis rotates around an antero-posterior axis to an extent corresponding to the inequality in the length of its lateral supports, and there exists also such an amount of rotation around a transverse axis as is necessarily associated with the excessive rotation around an antero-posterior one.

This last movement brings the normal hip-joint and the new joint into the same vertical transverse plane, and as the latter allows of no vertical play of the bones on one another the superjacent weight is safely and securely transmitted to the femur of the shorter limb.

Compensation for shortening produces a rotation of the pelvis around an antero-posterior axis so as to render it symmetrical, or, more commonly, there is also a slight amount of rotation of the pelvis around a transverse axis in a direction the reverse of that which takes place after compensation, for shortening is made with a joint on the dorsum ilii, and the lumbar, lumbo-sacral, and sacro-iliac joints are slightly flexed. The only discomfort from which such a patient suffers is the inability to move the thigh upon the pelvis with any great freedom; but this is a small trouble as compared to the mechanical disability of the patient who has a loose and insecure joint behind and above the acetabulum, such as exists in one variety of congenital dorsal dislocation of the hip-joint, in many cases of acquired dorsal dislocation, and in some forms of dorsal dislocation resulting from disease of the hip-joint.

Any attempt to compensate for the shortening in the latter deformity increases the amount of what is called "lordosis," which I have shown you is an over-extension of the lumbar, lumbo-sacral, and sacro-iliac joints, a position of great insecurity and mechanical disability. This occurs because the dorsal joint is situated behind the transverse axis of pelvic rotation, and in consequence the pelvis cannot be made to rotate satisfactorily around an antero-posterior axis.

Compensation for shortening throws an additional strain on a joint which is already insecure, and tends to increase its mobility in a vertical plane, together with the deformity and insecurity which result from it. This is well seen in that variety of congenital dislocation of the head of the femur upwards and backwards on the dorsum ilii.

I propose now to consider this congenital deformity first, and in doing so we should commence by asking ourselves these questions :

1. What is the anatomy of the condition ?

2. What are its mechanics, or, in other words, its functions or physiology ?

3. Can the head of the bone be restored to its normal position, and if not, on what principles should its treatment be based ?

I do not propose to drag you through the literature of the subject, as I have already plodded through it and experienced how obscure, contradictory, and apparently deliberately misleading much of it is, but I will confine myself to submitting to you my own experience and arguments for your consideration and criticism. I have operated on several of the worst cases that I have seen, sometimes on one side, sometimes on both sides.

1. *Anatomy.*—In nearly every one of them I found precisely the same structural conditions. The femur was, roughly speaking, normal in form, except that its neck was shorter than usual, and its head was very decidedly flatter. It was such a condition as one would expect to result from the articulation of the head of the growing bone with a flat surface instead of with a uniform concavity, since *the form of a bone varies with its function or physiology.*

There was a complete capsule attached both to the femur and to the innominate bones, whose areas of insertion corresponded more or less with the normal. The arrangement of the fibres was also very similar, since it was thickest above and in front, and thinnest below and behind; in other words, *the structure and strength of its several parts varied directly with the strain sustained habitually by them.* It differed from the normal capsule chiefly in its greater length and thickness. The ligamentum teres presented similar conditions of elongation and hypertrophy.

On manipulating the leg, as during locomotion, it was clear that the capsule and ligamentum teres were the sole means by which the weight of the body was transmitted to the dislocated limb, and that the excessive strain thrown habitually upon these ligaments was responsible for their elongation and hypertrophy.

In but very few of these cases was there a normal or anything approaching a normal acetabulum, and no amount of cutting rendered it possible to replace the head of the femur in a cavity corresponding to its position.

Very rarely an acetabular cavity was present, into which, after freely dividing the restraining structures, it was possible to replace the head of the femur, and to retain it there by means of wire sutures passing through the margin of the acetabulum and the capsular ligament. Even in the same subject the conditions may differ widely on the two sides. For instance, in an infant about two years of age there was present on the one side a well-formed articular cavity into which it was possible to place the head of the bone, and to retain it by sutures; while on the other, in the position of the acetabulum, there was merely a depression to whose level it was found impossible to bring down the upper end of the femur.

Curiously enough the newly-formed joint proved more efficient than that in which the dislocated head had been replaced. As a general rule it would be true to state that *the structures forming the hip-joint differ from the normal in direct proportion with the age at the time of operation.* In other words, *the older the child the more advanced are the changes which have been described above.*

2. *Physiology.*—The capsule and ligamentum teres controlled the movement of the head of the femur upon the outer surface of the iliac bone in the form of an ellipse, the head being much nearer the iliac attachment of the ligaments when the body was in the recumbent posture, and most distant from it when force was directed upwards along the length of the shaft. This was apparently due to the fact that in the recumbent posture no strain was thrown upon the ligaments, which were relaxed, while the transmission of the superjacent weight of the trunk through the ilio-femoral ligaments separated their points of attachment to the utmost.

When this condition exists on both sides the pelvis ceases to exert any leverage action, since there is no fixed point on which the head of the femur can act as a fulcrum, and consequently there is no such resistance to pelvic rotation as is exerted chiefly by the normal ilio-femoral ligament. That portion of the sacrum through which the superjacent weight of the trunk is transmitted has both in the active and easy erect posture to be brought into the same vertical transverse plane as that occupied by the heads of the thigh bones when supporting this weight. The degree of extension of the pelvic and lumbar joints must therefore be considerable. This condition is less marked where the dislocation only exists unilaterally, but is similar in its mechanics on the affected side.

On exerting traction on the femur in a direction away from the joint, the capsule offered no resistance, but movement in this direction was opposed by all the muscles attached to the femur, by the fasciæ and other soft parts.

In order to remedy this very faulty mechanical condition it was clear that the best method would be to replace the head of the bone, or what represented the upper articulating surface of the femur, in a cavity occupying the position of the normal acetabulum, or, in other words, in the transverse axis around which the normal pelvis rotates. Then by compensating for the shortening the pelvis could be rendered symmetrical.

I would for one moment call your attention to the form of the upper end of the femur in this condition, since some writers seem to speak of it as if it were normal in form when they discuss the possibility of replacing it in an acetabulum which is presumably also of the natural shape when the subject has reached even adult age. This may possibly be true in certain cases, but it neither corresponds with my experience of the conditions found in the vast majority of patients operated on, nor with those which arguments by analogy afford.

As far as I know, a growing bone remains normal only so long as it performs its normal functions.

Alter the mode in which pressure is transmitted through it and you change its form in a definite manner, and in one in which you, aware of the physiology of the skeleton, could readily preconceive by a study of the alteration in the pressure from the normal, without any experience of the anatomy of the deformity.

In some of the cases the surface covered with cartilage and synovial membrane does not correspond to the position of the normal head of the bone, and much of what ought to correspond to the head has no such covering. I found that however freely I divided the soft parts—and that I did not hesitate to do as extensively as possible without destroying the vitality of the limb,—I was unable to place the upper end of the femur, which was trimmed down to resemble and perform the function of the normal head, in a cavity cut in the position of the acetabulum.

Thereupon, remembering the great mechanical advantages possessed by a secure joint beneath the anterior inferior spinous process of the ilium in front of the transverse axis of pelvic rotation over a loose one behind and above it on the dorsum ilii, I determined to evolve such a joint in these cases, which to my great satisfaction I did with a most happy result.

The method of operating is the following: An incision is made backwards from the anterior inferior spinous process along the upper limit of the femur. The structures superficial to the capsular ligament are cut through, and the front of the ilio-femoral ligament is freely exposed and its limits and attachments clearly defined. This ligament is then divided at its attachment to the innominate bone, being left as a long strong plane in connection with the femur. The ligamentum teres is cut away from the head of the femur.

The soft parts are cut through till it is possible to rotate the articular surface of the femur outwards and bring it forwards to the same horizontal plane

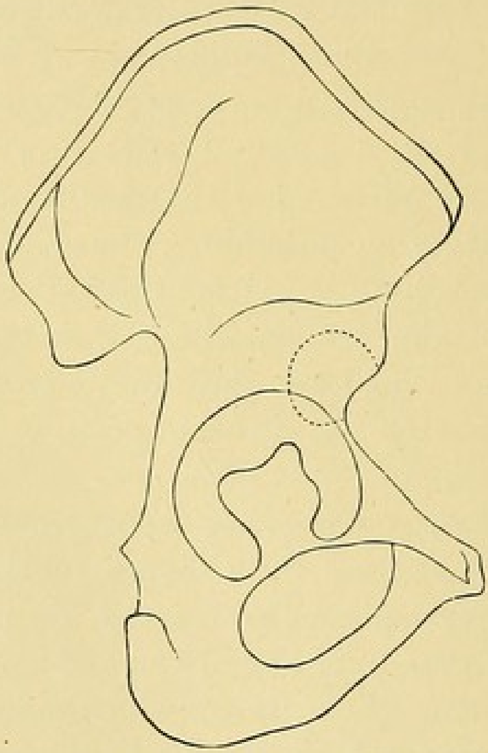


Fig. 153 shows the position of the cavity which is cut in the innominate bone.

as the anterior inferior spine. The upper end is so shaped with a chisel and file as to form a blunt cone.

A cavity is cut by means of a gouge in and beneath the anterior inferior spinous process, and the newly-constructed head is placed in it. It is retained there by sewing the anterior ligament to the bone and the rectus tendon and to the soft parts in the vicinity, wire being usually used for the purpose. This is done very thoroughly and carefully, so that the fibres of the ligament will be directed to the best advantage. If the head cannot be securely retained in this manner, as is occasionally the case, a thick silver wire is passed through the trochanter, neck and head of the femur, and through the floor of the concavity cut in the ilium, and so fixed as to allow of free movement of the bones on one another around the wire as an axis. The wire is removed subsequently, after the joint has reached a satisfactory stage in its evolution. But, as I have already stated, wire is rarely required, for the reason that the anterior ligament affords in the large majority of cases a means by which the head can be retained securely in position.

You will readily recognise the importance of performing every detail of this operation carefully, and of attending to it till a new ball-and-socket joint has been developed by systematic movements extending over a variable but considerable period. Any failure to obtain a good moveable joint is due to insufficient movement after the operation, providing that it has been properly performed.

In choosing the time to operate I would be guided by the knowledge of the following law, which I think is true. *The younger the subject the sooner is a new joint developed, and the more perfect are the structure and mechanism of the articulation evolved.*

I cannot impress the importance of this too much upon you. Unfortunately there is a mistaken idea that young children bear operations badly. Nothing can be more untrue. This cannot be better illustrated than by the operation of cleft palate, to which I called your attention recently. The only obstacle that early life affords is the comparative difficulty of securing cleanliness. Remember, then, that *if you want to obtain a moveable joint in any condition whatever, the earlier in life you operate the better will be the result.*

In cases of acquired dorsal dislocation of the hip in childhood the mechanical conditions are similar, though more marked, owing to the greater length of the head and neck. This produces a considerable amount of flexion of the thigh on the pelvis, with a correspondingly greater amount of over-extension of the pelvic and lumbar joints. The same factor causes a degree of rotation of the femur inwards which is unknown in the congenital variety. In these cases, if a sufficient time has elapsed to render it impossible to bring the head of the femur down to the position of the acetabulum, a new joint must be formed beneath the anterior inferior spine. In cases of some standing such an operation requires more extensive division of parts than in the congenital variety.

Figs. 154, 155, 156, and 157 represent the first case of this sort on whom I operated. The photographs were taken in September, 1892, two years and five months after the operation. The new joint was then perfectly secure, having undergone no displacement, and permitting all the movements present in the normal hip-joint. The boy was nine years old when operated on, and the dislocation had been produced three years before. He has improved still further during the last five years, and he can now run about as well, and his father says as fast, as any other boy of his age, and to all appearances the new joint is mechanically perfect.

The next condition I would call your attention to is that of dorsal dislocation resulting from disease of the hip-joint, usually tubercular. In this group we

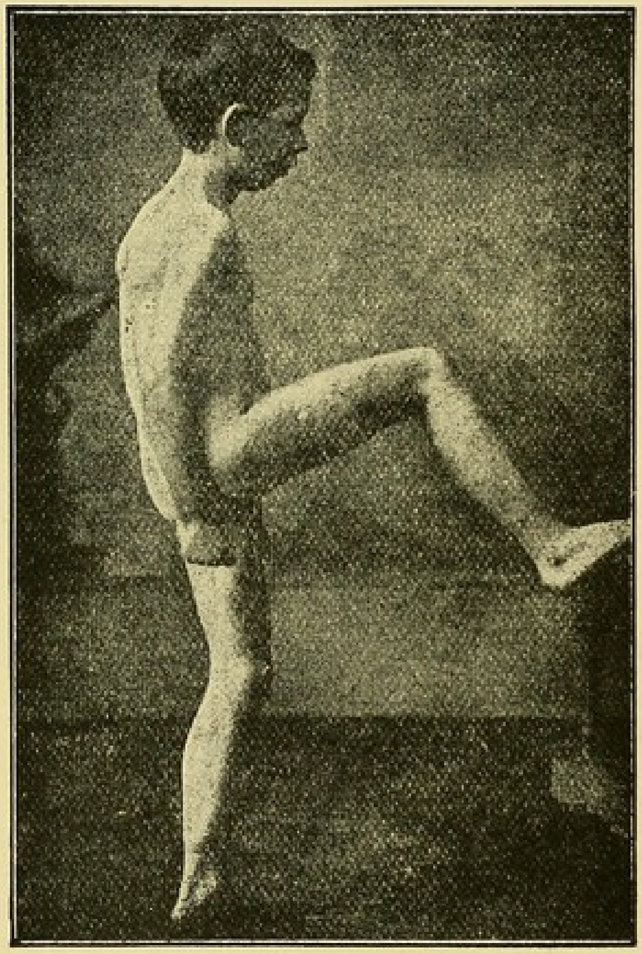


Fig. 154 shows the thigh flexed and abducted.

have to deal with a femur flexed and adducted upon the pelvis, and allowing either of limited movement of the bones on one another, or of practically no movement whatever. You are, unfortunately, very familiar with these cases, and are well aware of the great mechanical depreciation that results from this deformity.

These cases I treat on precisely the same principle as the last. You must remember that as there is very rarely any useful anterior ligament present,

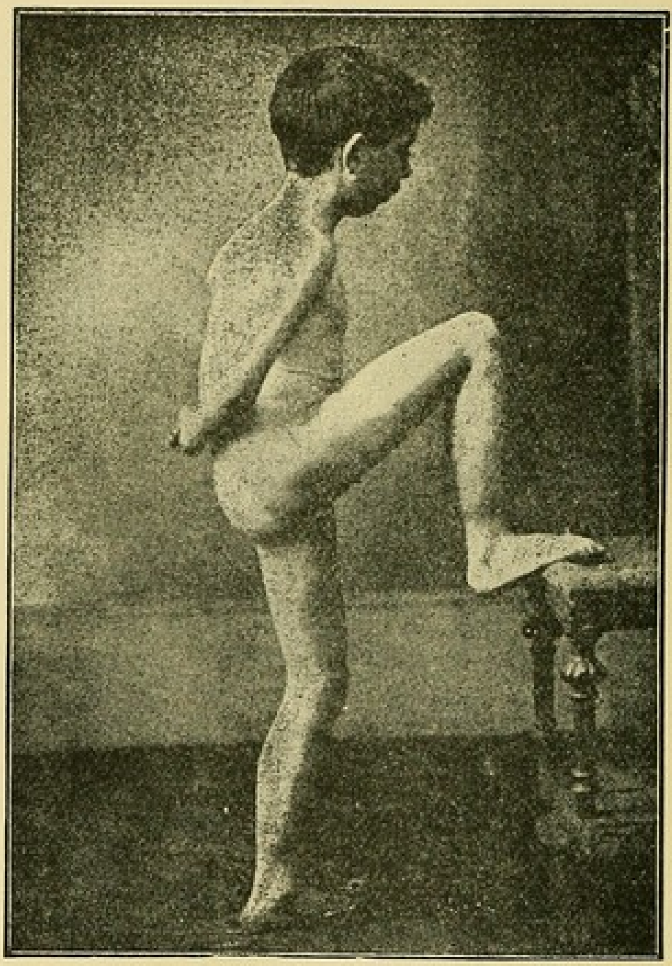


Fig. 155 shows the thigh flexed.

the head of the bone must be retained in position by means of wire till a new joint has been evolved, when the wire can be removed. Also that there is much more destruction of the head and neck of the femur, and latent organisms may be exposed. Any tubercular material should be carefully looked for and eradicated, and the child should be put upon some germicidal treatment. As in the case of tubercular infection elsewhere, I use for this purpose

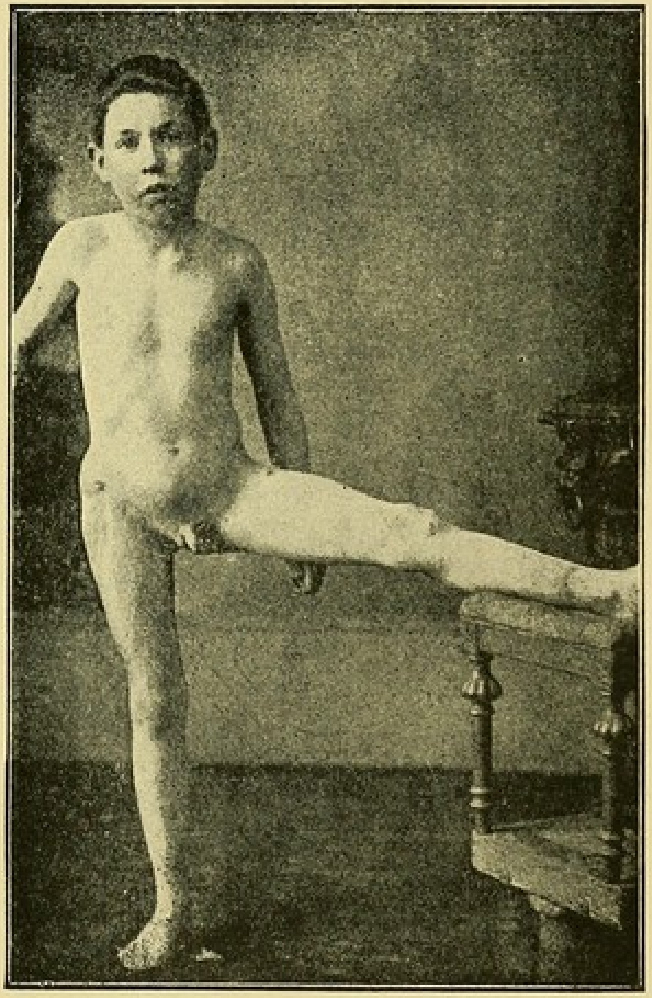


Fig. 156 shows the trunk supported securely on the new joint, the pelvis being retained in a symmetrical position.

mercury, arsenic, and the iodides of ammonium, sodium, and potassium, the dose of arsenic being steadily increased.

The procedure is indicated by the following cases:

G. B—, a girl æt. 6 years, was admitted into Guy's Hospital under my care on June 8th, 1897. Both hip-joints became affected before she was three and a half years old. She had had several abscesses in connection with each.

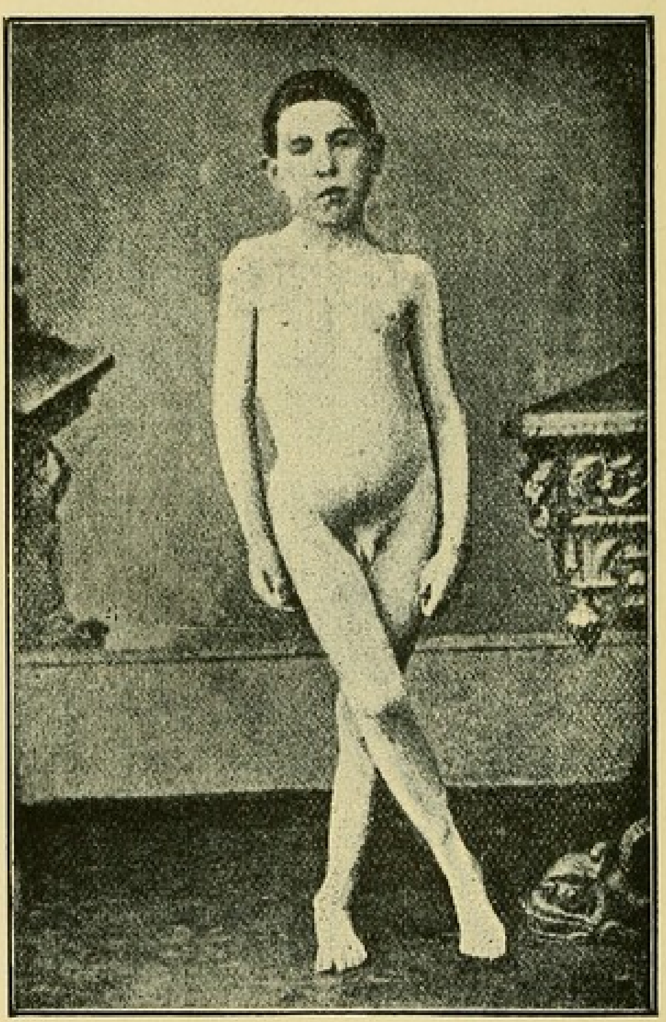


Fig. 157 shows the amount of adduction of which the hip-joint is capable in the erect posture.

On admission the thighs were flexed on the abdomen so as to form, with the horizontal plane, an angle of about 50° open upwards. In consequence of a considerable amount of adduction, the legs were folded on one another, the knees crossing. As far as could be gathered there was no movement between the femur and pelvis. She was able to sit by keeping her feet upon the seat of the chair. She could also stand if the trunk were supported in the horizontal posture, or if she sustained her weight on something with her hands. There were scars, apparently of considerable standing, indicating the presence of sinuses at some previous date. The trochanters occupied such a position as to indicate displacement of the heads of the thigh bones from the acetabular cavities.

The child experienced no pain on pressure on the joints, or on an attempt to move them. It was assumed, therefore, that the disease had probably completely or almost completely subsided.

On June 9th the right hip was operated on. An incision was made from the anterior inferior spinous process backwards along the great trochanter down to the innominate bone. The attachment to the pelvis of the femur was fully exposed. Its altered extremity was united partly by bone and partly by fibrous tissue to a corresponding surface on the ilium, behind and above the position of the normal acetabulum. Some foci of caseous material were exposed, and removed most effectually.

By dividing the muscles attached to the upper third of the femur it was possible to bring the mushroom-like head of the femur forwards into relationship with the anterior inferior spinous process, where a cavity had been cut with a gouge or burr. The flattened and expanded end was trimmed up with a chisel and file, so as to form a convexity which fitted the concavity on the ilium. This part of

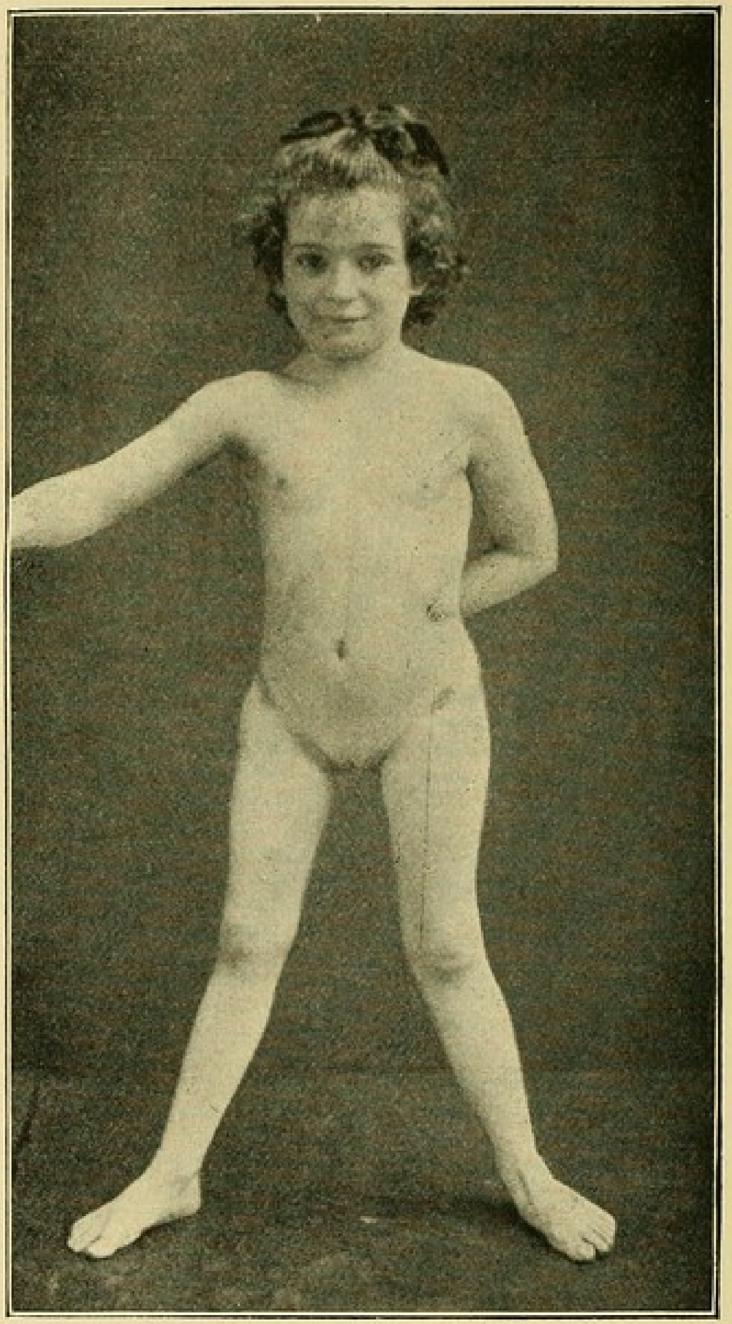


Fig. 158 represents the child in the erect posture with her legs apart to show that at this early period the new joint allowed of a certain amount of abduction.

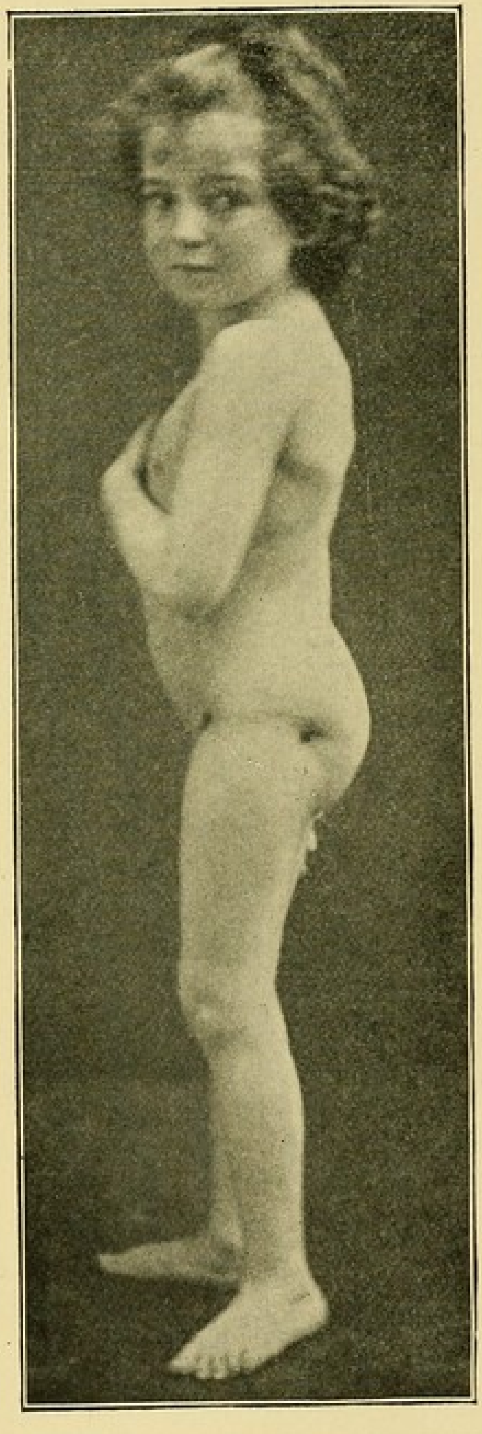


Fig. 159 shows the same patient standing in the ordinary erect posture.

the operation has been rendered more perfect and easy of performance by the use of an open-slotted cutter which renders the end of the femur uniformly convex, and of a size and shape to fit accurately into the concavity made in the ilium. This portion of the operation having been completed, a drill was

Fig. 160 indicates the amount of active flexion of which the joint was then capable.

passed through the upper extremity of the femur from without inwards, traversing the base of the trochanter, neck and head, should it exist, and then through the floor of the concavity in the ilium. Through the hole so made there was passed from without inwards a stout silver wire. Its extremity was caught by a pair of forceps as it entered the pelvis. It was then drawn forwards. The wire should be of virgin silver, and previous to its being used it should be raised to a red heat in a flame, and allowed to cool slowly. This renders it more pliable. The ends of the wire were brought forward, and were twisted together in front of the newly-formed joint.

The cut surfaces of the divided glutei muscles were firmly united with silk sutures as accurately as possible. A quantity of sterilised iodoform gauze was left in the wound, and the skin edges were brought accurately together, except at the place of exit of the gauze. The child was put upon mercury, arsenic, and the iodides of potassium, sodium, and ammonium. The gauze was removed in twenty-four hours, a smaller quantity being introduced.

In about a week movement of the femur upon the ilium around the wire as an axis was commenced, and was persevered with systematically. The wire was removed at the end of five weeks from the date of the operation, when movements of rotation of the femur upon its long axis were commenced.

On July 7th the left leg was operated on in a precisely similar manner ; the conditions found were practically identical with those on the right side. The patient left the hospital on August 31st. She could stand by herself securely, as is shown in Figs. 158 and 159, and with a little assistance she could walk very fairly with comfort. It must be remembered that but little more than six weeks had elapsed since the last operation, and that the child had not walked for a long time before the operations. In fact, she had to learn to stand and walk after the two operations had been completed.

She had gained in weight very considerably, and presented quite a different appearance from that she possessed before operation.

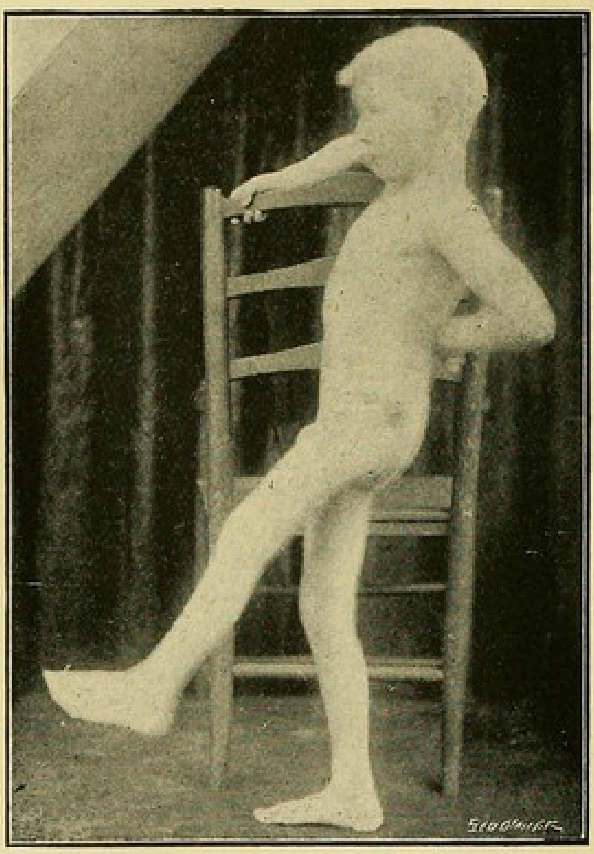


Fig. 161.

Fig. 160 shows the degree of voluntary flexion at the same period. The extent of passive flexion was far in excess of this. With time and patience a joint permitting of all the movements of the normal hip-joint should be obtained.

L. H—, æt. 9 years, was operated on on May 6th,

1897. Three and a half years before he fell out of a van, and had been lame and in pain since then. The left leg was two inches shorter than its fellow, the upper end of the femur was dislocated upwards and backwards on the dorsum ilii, the thigh was

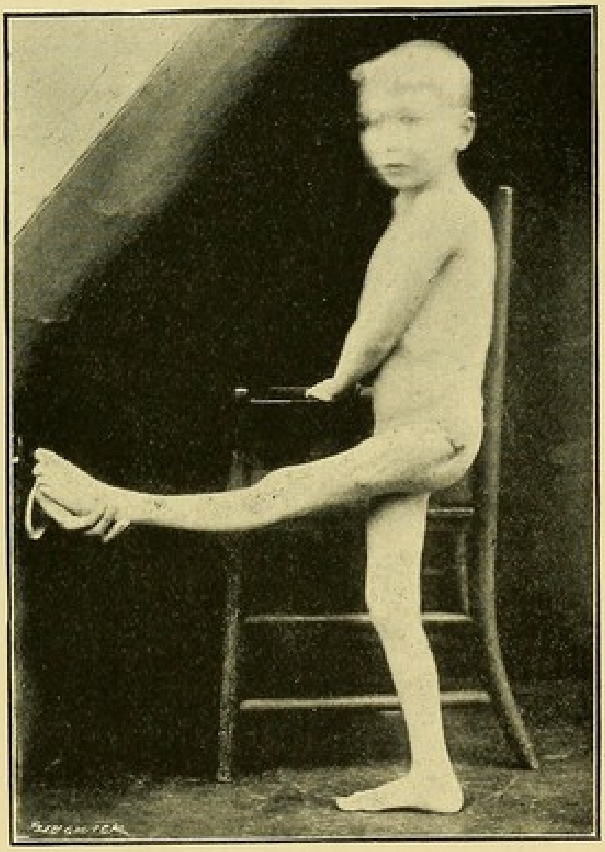


Fig. 162.

flexed and adducted, and movement was very limited and painful.

Extensive disease was found, and a sequestrum was removed. The neck of the femur was freed from disease, and was suitably trimmed. It was then secured by wire passing through it, and a cavity cut in and beneath the anterior inferior spinous process. The acetabular cavity, or rather the place corresponding to it, was rendered as free from the tubercular material as possible. A plug of iodoform gauze was inserted.

The photographs were taken on July 6th, two months after the operation. Fig. 161 represents the boy holding the thigh flexed. The long exposure has resulted in some blurring of the outline, the boy having moved slightly. Fig. 162 indicates the amount of passive flexion of which the joint was capable. The photographs also show that the adduction of the joint, which originally increased the deformity very considerably, has been completely removed.

Figs. 163, 164, and 165 illustrate the condition of a child, A. W—, æt. 4½ years, operated on on February 19th, 1897, in which the disease producing the deformity had been cured for a considerable time.

When five weeks old he had an acute inflammation of the hip-joint, which resulted in the bursting of a large abscess in the upper limit of the inner aspect of the thigh, where the cicatrix can be seen in the photograph, and in the dislocation of the upper end of the femur upwards and backwards on to the dorsum ilii, where the trochanter was within a couple of fingers' breadth from the crest. The child before the operation was only able to get about in the most clumsy way imaginable, the leg being three and a quarter inches shorter than its fellow, and a mere flail. Walking exercise was quite out of the question.

The operative procedure was that already described.

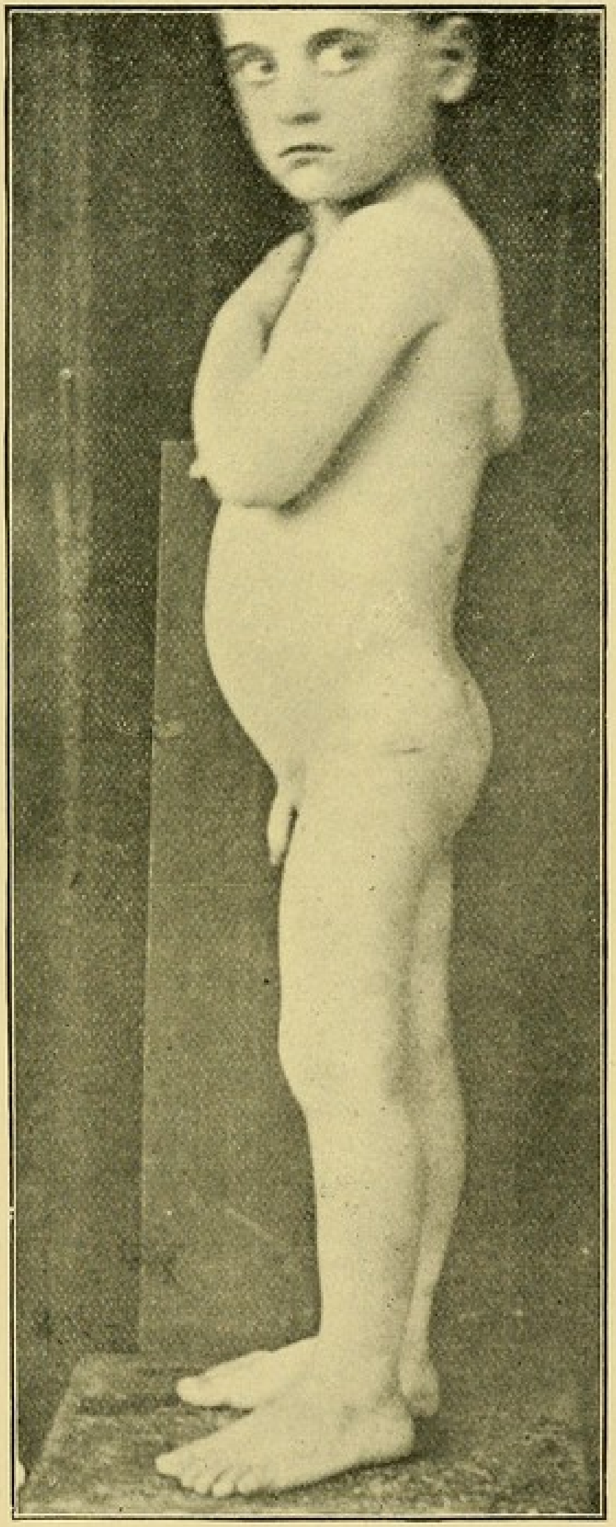


Fig. 163.

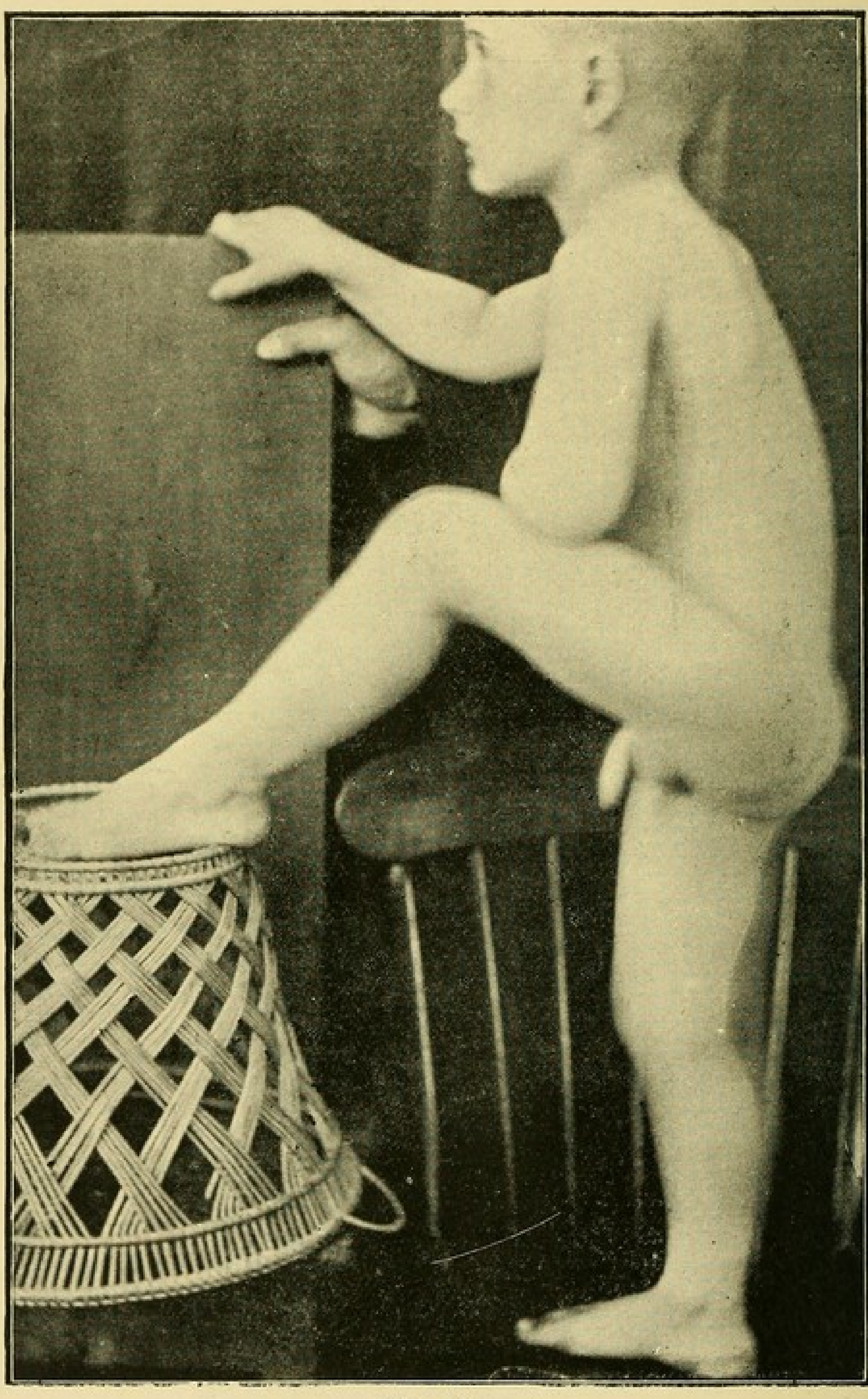


Fig. 164.

The articular surface was flat, and rested upon a short stumpy neck. The acetabular cavity was obliterated, a slight dip in the bone indicating its original position. There being but a very imperfect capsular ligament, besides utilising it it was necessary to pin the head in position with thick silver wire, which was removed at the end of four weeks, when the joint appeared sufficiently secure to allow of its removal. It was possible in this case to commence movements very early, as there was no suspicion of the presence of latent organisms.

These photographs were taken on the 27th March, about six weeks after the operation, and by that time a thoroughly efficient joint allowing of very free movement had been developed, and about two inches and a half of the shortening had been removed. With the small amount of shortening compensated for, the child could stand securely and gracefully, and could walk very fairly indeed, considering that he had practically only just learnt to do so. This patient has been converted from a condition of complete physical inability into a state of what will soon be almost complete physical efficiency by the application of the mechanical principles enunciated in this lecture.

The following is abstracted from the report of the boy's condition on August 9th, 1897 :

"The patient can walk and run well except for some tilting of the pelvis towards the shorter limb. This can readily be removed, since the left leg is now only three quarters of an inch shorter than its fellow. Flexion is perfect, as he can kiss his left knee with ease. The thigh can be abducted to an angle of 60°. Both active and passive rotation are as free as on the right side. The new joint is perfectly secure, and allows of no vertical play."

Considering the fact that before the operation the child dragged the leg, and was unable to use it with any security for purposes of locomotion, and that only five months have elapsed since the operation, I do not think one could imagine a better result.

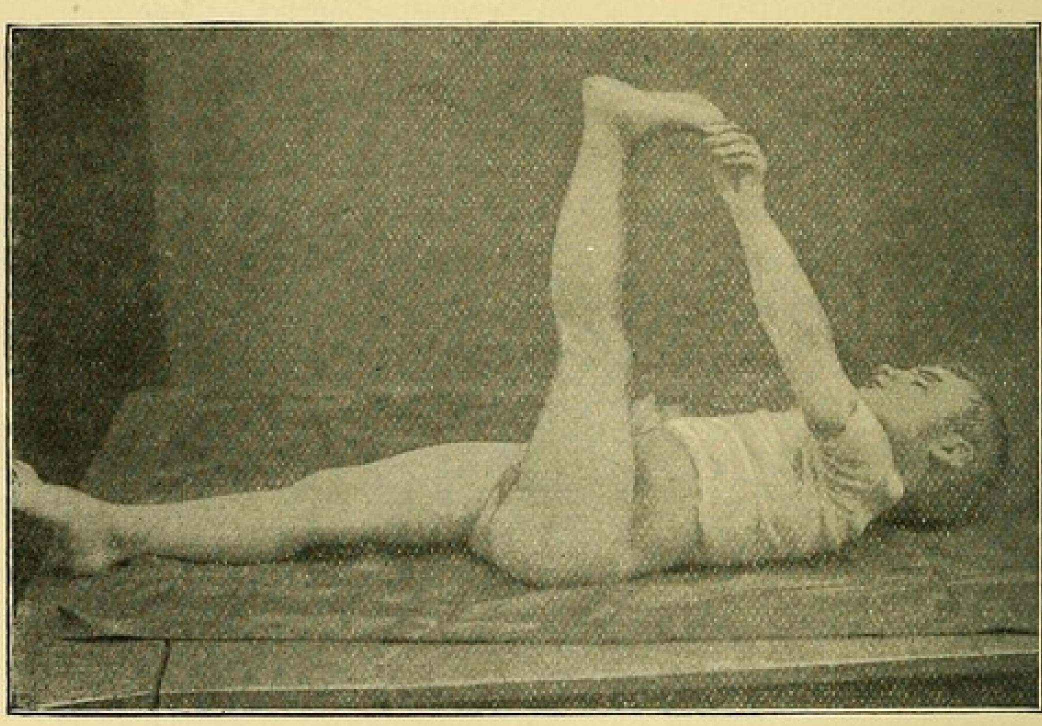


Fig. 165 shows the boy lying on his back holding his foot, he having raised it into this position.

In the last case the femur moved freely on the dorsum ilii. In cases of fibrous or bony ankylosis it is necessary to cut through the attachment with chisels, leaving as long a neck to the femur as possible, and shaping its extremity so that it will perform the functions of a head.

When the hip-joint is ankylosed either in an extended position, or, as is very much more usual, in a position of considerable flexion and adduction, the physical disability is very great. In such, after cutting the upper end of the femur out of the acetabular cavity and shaping it, it should be securely fixed in a cavity corresponding to the upper and anterior portion of the original acetabulum and the bone above it, or in one cut beneath the anterior inferior spinous process.

The former is possible in such cases of ankylosis as are associated with a femur occupying a position of extension on the pelvis, but when the relationship is one of flexion and adduction the shortening of the soft parts renders it impossible to bring the head down to the limits of the acetabulum. To develop a joint in these cases often makes a considerable demand on the patience, skill, and perseverance of the surgeon; *and if much care be not bestowed on the careful carrying out of the details of the operation, and of the subsequent treatment, the result may be by no means satisfactory.*

I have under observation at the present time several cases of dorsal dislocation from disease of the hip-joint, in which the patients have been restored to an active life with *a good working ilio-femoral articulation,* having been originally totally incapacitated and dreadfully deformed by the fixation of one or both limbs in a position of considerable flexion and adduction.

I know no operation in surgery that has afforded me more satisfaction or the patient more advantage than this procedure.

If you once grasp the mechanical principle on which these methods of operating are based, their application will ensure you a moveable and efficient limb in the young subject, providing you devote much time and attention to the evolution of the new joint.

Fig. 166 represents a set of instruments for this operation and for the surgery of fractures which I have found most useful. It was made for me by Messrs. Weiss and Son.

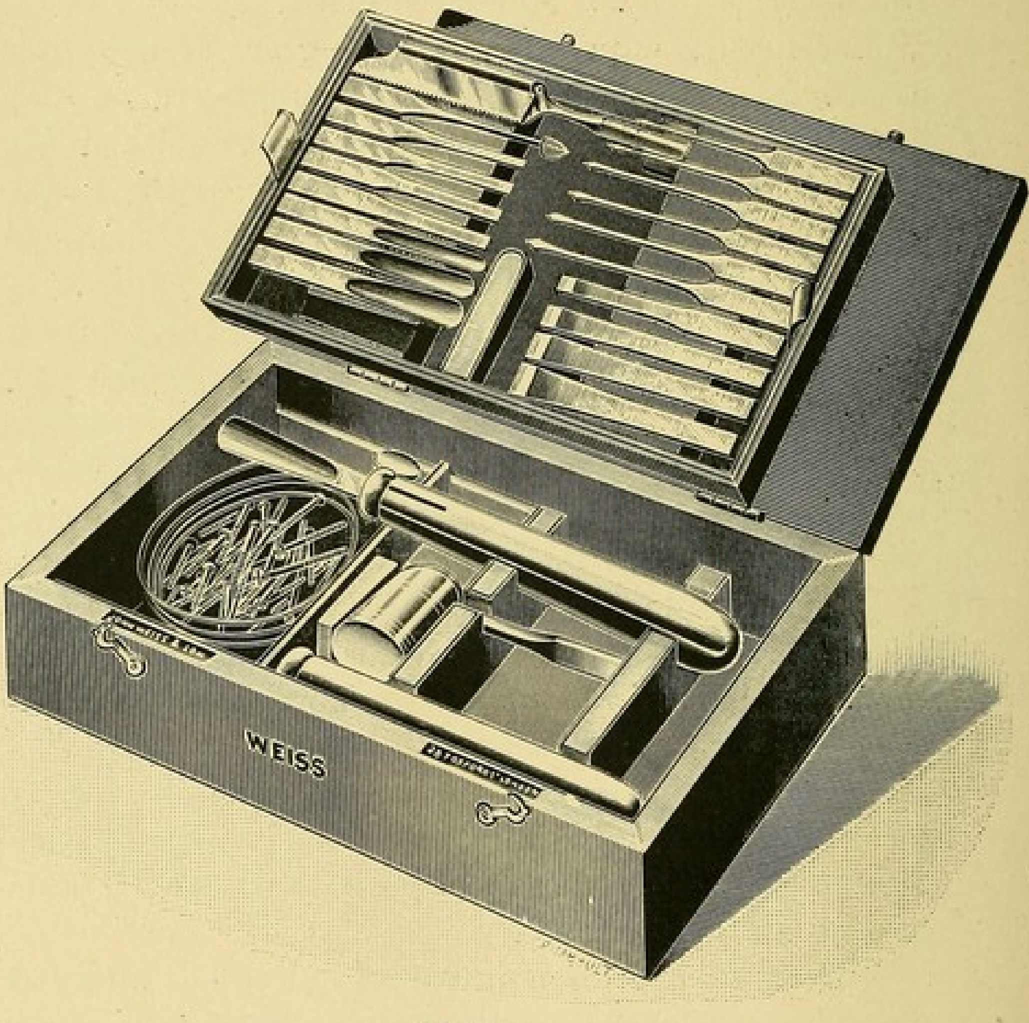


Fig. 166.

I do not propose in this present lecture to consider the operative treatment of hip-joint disease other than to point out to you that it must be founded on the same clearly defined mechanical basis. It seems to me only the other day that surgeons performed an operation which they were pleased to call excision of the hip-joint. It consisted in cutting off the upper end of the femur by dividing it transversely below the lesser trochanter. The broom-handle like extremity of the shaft was left unattached in the wound to form for itself some sort of connection somewhere, with a result that was mechanically disastrous, and from an æsthetic point of view disgusting and appalling. More recently surgeons have confined themselves to cutting through the neck of the bone, removing the head and portion of the neck. They prided themselves very much on the supposed advantages they gained in doing this through an anterior incision, and in obtaining what was called primary union. This childish fancy was marred mechanically by their rotating the shaft of the femur from the position of rest through an angle of forty-five degrees or more, till the inner margin of the foot occupied a vertical position. This being done after the wound was closed, the surgeon failed to observe that if he did not at once produce a displacement of the stump of the neck of the bone on to the dorsum ilii, it was placed in such a position that it occurred very shortly.

A recognition of the fallacy of the vertical foot-piece, the replacing such a set operation by the careful removal of diseased parts, and the use of iodoform * as a plug for cavities which used to be excised, has improved very considerably the

* "One of the best applications of iodoform in surgery" ('Lancet,' July 15th, 1893).

physical efficiency of these cases after operation. In deciding in acute cases of hip-joint disease, which on the one hand should be treated by careful erasion and plugging, the head or stump of the neck being replaced in the acetabular cavity, and which on the other hand can be most effectively met by the formation of a new joint above and in front of the acetabulum beneath the anterior inferior spinous process, you must be guided largely by the extent of disease present, the presence or absence of dislocation, the age of the patient, and the degree of irremovable flexion and adduction of the joint.

It is obviously better to secure at once a moveable joint, in a good working position, with a small amount of shortening that can be readily compensated for, than to obtain a limb even of full length in any position of flexion or extension allowing of no movement at the hip-joint.

Do not lose sight of general principles, and do not let details of such trifling importance as the position and direction of the incision, the particular structures cut through, or the rate of closure of the wound, occupy your mental vision to the exclusion of the former, which are vastly more important, and to which these, though deserving of thoughtful attention, bear but a very subsidiary relationship.

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