Henry Baker
with the author's kind regards
Sep:, 1900.

ORTHOPÆDIC SURGERY

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A HANDBOOK

BY

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PREFACE

When this work was planned out—nearly twenty years ago—there existed no systematic treatise on Orthopædic Surgery which recognised properly the revolution which had been made in all surgery by the demonstration of the germ theory of disease and by the introduction of 'the antiseptic system.'

In my judgment also the eminent men who were then the leaders of orthopædic surgery were, like their predecessors, too ready to put forth plausible hypotheses almost exactly as if they were proved theories. This practice has been from time immemorial the greatest hindrance to the progress of the healing art. The clouds of falsehood thus formed have usually proved nearly, if not quite, impenetrable to the sight of honest observers well qualified to discern truth when not artificially obscured.

I felt a desire to remove some of the dust in which mistaken ideas of what constituted proof had gradually been hiding simple facts about the pathology and treatment of deformities—of scoliosis, for example.

Since those days a number of excellent treatises on Orthopædic Surgery have appeared, both in English and in foreign languages, both in Europe and America. I do not, therefore, publish my book as one that supplies a great want, but rather as a statement of the views and as an analysis of the observations of a surgeon who has for twenty-two years devoted much time, thought, and labour to studying deformities and practising their treatment.

Some parts of the book, *e.g.* those on the nature and causes of scoliosis, on genu valgum, and on flat-foot, were published several years ago in periodical literature, and have now been re-edited. The substance of the chapter on Coxa Vara was recently read before the Medical Society of London.

So far as the literature of the subject goes references to it and acknowledgments of indebtedness to various writers will be found in the text. Perhaps I should make special mention here of M. Pousson, to whose book my article on Osteoclasis is greatly indebted; of M. Lannelongue, whose fine work on 'Tuberculose Vertébrale' led me to almost rewrite the pathological part of my own chapter on Spinal Caries; and to v. Miculicz, Busch, and the late M. Bouvier. If I have been on the right track in Orthopædic Surgery it is those three authors by whom I was chiefly placed there.

The origin of all illustrations is carefully stated, except such as are from sketches and photographs by myself. But I was sorry to find, when it was too late to remedy the omission, that the names of MM. A. Karmanski and E. Berveiller had been removed from the blocks of the illustrations borrowed from M. Lannelongue for Chapter XVII. This was done without authority from either publishers, printers, or myself. I have to thank Mr. Edgar Willett and Dr. Andrewes for permission to photograph specimens in St. Bartholomew's Hospital Museum, and Mr. F. Godart for the great pains he has taken with the engravings, and all my other friends who have lent me pictures and blocks.

Not liking the frequent repetition of such phrases as 'from a case sent to me by Dr. So-and-so,' I have used instead the expression 'from a case of Dr. So-and-so's,' although I have generally seen the patient. Fortunately Dr. Andrew Elliot had time to revise all the proofs before going with the Imperial Yeomanry to South Africa ; and Dr. James Allan has also corrected a few.

Messrs. Smith, Elder, & Co. have done for the work more than could have been expected of publishers ; *i.e.* they have done all that nearly twenty years' experience of Messrs. Smith, Elder, & Co. led me to expect of them.

It is a common practice to include in treatises on Orthopædic Surgery an account of ankyloses of certain joints, especially the knee and hip. Accordingly I wrote a chapter on this subject; but I have come to the conclusion that it will be better to withhold it, and, if the opportunity occurs, to incorporate it in an essay on ankylosis in general, more especially because nothing is more important about stiff joints than their prevention, and the due consideration of this involves the wide subject of the pathology and treatment of diseased and injured joints.

C. B. Keetley.

Grosvenor Street, London, W.
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CHAPTER I

INTRODUCTION

THE word *orthopædic*, or rather its French equivalent, *orthopédie*, was invented by Andry in or before the year 1741. Formed from the Greek words 'orthos' (straight) and 'paidion' (child), it was applied by its author to the art of preventing and correcting the deformities of children only. It has long ceased to have this limitation. On the other hand, it does not include all deformities. For example, plastic operations for hare-lip and cleft palate are not regarded as orthopædic. The precise limits vary with each author's tastes and opinions. One would exclude all deformities of the head, while another would include squint, and even obesity; and certain American authors add joint-diseases, on the plea that their proper treatment is essential for the prophylaxis of deformities. If this plea were allowed, orthopædics might include the treatment of syphilis and burns, as well as the management of pregnancy and of parturition. If, on the other hand, it were too strictly disavowed, a work on orthopædic surgery would be forbidden to more than mention the names of rickets and of the paralyses which lead to so many deformities, but are not deformities themselves.

In truth, orthopædics as a department of surgery has developed in accordance with professional and individual convenience. I have no ambition myself to either extend or narrow its bounds, and intend, therefore, in this book to take them as they are fixed, in a manner vague perhaps, but yet practical, in the orthopædic departments of British hospitals.

These bounds being identical with those of neither the 'surgery of deformities' nor the 'surgery of the locomotor apparatus,' nor with any other sharply defined portion of the healing art, orthopædics does not admit of a clear, rigid, and unerring classification and sub-classification into component parts, any more than a feather-bed which is shaken up every morning, and differently arranged by different chambermaids, can conveniently have the space it occupies divided into lettered and numbered cubes.

One of the most natural of primary classifications is into *congenital* and *acquired*. But, unfortunately, nothing is more frequently difficult, or even impossible, to decide than which of these classes a given deformity of early life belongs to. This classification, therefore, is useless as a general one; but it is very valuable in special cases, *e.g.* that of talipes equino-varus.

The next most important consideration to which to have regard in classifying would be that of etiology. The influences which bring about deformities may for the most part be tabulated as follows :—

Primary causes—

Injury.
Inheritance.
Rickets.
Osteomalacia.
Syphilis.
Gout.
Rheumatism.
Tuberculosis.
Osteomyelitis.
Tabes dorsalis.
Paralysis.
Adenoid growths in the naso-pharynx.

Causes which are usually secondary—

Cicatricial contraction.
Long-continued malposition.
Pressure (including that of superincumbent weight).
Nutritive shortening.
Atrophy from disuse.
Hypertrophy from irritation or from over-use.
Compensation (by secondary curves, hypertrophies, &c.).
Various influences of a debilitating nature, which may act either by predisposing to certain of the above 'primary causes,' or in a manner more direct. Such are attacks of zymotic disease, of chronic bronchitis, and the like.

Congenital as well as acquired deformities are for the most part traceable to one or more of these causes. I disagree respectfully but absolutely with those who would class, *e.g.*, (1) the weight of the head, trunk, and upper extremities, and (2) rickets as equal in rank in causing deformity. It is a matter of constant observation to a person holding the post of surgeon to any society which supplies raised boots, crutches, artificial legs, and the like, to see how rarely long-continued exposure to most unfavourable statical and dynamical influences will materially misshape the *healthy* skeleton. On the other hand, deformity follows all attacks of rickets, osteomalacia, persistent paralysis, tabetic joint disease, and all neglected fractures, almost as surely as does the night the day.

Such influences, therefore, as malposition, pressure, and muscular contraction are important, but secondary. They must be noticed in order.

Long-continued Malposition.—If, say, in treating a fracture of the patella, the knee-joint is kept fixed in one position (it is usually that of extension) night and day for a period of many months, the knee becomes practically as stiff as if it were ankylosed, and that quite independently of the fracture itself. This is mainly the result of *nutritive shortening*. The nutrition of the soft structures in and around the joint is adapted, in a spirit of economy, to its needs. Hence the joint capsule, the ligaments, muscles, tendons, aponeuroses, and skin around shorten to such an extent that they are ultimately put on the stretch by even the smallest attempt to flex the knee in question.

But, for this nutritive shortening to take place, the fixation must be continuous. If for ever so short a time each day the knee be exercised, nutritive shortening is prevented.

As with the knee, so with the other joints, including those of the vertebræ. When circumstances keep the spine curved in one direction night and day for a certain time, such '*a statical curve*' becomes fixed, but not otherwise. Hence cicatricial contraction after empyema will cause a permanent spinal curvature, but not the mere habit of standing in a certain position a few hours every day while playing the violin or nursing a baby.[1]

The bones, like the soft structures, but especially in

[1] Those like Hoffa, for instance, who take a different view, and have at the same time the courage to face the facts, are compelled to invoke the aid of a hypothetical individual 'weakness' of a more or less mysterious nature.

adults, less perfectly and much more slowly tend to adapt themselves to the new situation.

When, however, in addition to persistent malposition, an influence like that of rickets or osteomalacia is at work, then the two causes act together to misshape skeleton and soft parts alike.

Pressure.—So far as regards the bones, persistent malposition acts to a great extent by pressure. But purely compressive influences are exercised by (1) the weight of superincumbent parts, and (2) the compression of tight clothing.

The action of continued pressure in causing deformities was well known at the beginning of this century, and probably long before then. It was referred to by John Hunter, by James Wilson, and, later, by Bouvier and by Humphry.

It was afterwards studied more particularly and written on more elaborately by Hüter and Volkmann; and German orthopædic authors are in the habit of treating very prominently what they call the 'Volkmann-Hüter'schen Belastungs-theorie.' A sort of battle rages around it and its rival, Wolff's 'Transformationsgesetz,' about which more anon.

As put forth by Hüter and Volkmann the theory may be stated as follows: When the pressure in a joint is changed from the normal, which is assumed to be an evenly balanced one, to a pressure greater on one side than the other, the growth of the extremities of the bones becomes checked on the side of increased pressure, and favoured on the side where pressure is diminished. This effect is so much the greater if the patient be young, and still more if the bones be softened by rickets or osteomalacia.

It seems to me only necessary to put this theory in this way—namely, in the way usually adopted by its advocates—to recognise at once how undue is the prominence given to it by some of them. Take, for example, a case of osteomalacia. Without denying for a moment the *co-operating* force of pressure in bringing about some of the deformities, surely it would be absurd to regard them primarily and essentially as other than deformities due to osteomalacia. Indeed, the part played by pressure in such cases can generally be no more than guessed at, and does not admit of anything approaching to proof at all. As with osteomalacia, so also with rickets, either rachitis infantum or rachitis adolescentium; and so also with osteitis deformans and with tabetic joint diseases.

But even the influence of the weight-pressure in the manner above acknowledged is not allowed to hold the field undisputed. To make this matter clear some remarks on the structure of bone will assist. The beautiful fitness of the internal architecture of bones for their functions has long been known, and was described by Holden in the following words: The cancellous tissue 'is formed by the separation of the component layers of the bone, and these are connected by cross-plates or columns, so as to form a kind of lattice-work. The direction of these component layers in all parts of bones is arranged upon this principle: *they always run exactly in the line of pressure which the bone has to bear.* A beautiful example of this is seen in the section of the cancellous tissue of the thigh-bone. At the lower part, towards the knee, the layers run vertically—that is, in the direction of the axis of the shaft.' 'But in the neck of the thigh-bone the layers are arranged in the form of arches, one within the other, in order to sustain with the greatest mechanical advantage the weight transmitted on to the heads of the thigh-bone.'[1] These observations had been made long before Holden's time, but some Continental writers erroneously attribute the original exposition of the facts to Meyer of Zurich, who wrote about the internal structure of the calcaneum and of the neck of the femur in 1869. It had also been frequently observed, especially in connection with the ultimate condition of bones which had, after fracture, united more or less at an angle, or which became ankylosed together after disease of an intervening joint, that the process of repair was conducted with an eye, so to speak, to the internal arrangement of the uniting bone in an economical and workmanlike manner.

In 1884, Professor Julius Wolff, of Berlin, laid down as a law of Nature *that the internal architecture of bones altered by disease is modified in correspondence with the changed statical conditions.* This is Wolff's 'Transformationsgesetz.' Further,

[1] Holden's *Osteology*, 1st edition (1855), with illustrations, p. 8.

he says that the outward form of a bone changes with its internal structure, and *that deformities are simply the results of functional adaptation of osseous form to new statical conditions produced pathologically.* This teaching of Wolff's has been brought to a *reductio ad absurdum* by one of his disciples, who writes that the torsion of the scoliotic thorax is the expression of functional change in the thorax, and that it is a physiological, and therefore the best, form which Nature can give to the thorax with altered statical conditions. Korteweg of Amsterdam remarks that it is a pity that persons who suffer from this 'physiological' disease are so ill content with it.

There is an element of truth in 'Wolff's law,' which explains a portion of the new shape of deformed bones; *i.e.* a law of adaptation of structure to altered function does come into play in the case of diseased as in that of other bones. Hence the increase of compact substance on the concave sides of curved long bones. Hence the bony buttresses and the ankyloses which form in the concavities of scoliotic spines. But these changes are not the deformities.

Korteweg observes, and no doubt with truth, that the action of a *frequently intermitting* external pressure is to develop and sustain the normal internal structure of a bone, while that of *permanent* compression is to produce absorption.

We must not, however, forget that it is very common to find, in connection with deformities, marked absorption in combination with redundant deposition; osteophytic growths and new osseous bridges in association with, for example, wedge-shaped vertebral bodies. Can it be said that in these cases permanent and intermitting pressure act at one and the same time and place? Rather let us suppose that the simple mechanico-physiological hypotheses above sketched are not all-sufficient.

Not only does Nature struggle, with great success, to preserve normal form, but she also frequently succeeds in restoring it when lost. An excellent instance is seen in the spontaneous straightening of curved long bones. An ingenious explanation of this is suggested by Korteweg. It is that the concave sides of these bones have more stress laid upon them than the convex in the fulfilment of their usual functions;

that hence they are more exercised, receive an increased blood-supply, and grow faster.

It must be remembered that bones are elastic, and therefore compressible, and that compression, with its consequent recoil, tends to increase the movement of blood and lymph even in bones. Moreover, weight does not affect merely the surface to which it is applied. It is transmitted right through the bone, and felt more or less, though not equally, everywhere. Hence, for example, walking acts as a kind of massage of the bones of the lower extremities.[1]

In this way, perhaps, may be explained also the well-known phenomena of *atrophy of bone from disuse* and *hypertrophy from over-use.*

Hypertrophy from irritation is probably due directly to determination of blood and lymph, and consequent increased supply of nutritive material. It may also be more or less dependent on increased nervous activity or excitement.

An excellent example of this form of hypertrophy occurred in a boy-patient of mine, who developed a genu valgum as the result of an abscess of the internal condyle (which had been cured by erasion and iodoform). In quoting this case I may mention that an analogous case is explained by Oberst[2] as the result of (1) muscular action, and (2) pressure of superincumbent weight.

Of course, any inflammatory affection close to an active and important cartilage of growth would be particularly likely to cause deformity. I have sometimes thought it might with some advantage be produced artificially, in order to rectify deformities which are not treated satisfactorily by other, less objectionable means—spinal curves, for example; but the conditions would be complex, and the irritation might cause overgrowth in a wrong direction.

Compensation (by curves, hypertrophies, &c.).—When one part of the body is defective, it is a common and well-known occurrence that some other frequently alters to supply the deficiency. This is a salutary and beautiful arrangement, but it does not always lead to results which are beautiful in

[1] Let this be borne in mind when the question of ambulatory *v.* non-ambulatory treatment of leg-curves arises.

[2] See Hoffa, p. 26.

an æsthetic sense. It is a common cause of deformity. Just as when one kidney is destroyed the other may grow to the size of two, so when one leg is withered or lost the other sometimes develops to be immensely muscular and large-boned. So, again, when one side of the face lags in growth because of loss of teeth, the other, on which all the chewing has to be done, is apt to become muscular and massive — too much so for appearance, but not for function.

But the most interesting of compensatory phenomena take the shape of curves. When one region of the spine arches over backwards or to the left, in the region above or below, often in both, will be found an arching forwards or to the right. When, also, one rotates to the right, another rotates to the left.

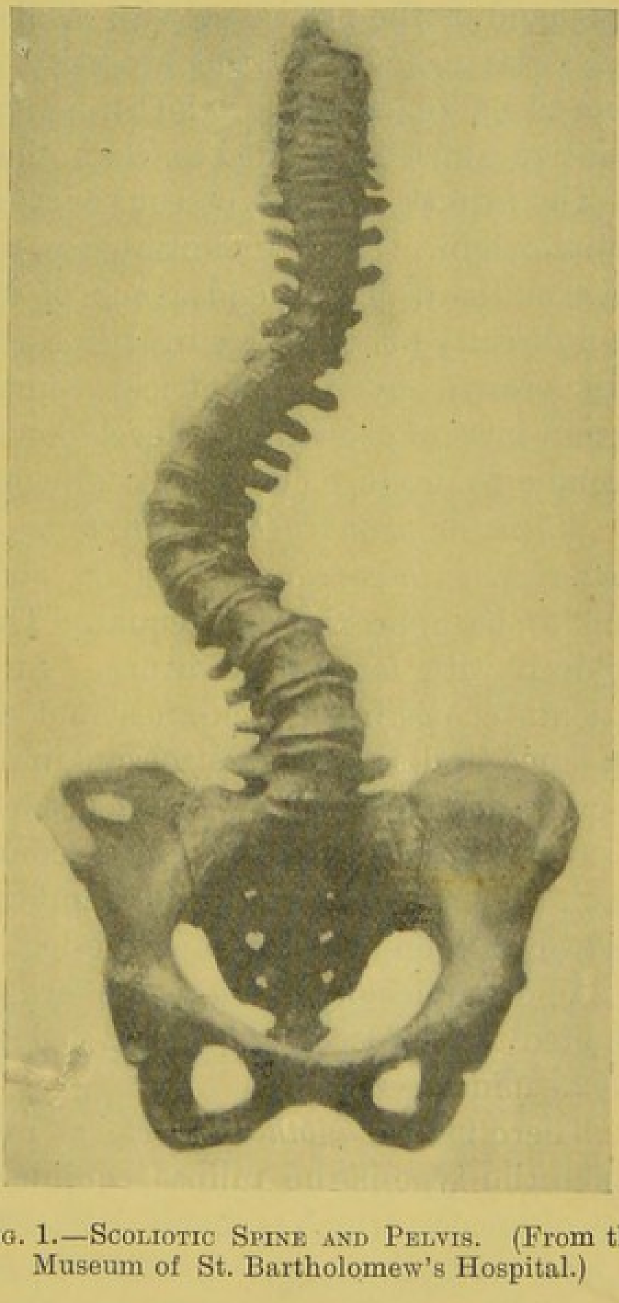


Fig. 1.—Scoliotic Spine and Pelvis. (From the Museum of St. Bartholomew's Hospital.)

These compensations are found not only in the spine, but in the ribs, in the pelvis, and in the limbs. In genu valgum the angle between the femoral neck and shaft is less oblique than normally, and the lower third of the tibia curves inwards in such a way as to assist in producing pes cavus.

These compensatory curves, though almost always present, except in recent cases of traumatic origin, and except also in many cases of deformity originating in adult life, are sometimes very insufficient, and rarely mathematically perfect.

Compensatory curves such as we have mentioned lie in the bones themselves. There are others, due to flexures of the joints—*e.g.* those which complete the picture of the claw-hand or the pes cavus with its flexed and retracted toes. The latter are due to the necessity of the joints adapting themselves to tendons which, being overstretched in one situation, must be yielded to in another.

The former—*i.e.* the osseous curves—have probably a compound origin. In the rachitic cases, which are the commonest, the rachitis itself, the endeavour of the muscles to keep the head directly above the central line of the body, interference with growth by asymmetrical compression, and doubtless certain laws of growth and development not yet fully known, combine to produce curves of compensation.

When the primary bone affection is general, as in cases of early rickets, the various curves are mutually compensatory, and tend to be approximately equal. This is well seen in little children with lateral curvature. And in the same class of patients coexisting knock-knee and curved tibia often cause hip, knee, and ankle-joints to remain in line, in spite of marked in-curvations and ex-curvations between.

In old age the effects of want of compensation are constantly seen. The aged man with extreme kyphosis may almost be said to walk on all-fours, his fore-legs being his two sticks.

As examples of curves which are *purely compensatory* may be cited the lordoses above and below an angular curvature of the spine.

There is also *another variety of compensatory deformity*, of which the type is the talipes equinus, which develops in the foot of one leg, which is much shorter than the other. Persons so affected walk more or less digitigrade as regards one foot. They have usually suffered from infantile paralysis, from hip disease, from unreduced dislocation, or from so called congenital dislocation.

The Etiology of Congenital Deformities.—Injury, inheritance, rickets (genuine or pseudo- ?), syphilis, and paralysis, are all liable to attack the fœtus in utero.

Its development is also modified by pressure, by restricted freedom of movement, by constriction, and by malposition.

And, lastly, it may inherit deformities of such a character that it seems most reasonable to suppose them due to some modification of the germ itself.

It is often difficult to trace acquired deformities to their source. It is doubly difficult to be sure of the origin of congenital malformations. Nevertheless, many ingenious hypotheses have been set forth, and so far supported by observation and argument that they deserve respectful consideration, and some of them actual acceptance.

The following classification of (known or supposed) causes of congenital deformities may be given :—

1. *Primary*

Those which arise from something existing in the germ itself, independently of its surroundings.

2. *Secondary*

Those which arise from the influence of something external to the germ. Such influence may be exercised by—

A. 1. Amniotic folds.
2. Amniotic adhesions.
3. Amniotic bands;
4. The umbilical cord.

B. The uterus itself (1) in consequence of uterine tumours or other diseases, (2) in consequence of deficient liquor amnii.

C. Malposition in utero and consequent fixation, locking, jamming, compression, counter - compression of parts, which also may or may not act in association with any of the causes previously mentioned.

D. External traumatism; *e.g.* blows on the maternal abdomen; (constriction by the umbilical cord or by an amniotic band may be regarded as internal traumatism).

E. Infectious diseases of the fœtus originating in utero.

F. Injury during the act of birth (1) by prolonged pressure of the pelvis, (2) by obstetric instruments or procedures, (3) by the umbilical cord.

It is easy enough to imagine how these causes can produce many deformities, but it is when face to face with an individual example that we ought to be cautious about asserting too dogmatically its origin from a particular cause acting during intra-uterine life.

Even the simple question whether a cranial or intra-cranial injury has been caused by the use of forceps or by the impaction and prolonged labour for which they were applied, frequently admits of no positive answer.

This subject will be further dealt with in connection with congenital club-foot, wry-neck, dislocations, absence of tibia or of radius, of limbs or limb-segments, supernumerary parts, asymmetry, dwarfish growth, and fœtal rickets.

Such important causes of deformity as *rickets* and *paralysis* will have separate chapters devoted to them, and others will be dealt with in connection with the chief deformities they cause, *e.g.* *tuberculosis* in the chapter on 'Caries of the Spine.'

CHAPTER II

GENU VALGUM—GENU VARUM—GENU RELAXUM—GENU RETRORSUM

Genu Valgum or Knock-knee

Definition.—A deformity of the legs in which, when the patient stands with his knees fully extended, and their inner surfaces touching each other, the internal malleoli are separated by an interval more or less marked. Not a perfect definition, because, with marked genu valgum, the malleoli might still touch, owing to coxa vara, or bowed tibiæ of the same side, or to genu varum of the other limb.

Varieties.—(1) Rachitic, of infants and young children; (2) rachitic, of adolescents; (3) osteitic; (4) rheumatic; (5) paralytic; and (6) traumatic. By far the commonest varieties are the first two—namely, the rachitic. The others are, comparatively speaking, so exceptional that it would cause a great deal of unnecessary confusion and trouble to take them into consideration at the same time with the common varieties of knock-knee. I shall therefore leave them to be noticed by themselves, and the general remarks on knock-knee about to be made must not be understood to refer to osteitic, paralytic, or traumatic knock-knee, except when the names of the latter are particularly mentioned.

Etiology and Pathology.—All ordinary cases of genu valgum are caused by either the well-known infantile form of rickets, or by that variety which has been named 'rachitis adolescentium.'

The true axis of the femur is not the axis of its shaft, but rather corresponds to a straight line running between

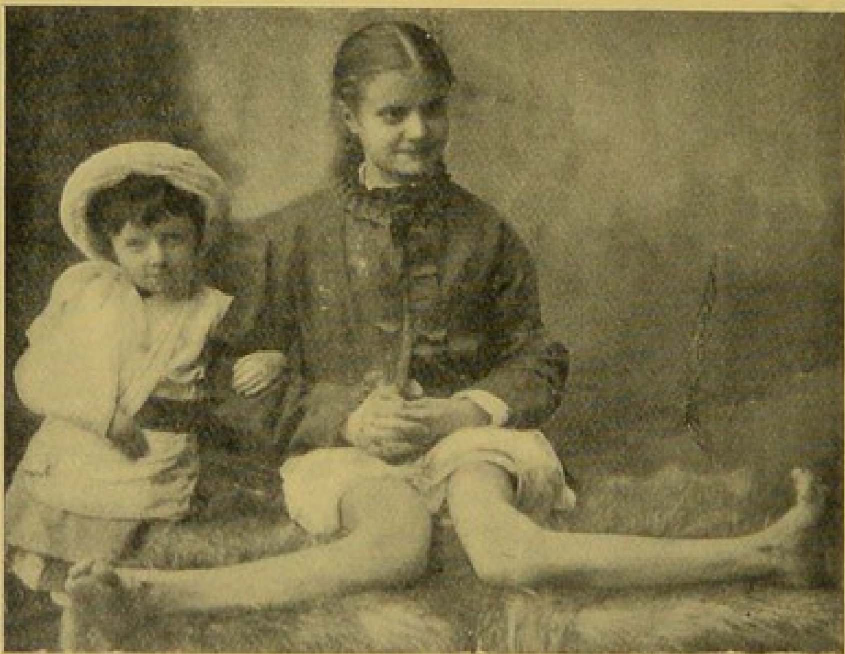


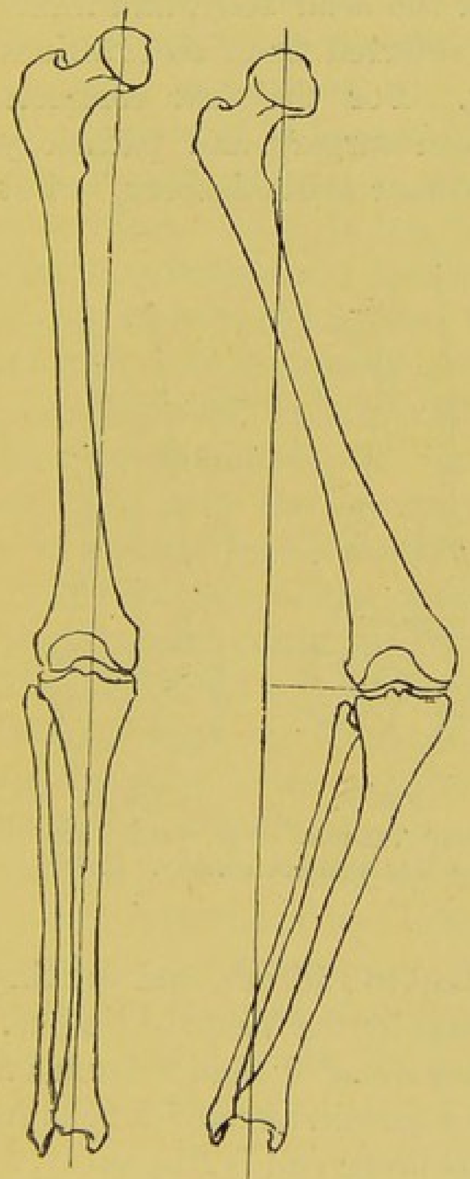
Fig. 2.—Extremely severe Genu Valgum. (A Case of Mr. A. G. Miller's, of Edinburgh.)

the centre of the head of the bone and a point between the two condyles. Obviously that is the line in which the weight of the body is transmitted through the acetabulum, knee, and ankle to the foot and the ground on which it stands. The true axis of the femur and the line of transmission of the weight of the body when supported by the lower limbs should correspond, and they do so in normal limbs.

The line of junction of the diaphysis of the femur with the lower epiphysis is, roughly speaking, when normal, at right angles to the axis of the femur. But in knock-knee the epiphysial line and the axis of the femur form an angle with one another whose acuteness outwards (and obtuseness inwards, of course) are in direct proportion to the severity of the knock-knee.

A precisely analogous statement may be made concerning the angle at which the upper epiphysial line of the tibia lies with respect to the shaft of that bone.

The two bones are far from being regularly affected in equal degree. In the great majority of cases both bones are affected, and though frequently the femur is altered most, I am quite certain that the tibia plays a more frequent and a greater part in the production of knock-knee than some surgeons grant. Now, the consequence of these changes is inevitably to make the plane of the knee-joint—namely, that in which



FIGS. 3, 4.—THESE ARE PURELY DIAGRAMMATIC, AND THE STRAIGHTNESS OF THE BONES MISLEADING. COMPARE WITH FIG. 12.

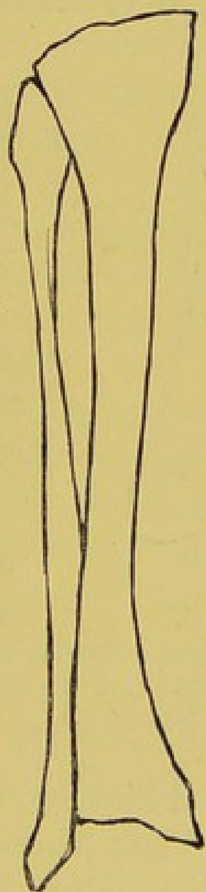


FIG. 5.—DIAGRAMMATIC OUTLINE OF TIBIA IN GENU VALGUM.

the opposite surfaces of the femur and tibia touch when the leg is extended—lie, not at right angles to the axis of the femur and that of the tibia, but at acute angles outward to both. Knock-knee is the name for this condition.

So far I have been dealing with absolute facts, which have been conclusively demonstrated on the dead body, and which may with reasonable certainty be inferred from observations easy to be made on the living. For the first complete demonstration of the chief of them surgery and pathology are indebted to Miculicz, now Professor at Königsberg, but at

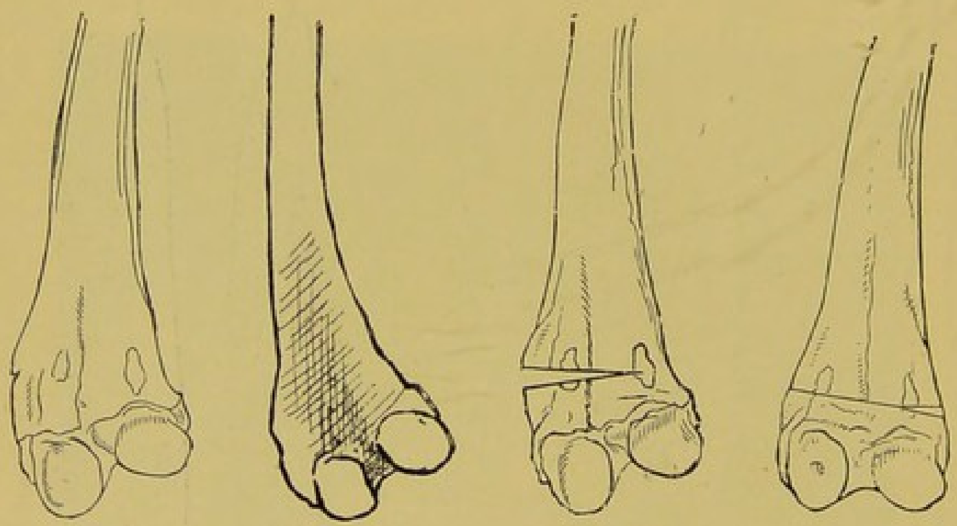


Fig. 6. Fig. 7. Fig. 8. Fig. 9.

The Lower End of the Femur in Genu Valgum. Figs. 8 and 9 are diagrams of the 1st and 2nd stages of Macewen's osteotomy. (After Dr. Macewen.)

the time of his observations assistant to Billroth, and working with materials placed at his disposal by the Vienna Clinique.

But the nature and immediate cause of genu valgum are not absolutely simple. Doubtless a certain amount of bending of the shaft of the femur near the lower end is frequently, at least a contributory cause (figs. 6 and 7). But, when present, it has not in a single one of my cases been sufficient to account for all the deformity. It is more marked among children than adolescents, and when severe is associated with curves of the shafts of other bones.

The internal condyle itself is also frequently lengthened, but only to a small extent (fig. 6). This is a matter which has been strongly discussed, and sometimes denied, and a great deal of undue importance attached to it. What does the internal condyle consist of? Its upper portion forms the lower end of the diaphysis, and its lower portion forms the inner part of the epiphysis. The former grows from the cartilage of the diaphysis, *i.e.* the so-called epiphysial cartilage; while the latter or major portion of the condyle grows mainly from the cartilage of the articulation. Bearing these facts in mind, it is easy to understand why sections of bones from cases of genu valgum show the epiphysial part of the internal condyle little, if at all, thickened, while measurements of the condyle as a whole, made during life, sometimes demonstrate perceptible enlargement; for the rickets which brings about genu valgum mainly attacks the 'epiphysial cartilage,' and has less influence over the articular cartilage.

To Macewen we are indebted for careful measurements of the internal condyle, &c. But he seems to me to exaggerate somewhat both the importance and extent of its overgrowth as an element in the causation of knock-knee.

The question arises, Why is knock-knee rather than out-knee, or genu varum, more commonly produced by rickets? Why should not a general disorder affect the two condyles in the same degree? This is not a question to be settled offhand, and one must beware of the common practice of seizing the first plausibility that presents itself, and exalting it, by special pleading or bold assertion, to the dignity of a proved theory.

Mr. Edmund Owen attaches great importance to the action of the aponeurotic structures which extend from the ilium over the outer side of the thigh down to the tibia and fibula; and I think he is right to this extent, that their existence and strength may predispose the bony pillar along which they lie to bend with its concavity towards them, rather than away from them.

A column like the lower extremity of man, which differs so much from a straight cylinder of uniform diameter and strength, naturally has segments where it more readily bends in one direction, and also segments where it bends preferably in the other.

It seems to me that everywhere, from the ankle to the hip, the concavities of the more usual rachitic curves are towards the side of the more powerful muscles and aponeuroses. The lower part of the tibia and fibula bends forwards, *i.e.* with concavity towards the tendo Achillis and the strong flexors of the toes, and with the convexity towards the comparatively weak extensors. The upper part of the shafts of the tibiæ and fibulæ bend outwards, *i.e.* with the concavity inwards, and (in consequence of the position of the tendons at the ankle) the axis of the combined flexors lies internal to the axis of the bones.

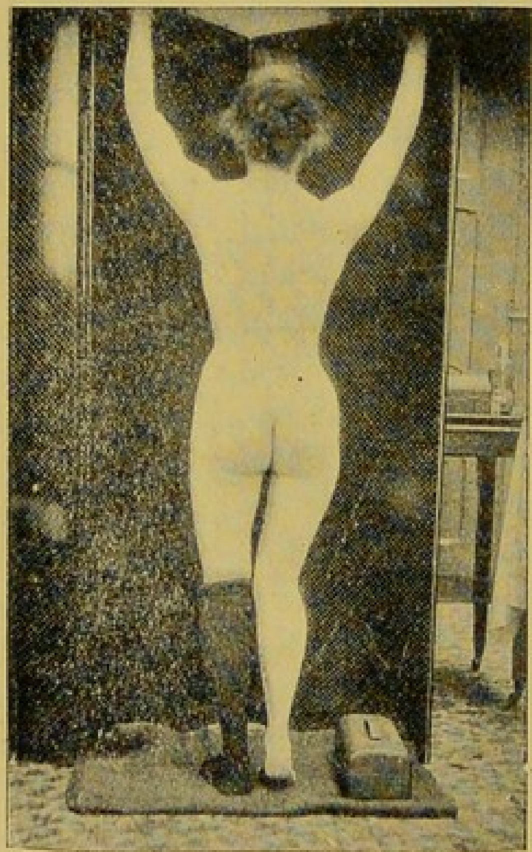


FIG 10.—GENU VALGUM COMPENSATORY TO ADDUCTION (OR VARUS) OF AN ANKYLOSED HIP.

But there are other directing influences besides the above-mentioned, and one is that which, in both the trunk and the limbs, tends to bring about compensating curves. For example, in cases of genu valgum, not too recent, a varus curve of the lower end of the tibia and fibula is frequent, and in the same cases, as pointed out by Macewen, it is usual to find pes cavus.

It is not unlikely that the position of the natural curve formed by the neck of the femur with its shaft is the reason why a valgus curve is much more frequent at the lower extremity of that bone than a varus. When a rachitic femur is examined, it is almost invariably found that the angle of neck and shaft is lessened. The natural compensation for this would be a valgus near the epiphysial junction next below it, namely, near the knee. In other words, genu valgum is a curve compensatory to coxa vara. Valgus of the neck and shaft is, of course, exceptional as a result of rickets. Hence the rarity of varus of femoral origin at the knee.

The influences being complex and of variable force, the effects are not uniform, and a kind of genu varum which is in nature the true pathological converse of genu valgum [1] is occasionally, though rarely, seen.

Before concluding these remarks on pathology, the actual changes in the condyles demonstrated by Miculicz should be mentioned. They are secondary, and the points chiefly noticeable are three in number: (1) The radii of the curves of the posterior segments of both condyles keep within the normal limits of variation; (2) the sagittal curve of the anterior segment of the external condyle, when compared

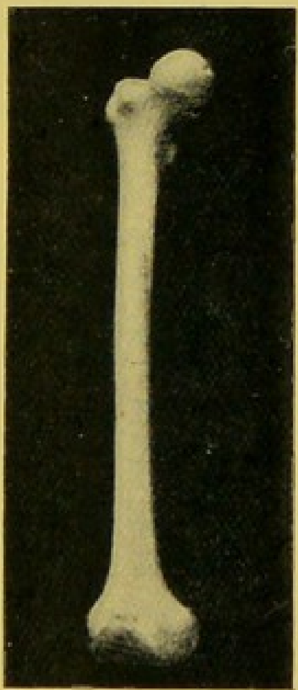


FIG. 11.—A NORMAL FEMUR, SHOWING OBLIQUITY OF NECK AND STRAIGHTNESS OF SHAFT. (From St. Bartholomew's Hospital Museum.)

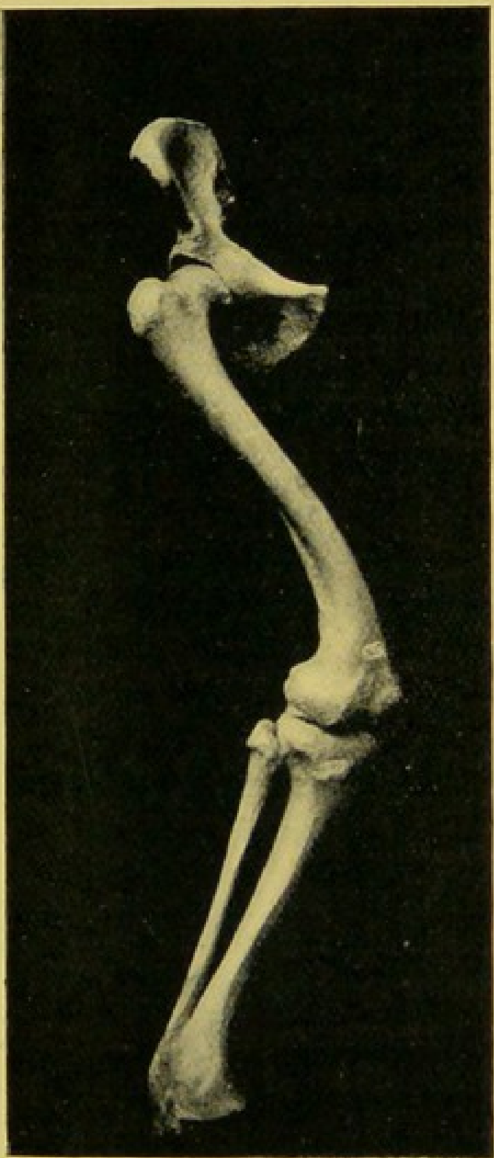


FIG. 12.—BONES FROM CASE OF GENU VALGUM IN AN ADULT. Note the presence of coxa vara, indicated by the femoral head's being scarcely higher than the great trochanter. Note also the curve in the femoral shaft and the compensatory curve in the lower half of the tibia. (From St. Bartholomew's Hospital Museum.)

[1] Common genu varum is due to curvation of the upper part of the tibia.

with the normal, is more or less flattened ; (3) the external condyle is pressed somewhat flat (*etwas plattgedrückt*) throughout its whole anterior segment.

It is very noteworthy that the articular cartilage on the external condyle, and that on the corresponding tibial surface, are more or less thickened, while on the internal condyle, especially at the inner border, the cartilage is thinned—that is to say, the cartilage is thickest where it is most pressed upon.

Symptoms.—The appearances in the living patient exactly correspond with the anatomy. To determine the amount of the deformity the knees should be put into a position of extreme extension.

They should also be fully extended when the laxness or tightness of the ligaments is to be tested. All knees permit a lateral movement when the joints are at all flexed. If it were not so, complete extension would be impossible. The obliquity of the femoral and tibial epiphyses, and the comparative share of the two bones in producing the deformity, can be best seen when the knee is extremely flexed, so as to disengage the joint-surfaces from each other as much as possible.

The gait is characteristic. The knees are shuffled past each other, and are kept bent, in order to help in keeping them out of each other's way.

Prognosis.—The first question to answer is, 'What is the probability of complete spontaneous cure?' It is practically *nil.* When supposed to have occurred, examination shows knock-knee still present. In this there is a contrast with tibial curves. The strain caused by the weight of the body and the long leverage of the femur and tibia is probably the reason. Next, what may be hoped from treatment? what from splints? what from irons, used in an ambulatory manner or while at perfect and continued rest? what from manipulation? what from osteoclasis? what from osteotomy? How is the prognosis affected by the variety of the knock-knee, and especially by the age of the patient? In young children good will usually follow the use of splints. But it must be long-continued, and not carelessly. The length of time is, in a serious proportion of cases, to be counted rather in years than months. It is said that the treatment is much more effective when combined with 'manipulation.' What claim has this statement on our belief? A little scepticism is very excusable, considering the number of baseless pretensions of various kinds that have been previously made by respectable, and even eminent people, who have fancied and vigorously asserted they were curing their patients, when they were only aggravating an already deplorable condition and deceiving themselves.[1] The more I see of genu valgum, the more firmly do I become convinced that there is no royal road to its cure, unless the simplicity, safety, and rapidity of Macewen's osteotomy, and of osteoclasis in suitable cases, entitle those operations to be regarded as royal roads; but they are *operations*, and for that reason alone intensely objectionable to some people. Is there much real tendency to relapse after operation? I am inclined to suspect that some of the so-called 'relapses' are really instances of imperfect result, due to defective after-treatment. It is not always easy to preserve the gain possible from operation in children with elastic bones. As soon as taken out of splints it is seen that the limbs are not really straight. No doubt the affection which originally caused the deformity must sometimes persist after the operation has removed the latter; but I do not think rachitis of adolescents, not to speak of children, is a very prolonged disorder. I am certain it has often passed quite away before the patient comes to the surgeon. Is there any way of judging of this; *i.e.*, of judging whether the rachitis has or has not passed away? One should inquire whether the deformity has been increasing lately or not. Note this particularly. Note also the state of the general health. In many old cases relapse is entirely out of the question, if the cure is once effected. During the surgical treatment do not forget the general indications.

There need be no fear of unpleasant consequences on account of the obliquity of the joint-surfaces, which necessarily

[1] Read, for instance, what James Wilson and John Shaw, two of the leading and most respectable surgeons of their time, and personal friends, thought of each other's statements as to fact in orthopædics.

remains after a Macewen's osteotomy done in a case where the tibia is greatly affected. After a properly performed operation the movements of the knee are in no way limited; the gait should be perfect. But when the deformity has been severe, the appearance of the lower end of the femur usually indicates plainly, at least to the surgeon, that knock-knee has existed and been corrected. There is, probably, little or no danger of rheumatoid arthritis eventually coming on, as it is apt to do after operations which divide the osseous surfaces of joints.

Treatment.—That of confirmed and severe cases in adults and adolescents is summed up in two words—'Macewen's osteotomy.' But there is legitimate room for difference of opinion and for careful consideration in slight cases, and in both slight and comparatively severe cases in early life. The alternatives are treatment by (1) splints, without taking the patient off his feet; (2) splints, combined with a cessation from walking; (3) instrumental appliances, without taking the patient off his feet; (4) instrumental appliances, with walking forbidden; (5) osteoclasis. I should be very sorry to say that the forms of treatment numbered 1, 2, and 3 are quite ineffective; but, certainly, to think them sufficient one needs to be satisfied with small mercies. Where one child gets any quick and marked benefit from them several are 'encumbered,' to use a mild expression, for a long, perhaps a very long time, and frequently with injury to their own health and well-being and to the slender purses of their parents, or to the already overtaxed ones of the charitable.

In saying this I am inviting other surgeons to tell me that I do not know how to use the means I am slighting, or that I should get excellent results, as they claim to do. I reply that I have seen many surgeons besides myself use the same means with no better result. Even if we turn to the plan I have numbered 4, which includes the combined use of carefully made and superintended appliances, with complete disuse of the lower extremities, we see results attained but slowly, and then often of a questionable description. With regard to an ambulatory treatment with well-made irons, when the patient is seen regularly, and suitable general anti-rachitic treatment given, usually a slow improvement follows, and always an arrest of the progress of the deformity. I have had an exceptionally large experience of this last-mentioned plan. But it should be remembered that new irons, some forms of which cost 5*l.*, have to be got for each case.

We now come to *osteoclasis*.[1] In a great many cases all consideration of this is out of the question, as it is impossible without a machine, and most British surgeons would as soon

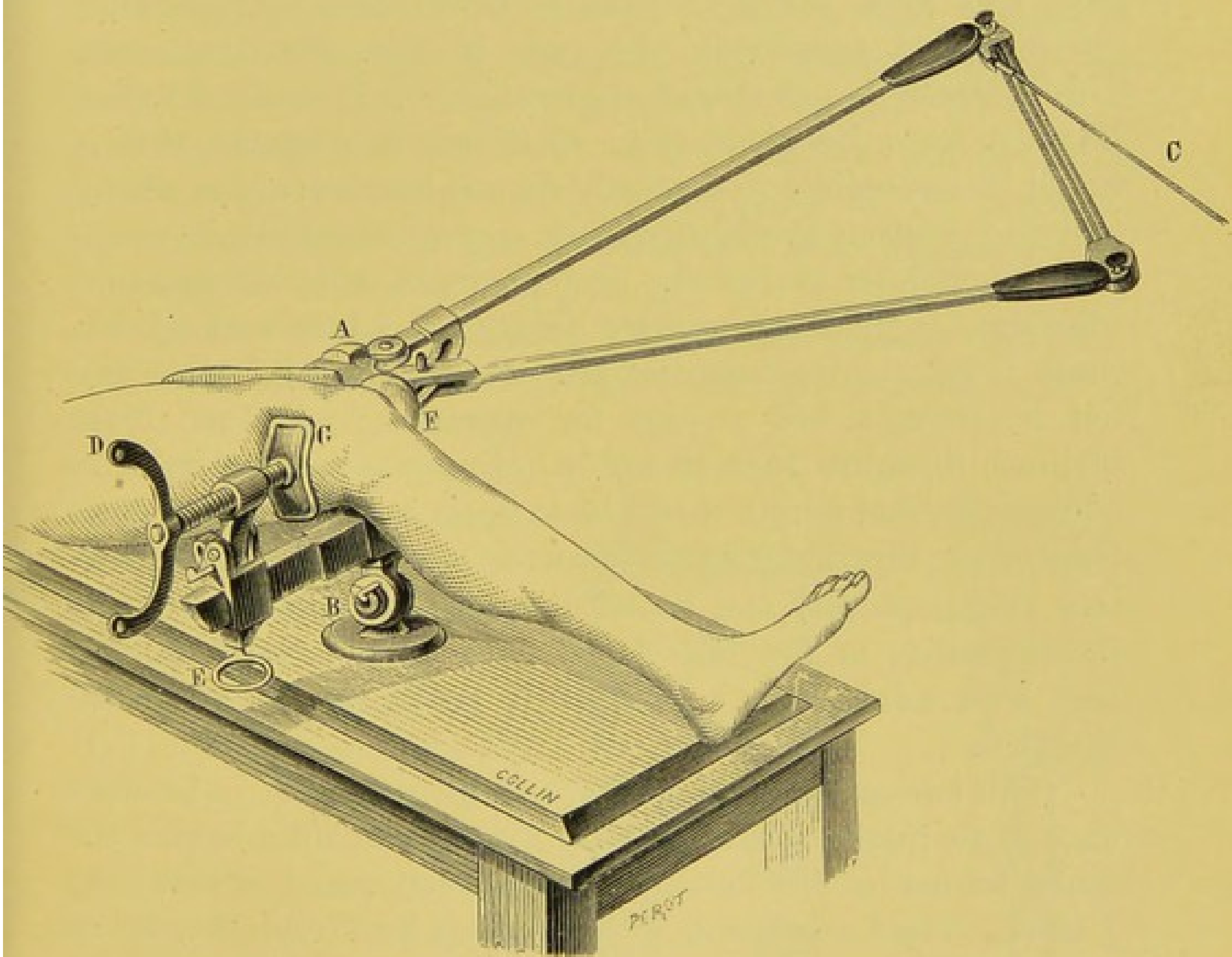


FIG. 13.—COLLIN'S OSTEOCLAST.

think of tearing the tendo Achillis by machinery in preference to tenotomy, as of machine osteoclasis in preference to Macewen's osteotomy. One may well ask, What is antisepticism worth if it will not justify so simple and exact a cutting procedure?

There is not even the excuse of less danger of damaging

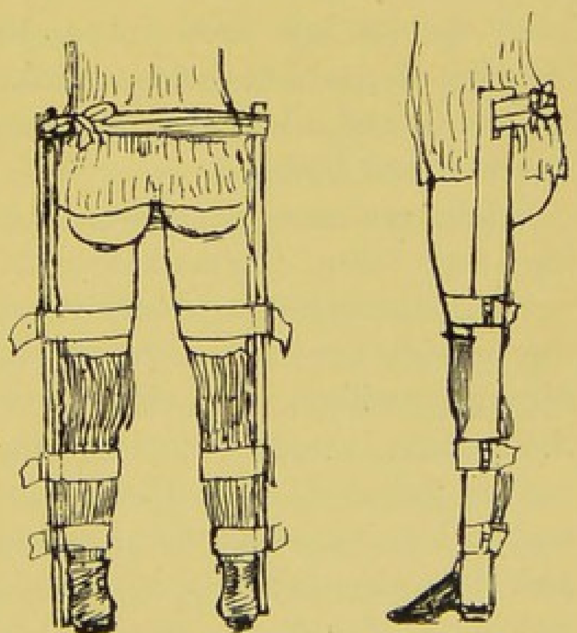
[1] Dealt with in more detail at the end of this chapter.

the popliteal. In the only fatal case of that complication recorded as complicating antiseptic osteotomy, it was a spicula of bone that pierced the vessel, and there may be spiculæ after osteoclasis as after osteotomy. For young children osteoclasis is admirable, and I am inclined to agree with Ogston that, all things considered, it is generally better to resort to it in the first instance than to waste time on splints, and both time and money on irons. There is only one objection to it that I have met with, namely, there is more difficulty than after osteotomy of preserving the gain in the after-treatment. This difficulty is not absent after osteotomy in small children. It must be quite clear, from what has been stated, that it would be impossible to correctly fix any limits of age or of any other description at which splints, irons, osteoclasis, or osteotomy should be preferred. Practically, it will be found that osteotomy is the treatment for almost all adults and adolescents requiring treatment at all. Just a few mild cases will not be thought bad enough for operation; and then I am inclined to think that to apply ordinary splints or irons to adolescents and adults would be to apply a remedy worse than the disease, injurious to the character, morally painful to sensitive young people, and sometimes anatomically injurious to the ligaments of the knee-joint. I must not forget to add, that with adults this 'remedy' is pretty sure to prove ineffectual.

Both adolescents and adults with genu valgum not severe enough to justify operation may find benefit from having the inner border of the boot (sole and heel) raised a little, say $\frac{1}{4}$ inch. The former can, without much inconvenience, follow out a treatment consisting of wearing a cushion strapped between the knees at night, the ankles at the same time being kept in contact, either by padded straps or flannel bandages. In the daytime they can be fitted with an elastic spring or accumulator along one side of the knee, fixed above and below by strapping or by broad girths of leather. Such contrivances are much lighter and less noticeable than genu valgum irons or splints which extend from the ankle upwards.

In the case of young children appliances may be used at first, but the parents should be distinctly told not to be too sanguine of a satisfactory cure, and under any circumstances to be prepared to exercise much patience. After a reasonable trial of appliances, say four or five months, if there is not much improvement, resort to osteoclasis. If the bone will not yield, do a Macewen's osteotomy. I have occasionally, when attempting manual osteoclasis, found the bone too hard to break under justifiable force, even at the age of five. The bones themselves are not always actually soft in rickets in the way that is popularly imagined. One does not always see the patient at the stage of greatest softening. What do I mean by justifiable force? It is, to a certain extent, a force which varies in amount with the strength of the operator. The latter should always be working within his powers, or he ceases to be able to control them.

Splints for Genu Valgum.—These are usually of plain deal, and should be sufficiently thick not to bend, and of width reasonably, though not precisely, proportional to their length. Each splint is carefully padded on one side; each does for either the right or the left side. *Mode of use:* A splint of right length is selected by measuring from the ankle to just beyond the buttock, the knee being straight and the hip flexed. This gives the length of the splint, which when applied lies along the outer side of the limb in the position named. The slits are placed at the buttock end. Through them a piece of webbing or bandage is passed, by means of which the upper end of the splint is prevented from tilting forward; for this webbing or bandage is passed from one splint to the other behind the buttock. If the splints are shorter than the length I have given, this



Figs. 14 and 15.—Outside Splints applied.

buttock-band, instead of lying at about the level of the upper part of the sacrum, falls inconveniently low. If the splints are made too long, they stick out in a very awkward way when the child tries to sit down. These splints are not, as a rule, intended to keep the child off his feet; they must not, therefore, descend farther than just below the ankle; and they are put on *over* the boots. They are fixed to the limbs by either (1) calico rollers, or (2) rubber (Martin's) bandages, or (3) webbing straps. The first are very apt to get displaced; the second are too hot for summer use; the third do not keep up such continuous action as the second. The calico bandage should extend from the ankle to the groin, the rubber bandage should do the same, and a length of rubber equal to about three and a half times that of the splint usually suffices to each limb. Three webbing straps are required for each splint, of which one goes above the knee and high up the thigh. Taking all things into consideration, webbing straps are preferable to either calico or rubber bandages. When short inner splints are used simultaneously with long outer, great security of position can be attained by bandaging the inner splints on first, then, after applying the outer, passing webbing straps round both.

Children soon get used to these splints, though at first they may resent the confinement.

Sometimes a second uniting strap is required to connect the splints together in front of the pelvis. The practice of carrying a single strap right round the body, over the top of the splints, is not an efficient one.

'Irons' and other Appliances for Genu Valgum.—Weights and pulleys have been arranged so as to pull the knee outwards and the ankle inwards while the patient lay in bed, but I do not know of any surgeon who uses these at present. They are very powerful, and, I have heard, were more successful in stretching the external ligaments and loosening the joint than in curing the genu valgum.

All appliances are liable to do this, because they use the leg below the knee as a lever. Since 1881 I have, therefore, had the screw movement used in ordinary genu valgum irons transferred from the level of the knee-joint to a point at the junction of the middle and lower thirds of the thigh. At the same time the pressure inwards is applied mainly at the knee instead of the ankle.

Genu valgum irons extend along the outer side of the lower limb, from a pelvic girdle down to a socket in the boot-heel. They have one girdle buckled round the middle of the thigh, and another round the leg. A leather cap braces the inside of the knee outwards to the iron. At the knee is a free joint, permitting flexion and extension; and also, except in my instrument, a screw movement, worked by a key, in opposition to the tendency to genu valgum.

This screw, as I have already said, I have moved one-third the length of the thigh upwards.

Frequently a T strap is carried from the inner side of the boot over the instep to the iron.

Mikulicz and Vogt apply elastic extension along the inner side of the knee, obtaining fixed points above and below by means of plaster-of-Paris bandages. A jointed iron connects the upper and lower plaster segment.

Landerer fixes the ends of the elastic band by fan-shaped straps of adhesive plaster. Schreiber praises this plan highly.[1]

Some years ago I found, after a careful trial, the claims made for Hüter's plan of fixing the bent knee with plaster of Paris to be almost baseless.

Professor J. Wolff[2] applies a plaster-of-Paris case to the limb. Every two or three days he cuts out a wedge-shaped piece, endeavours to straighten the limb a little, and to preserve the gain by fixing once more with plaster. He claims that in twelve to thirteen weeks even severe cases are completely cured, and recommends it for adults as well as younger persons.

In the third week of treatment he permits the patient to go about, and he fits on a metal joint to permit flexion of the knee.

I do not see how better results could be expected from this method, which is apparently an imitation of a mode of treatment of scoliosis described in 1881 by Professor Sayre,

[1] *Orthopædic Surgery*, p. 208.

[2] *Deutsche med. Wochenschrift*, 1889, No. 50, and *Centralblatt f. Chirurg.*, 1890, p. 340.

and perfectly useless, than from similar treatment by instruments of steel and leather. The latter has been often seen to result merely in complicating the genu valgum with a loose knee-joint.

The troublesome character of this treatment to the surgeon and its probable irksomeness to the patient need no pointing out. It has, however, the advantage of making the surgeon independent of the instrument maker, and the plaster case cannot be tampered with by the patient or mismanaged by the nurse.

I got satisfactory results in the case of a little boy with slight genu valgum, a patient of Dr. H. Wharry, by applying several times, at intervals of about three weeks, a new plaster-of-Paris case, each time giving the little boy chloroform and straightening out the limb as much as could be done without risk of rupturing or fracturing anything. He was allowed to run about under treatment.

Osteotomy for Genu Valgum.—This, in my opinion, means Macewen's osteotomy, and no other operation. I shall, therefore, at once give practical directions for its performance, and leave till afterwards a brief historical and critical sketch of other methods of operating.

Macewen's Osteotomy for Genu Valgum.—Instruments and appliances: A sand cushion; either a proper splint with pads, strapping, and bandages, or else material for fixing in plaster of Paris; antiseptics of course;[1] a scalpel, osteotome, and mallet. The sand pillow should measure about 18 inches by 12 inches, and not be too full. Dr. Macewen, who says that its use was suggested to him by one of his pupils, Mr. Beattie, has it moistened before using it, and then wrapped in jaconet. I use one permanently covered with waterproof, and am only careful to keep it clean and to reserve it for its proper use, not always an easy thing in a general hospital. Macewen's osteotomes should be used. These resemble what are called 'turners' chisels,' in that they are bevelled on both sides of the edge. The blade is of quite or

[1] Throughout this book it will be assumed that no cutting operation will be done except on antiseptic or so-called aseptic principles, not even a subcutaneous tenotomy.

nearly uniform width, but gradually increases in thickness from the edge to the handle. The latter is octagonal in section, and made of one piece of metal with the blade. The material is Stubbs's finest five-eighths steel, forged at a low heat; the temper is obtained by raising the instrument to a cherry-red heat, dipping into oil, and then plunging into cold water till cold. Then the polish is given. The temper of about an inch of the chisel, measuring from its cutting edge, is drawn back by raising to a copper-yellow colour with purple spots (probably a temperature of about 520°). The osteotome should be sharp enough to pare easily the finger-nail.

Position.—The patient lies on his back, with the leg to be operated on, flexed and lying on its outer side, firm upon the sand cushion. An assistant grasps it in the middle of the thigh with one hand, and by the middle of the leg with the other. A beginner should have the leg Esmarched. But with a little experience the operation can be done so quickly that it is, perhaps, better for the practised operator to discard Esmarch's bandage in this operation, on account of the lessened tendency to recurrent hæmorrhage, and the consequent less necessity of bandaging the dressings on tightly, a source of after-pain. To decide upon the place of incision, find the adductor tubercle and the tendon of the adductor magnus. Pass in the scalpel at a point one finger's breadth above the level of the former and half an inch in front of the latter; it is convenient to press the left forefinger down just above the tubercle, and Mr. Willett marks the skin with the thumb-nail immediately on the other side of the finger. This nail-mark is the place of incision. Pass the scalpel straight down to the bone, with its back towards the knee; hold it still for a minute, and then incise sufficiently to permit the osteotome to go down to the bone; divide the muscles as much as the skin. Do not withdraw the knife till you have made the osteotome glide along it to the bone. The osteotome has now to be rotated on its own axis till its edge is transverse to the femoral shaft. It should be placed against the inner edge of the bone, and at first driven outwards and forwards. When about halfway through the bone its direction should be changed to one quite transverse; or, rather, the change of direction should be continual at each stroke of the mallet, not single and angular. The bone is not to be entirely cut through; the small bridge left is to be broken. The inner border of the bone must always be divided completely. The osteotome conveys information to the hand of the state of the bone incision. It is a little difficult to teach in words how to manipulate it. For instance, I want to point out that by

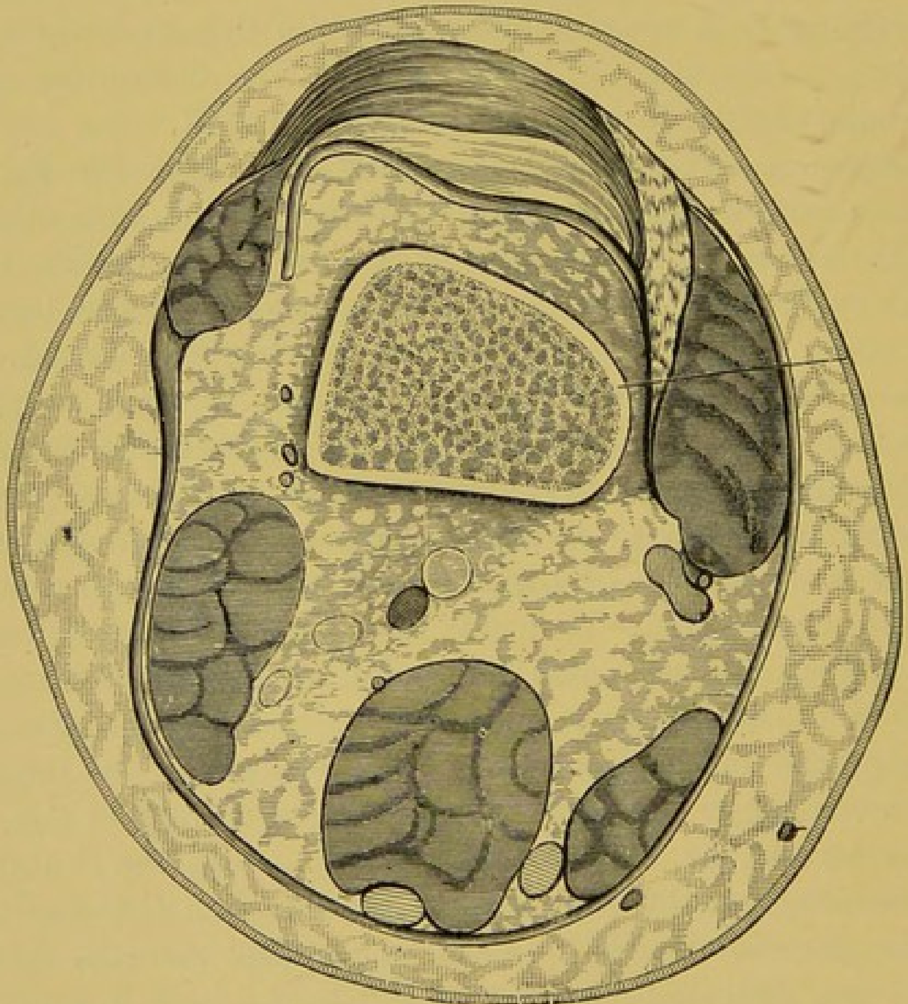


Fig. 16.—Transverse Section of Thigh at Site of Operation. (After Macewen.)

swaying, very lightly and gently, the osteotome from side to side in the plane of its own blade one can judge sometimes whether the bone requires further division, anteriorly or posteriorly. I am conscious that this description may not be clear to everybody, and it would do positive harm if it were to lead any one to move the osteotome from side to side in a plane transverse to its own plane, as, *e.g.*, a crowbar is used.

The osteotome would very likely break and leave a chip in the bone. It is always safe and almost always necessary to thoroughly divide the anterior segment of the bone. The inner border ought always to be effectually divided by the first stroke or two of the mallet. The outer border of the bone can be cut easily and safely enough by one who can judge correctly of the thickness of the bone and the depth of the osteotome. Only once have I found myself at all baffled. I then enlarged my incision an inch or more, and discovered what I had not suspected, namely, that the *anterior* surface of the bone was intact, although the chisel had been right through the bone. This case had been osteotomised before, but the deformity had been only partially corrected; it was, in fact, a 'pseudo-relapsed' case. Two osteotomes should be ready, and the thicker one used first. If this gets tightly jammed before the bone is sufficiently divided, it should be withdrawn and the thinner one substituted.

Figs. 8 and 9 illustrate diagrammatically the rationale of performing supra-condyloid osteotomy from within outwards. The thick wedge-shaped osteotome, compressing the bone, makes, on the inner side, a wedge-shaped gap, which closes up when the limb is straightened. When the osteotome is done with, press a sponge upon the wound firmly. Now, assuming it to be the right limb, hold the thigh down to the table with your left hand. To do this effectually you should be sufficiently high up for your arm to be both straight and perpendicular. You will most likely have to stand on something. Grasp the ankle with your right hand, and, using the leg as a lever, snap the femur in two. In this action, if the thigh be supposed fixed, the ankle should be pressed outwards (as if it were desired to increase the knock-knee). A slight twist will further help to effect the fracture. If you cannot break the bone you will have to use the osteotome again. It is a pity when that has to be done; but the bone will generally go easily enough if you carry out minutely and coolly the above-given directions. If you have to reinsert the osteotome, it will be more than ever necessary that you should proceed methodically, or you will get into mischief. Be sure to get it into the old groove again. Survey your bony landmarks carefully. Do not chisel wildly and blindly; you had better enlarge your incision and use retractors than do that. Now redouble your care to keep everything aseptic.

If you are going to osteotomise both limbs, bind with a gauze bandage a sponge over the wound in the first while you are operating on the second. All tendency to hæmorrhage from the first limb will probably have stopped by the time you have operated on the other.

Dressings.—An ordinary Listerian dressing with a jaconet and eightfold gauze, extending from near the groin to the middle of the calf, the packing chiefly placed along the back of the limb, and a fold or two of iodoform gauze about 5 inches square, next the wound, was formerly used. But for many years I have dressed as follows:—

A piece of iodoform gauze, several folds in thickness and about 3 inches square, is dipped in warm sublimate solution (1 : 2,000), and placed next the wound; over it a large and substantial wood-wool pad or two, which should have been neatly flattened with a rolling-pin. Bandage these on firmly. Comfort is increased by placing round the lower part of the knee and patella, and beneath the bandage, salicylic or plain absorbent wool torn from the sheet (not, therefore, in lumps).

Firm bandaging, combined with elevation, protects against recurrent hæmorrhage. The next day any painful tightness is relieved by cutting the bandage on the outer side of the thigh, and not removing either it or the dressings, but refixing them less tightly with strips of strapping.

The setting and splinting.—The deformity, unless extreme, may be corrected at once and the good position preserved.

M. Robin, of Lyons, the inventor of Robin's osteoclast, does not rectify the genu valgum until several days after osteoclasis. 'Thanks to this mode of proceeding,' we are told, 'rupture and stripping up of the periosteum, and consequently general and local reactions (fever, pain, swelling, hydrarthrosis), are avoided.' We do not expect either fever, or swelling, or hydrarthrosis after Macewen's osteotomy, neatly performed and properly treated, even when rectification is immediate, but we do frequently witness pain. I have therefore tried Robin's method. Neither after osteotomy nor after osteoclasis have I found that it deserves more than a small share of the praise he awards it, and it may involve two administrations of anæsthetics.

Nevertheless, I think when the deformity is extreme it is wise to correct it only partially at the time of operation.

I have seen some cases in which the surgeon has almost entirely failed to get the improvement possible from the operation. Such cases are often supposed to be instances of recurrence, but they are really only examples of bad management. The points to attend to are—(1) Correct the deformity while the limb is in a position of extreme extension at the knee. The slightest flexion of that joint hides the deformity and deludes the surgeon into a false sense of satisfaction. (2) The exact amount of looseness of the knee-joint, if any, should be noted before the bone is divided, and allowed for in putting up the limb. To this end the adjustment will sometimes have to be to a position of distinct varum. (3) A certain amount of spring in the bones and of extensibility in the ligaments, especially in the case of children, must be allowed for in the same way. If these cautions are borne in mind, it is a matter of minor importance which of the many possible ways be chosen in which the position can be maintained. A method which has much in its favour is immediate fixation in plaster of Paris.

When only one limb is operated on, it can be fixed in the following way:—

Use one long deal back splint, reaching from below the heel to above the buttock, and well padded. Take another, a little shorter, to use as an outside splint. Have the limb forcibly extended by one assistant, who grasps the ankle, and another who uses a perinæal band. Put the back splint in position. Place a considerable thickness of firmly stitched padding (not loose cotton-wool) beneath the ankle, with the double object of protecting the heel and keeping up the necessary extreme extension of the knee-joint. Fix the limb to this splint at the ankle and the upper third of the thigh by long broad strips of strong strapping, properly warmed and smoothly applied. Then lay a strip of strapping, $2\frac{1}{2}$ inches broad, on the front of the limb, at the level where the osteotomy has been done, but do not wrap it round the splint yet. Now lay the other splint along the outer side of the limb, and place thick pads between it and the ankle below and the upper part of the thigh above, as if with the intention of producing a state of varum. Place two other pieces of strapping round the limb on each side of and close to the piece already lying loose upon the knee. Simultaneously these two should be drawn rather tightly round the outside splint, and the middle broad piece bound tightly round the back splint. For further security it is sometimes desirable to fix the strips of strapping with safety-pins. It is also desirable to have a foot-piece to the back splint, especially if the patient be young and restless.

For cases in which both limbs have been operated on the double splint or trough described in my paper on 'Osteotomy of the Hip' may be used instead of two outer splints.[1] The back splints and strapping are used in the same way as after single osteotomy. Constant attention must be paid to them, to prevent their getting loose or displaced.

After-treatment.—Tip up the bed-foot during the first few days. This will relieve congestion, diminish after-pain, and lessen any tendency there may be to recurrent hæmorrhage, and thus contribute to the probability of no dressing being required till the wound is healed or nearly so. This may be looked for in from a fortnight to three weeks. If the wound is not then perfectly cicatrised, apply no packing, but only a small thin dressing of gauze, with a single layer of boracic lint dipped in boracic lotion, or a fragment of iodoform gauze, next the wound. Now pay, if possible, more attention than ever to securing a perfect removal of the deformity, as the fracture will soon be too rigidly set to correct position without re-fracture.

If, when the limb is finally unbound, at about the end of the fifth week, the genu valgum has not been cured, you cannot have attended to the above warnings, and there is no choice but to anæsthetise the patient, break down the callus, and start again; but do not forget to put down the failure to your own credit, and not the operation's. There is little or no

[1] See *Brit. Med. Journ.*, February 9, 1884.

tendency to overlapping of the fragments, so there is no indication for the use of continuous extension, except that it sometimes diminishes the after-aching, which is usually present for a day or two and then disappears. Adults and adolescents may be injected with morphia if the pain is intense.

HISTORICAL.—Nearly forty years ago, Mayer, a German orthopædic surgeon, recognising the essentially osseous nature of the deformity, osteotomised the upper extremity of the tibia for the cure of genu valgum. He had the misfortune to lose his first case, and though he afterwards twice operated successfully, his contemporaries declined to follow his example; and, considering the then helplessness of surgery in dealing with the complications of wounds, they were more than justified in thus holding back. The antiseptic era arrived and reopened the question. Professor Annandale first attempted an answer by, on March 16, 1875, removing a wedge with its base at the inner surface of the internal condyle and its apex in the outer condyle. This experiment proved to be rather too severe, although the patient recovered. Surgeons being still a little deceived by the great *apparent* size of the internal condyle, Professor Ogston brought out his now famous operation of separating the internal condyle by an oblique saw-cut, which permitted that bony segment to glide upwards as the leg was straightened. This neat and workmanlike, perhaps even brilliant, procedure has been shown by time to be marred by two flaws. It is based upon a not entirely correct view of the pathology of genu valgum, and in causing an articular fracture it invites the future inroads of rheumatoid arthritis, an affection to which old cases of genu valgum, even when unoperated on, seem unusually prone. The latter consideration is the more serious of the two, for no simple operation has been or can be devised mathematically opposed to an affection so complicated and (within certain limits) varied as genu valgum.

That which approaches nearest to the ideal is Macewen's. It was first performed in 1877, the year after Ogston's came out (May 17, 1876).

Macewen's operation is now almost always preferred in this country, and I believe everywhere else. But there are

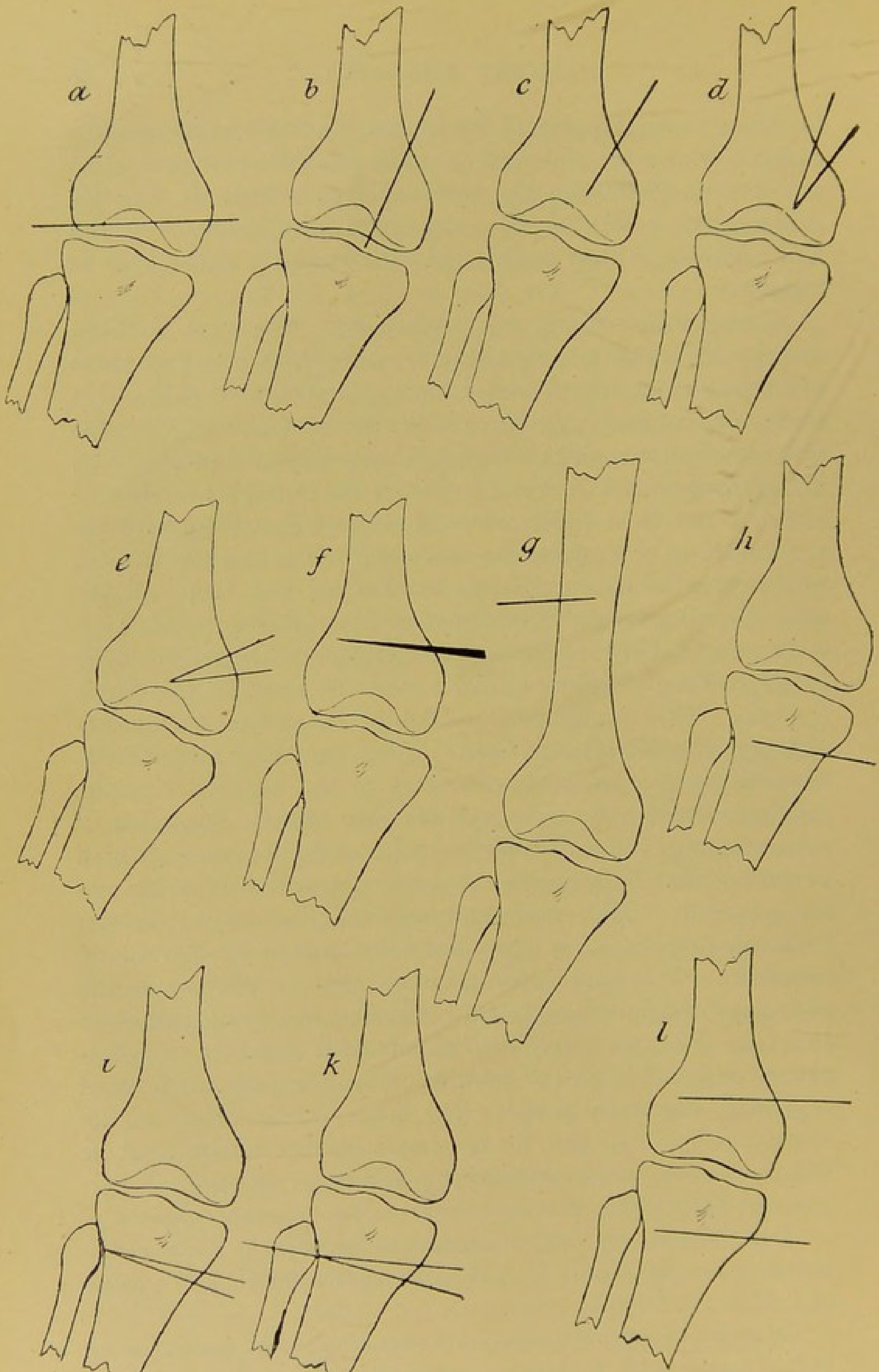
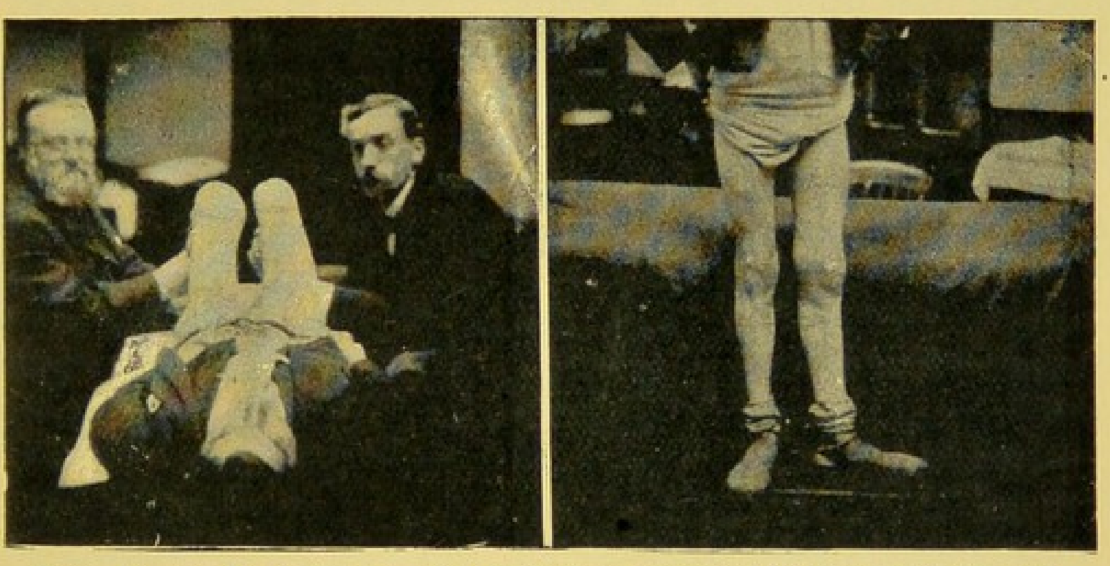


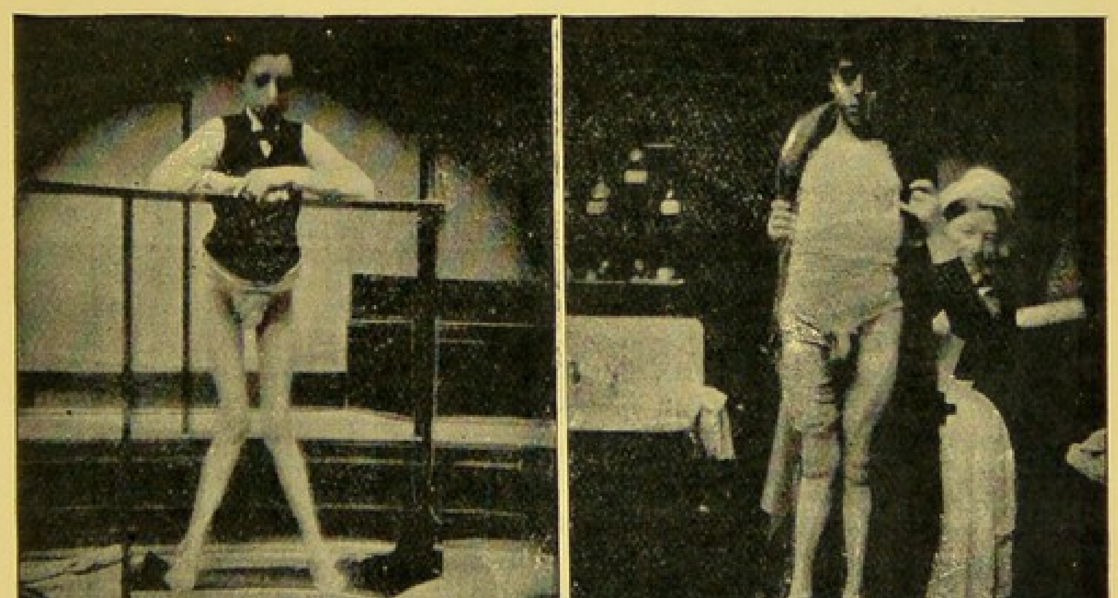
FIG. 17.—DIAGRAM OF VARIOUS MODES OF OSTEOTOMY FOR GENU VALGUM.
(From Hoffa's *Lehrbuch.*)

a, Annandale's operation (1875); *b*, Ogston's (1876); *c*, Reeves's (1878); *d*, Macewen's (1878); *e*, Chiene's (1877); *f*, Macewen's (1878); *g*, Reeves's (1881); *h*, Billroth (1873); *i*, Mayer (1853); *k*, Schede (1877); *l*, Barwell (1879).

various modes of osteotomising for genu valgum besides those referred to. Schede divided the fibula as well as the tibia. Barwell added the femur to these, and recommended a triple



Figs. 18 and 19 are from a Patient with genuine Enlargement of the Internal Condyle, without Genu Valgum, and may be contrasted with



Figs. 20 and 21, in which Genu Valgum is present and the prominence of the Internal Condyle simulates Enlargement.

osteotomy for one genu valgum. If nothing but pathological anatomy had to be considered, Barwell's operation would be the best. Reeves introduced diaphysial osteotomy, *i.e.* division of the femur at the junction of the middle and lower thirds of the shaft. This is perhaps the easiest and safest operation, especially for one inexperienced in osteotomy; but there is about it a little too much of the fault of hiding one deformity by adding another, in which respect it is analogous to infra-trochanteric osteotomy of the femur for ankylosed hip. Billroth divided the femur five centimetres above the condyles, which seems to be a compromise between Reeves and Macewen. Not all this activity—not even Mr. Barwell's, above referred to—has exhausted *every* mode of varying the operation of osteotomy for knock-knee. There are still several inches of the bones near the knee-joint, especially in the upper halves of the tibiæ and fibulæ, unappropriated by either British or German surgeons.

None of these operations appear to be dangerous *when performed by skilful operators, experienced in osteotomy and antiseptics.* Macewen's osteotomy had been performed over a thousand times before a single death could be laid to its charge. Is tenotomy safer than this?

The after-growth *of the limb is not interfered with.*

Genu Varum

Definition.—This title includes those forms of bow-leg in which the outward bend is not solely at the lower part of the legs, near the ankles.

Varieties.—(1) rachitic; (2) osteitic; (3) rheumatic; (4) traumatic. I do not know of the existence of a paralytic form. Almost all cases are rachitic; the other forms are quite exceptional.

Genu *varum* depends more on change in shape of the tibia than does genu *valgum.* This is true both of the common rachitic form and of the not less marked but much more rare variety due to osteitis deformans. In the case of the rachitic tibia, it is usually found that at the upper epiphysial junction there is obliquity, often considerable, and above the lower epiphysis an outward bowing. In the case of the rachitic femur, it is sometimes the lower end, and often the middle of the shaft, that is curved out in case of genu varum. The osteitic form is a special one. It depends sometimes upon a curve of the tibia alone, and sometimes upon one single sweeping curve of both femur and tibia. It is rather the exception than the rule to find the condyles distinctly oblique in genu varum. Indeed, I have seen the inner condyle apparently lower than the outer, as in valgum, but the out-bowing of the tibia so preponderating as to cause varum.

Fig. 22.—A Typical Example of Rachitic Genu Varum. In this case the femur is curved with the convexity outwards and forwards, the condyles of the femur at the same horizontal level, the surface of the tibia in the knee-joint oblique, the lower part of the tibia also curved; and there is a compensatory valgus at the ankle. (From a photo by Dr. James Allan.)

Treatment.—Either (1) appliances or (2) operation, and, in addition, the general treatment of the prime disease. The indications are strictly analogous to those for the management of genu valgum; so also are the appliances and operative measures. But inside as well as outside splints should be used, and, if irons are employed, they should be inside from the thigh downwards, though necessarily outside at the hips.

Again, although the tibia is almost always the bone chiefly at fault, it will usually be quite as effectual, and always easier, to rectify by osteotomy or osteoclasis of the femur.

Osteotomy of Tibia for Genu Varum. — The following are Macewen's directions for performing this operation: 'An incision in the soft parts, sufficient to admit the osteotome, is made at a point on the inner side of the tibial surface, midway between the anterior and posterior border, and opposite the lower border of the tibial tuberosity. The tibia is then divided from within outwards, commencing from the posterior border, and raising the osteotome gradually up until it comes into contact with the anterior surface of the lower portion of the tubercle, which is by far the most dense portion. The osteotome ought then to be directed from before backward, the tissues to the outside being gently retracted meanwhile, and so this dense part is divided.'

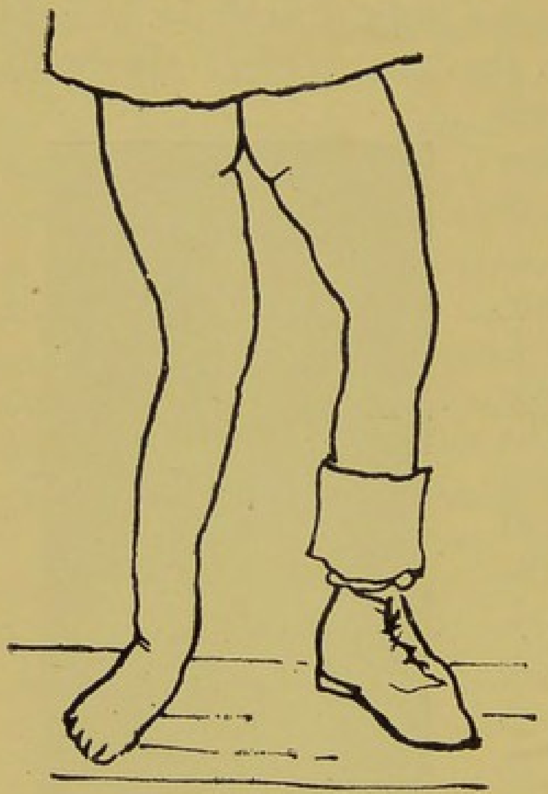


FIG. 23.—GENU VALGUM OF ONE LIMB ONLY (THE RIGHT), WITH VALGUS OF THE ANKLE. There was also genu varum of the left limb.

The effect of the division of the tibia is small compared with that of division of the femur.

When both operations are to be performed on the same limb, as in some very severe cases of genu valgum, they had better be done on the same occasion.

Genu varum is often combined with in-bowing of the lower third of the leg. In such a limb, if a perfect result be desired, osteotomy must be performed on both tibia and fibula in two places each.

LOOSE KNEE

DEFINITION.—A condition of the knee-joint in which lateral movement is permitted even when the limb is fully extended. It is essential to bear the whole of this definition in mind when examining the condition of a knee as regards the point in question. *All* knee-joints permit lateral movement when flexed ever so little, unless they are in a condition of ankylosis. It is only in full extension that the ligaments of the knee tighten up completely. It is very easy, if the point I am insisting on be neglected, to confound muscular weakness, or even natural mobility, with ligamentous relaxation. I have known a teacher make this mistake persistently, and every week demonstrate to his class an imaginary relaxation in every case of rachitic genu valgum which came before it. Even Busch, accurate as he is for the most part, contrasts genu valgum in the child and in the adult or adolescent, saying that in the former the ligaments are relaxed, in the latter they are not, except when artificially made so by the surgeon. The very opposite is the case. A severe and old genu valgum in the adult or adolescent, whether the surgeon has interfered or not, is almost always accompanied by a state of more or less loose knee; in children, on the contrary, and also in adolescents when the affection is recent, it is quite the exception to find loose knee. It is far more common to find the knee extremely loose without a trace of accompanying genu valgum. I am aware that this teaching is quite contrary to that of authorities, but of its truth I am certain. I am ready to demonstrate it at any time on the patients.

Causes of Loose Knee.—These may be divided into congenital, mechanical, and pathological.

Congenitally loose knees are associated with looseness of other joints in the same patients. Such individuals are commonly described as 'double-jointed.' Doubtless their joint-surfaces are unusually extensive, especially on the extensor side. It is not a condition which requires treatment as a disease. It is frequently inherited, and obviously a family peculiarity, although it by no means always affects all the members of the same family.

One of the commonest ways in which loose knee is mechanically produced, or rather, I hope, *used* to be, is by the treatment of genu valgum by screw instruments, or by division of the external ligaments. I think also that it is sometimes caused mechanically by the weight of the body straining the internal lateral ligament in old severe cases of knock-knee. Accidental rupture of the ligament has also been known to produce it.

Treatment.—With regard to such things as blistering, firing, and other measures, which can only act by tightening up the skin and subcutaneous tissues, it is difficult to believe that, if done thoroughly enough to effect any material improvement, they would not produce more inconvenience than benefit. When the looseness of the joint is excessively severe, however, any state is preferable to the existing one, and a change to the rigidity of a thick cicatrix would scarcely be a change for the worse.

The treatment by tonics is also not one on which much reliance can be placed.

There is, however, *one* indication which must always be fulfilled if possible, namely, to remove any mechanical influence which may be tending to perpetuate or even to increase the trouble. For instance, genu valgum itself is such a cause.

If a ligament is divided and cannot be sutured together again, the case is probably incurable, and ought to be palliated by some simple appliance, such as that recommended for liability to subluxation. If the looseness complicates knock-knee, the latter should be cured by osteotomy, and great hopes may then be entertained of a steady improvement in the joint as regards its firmness. I have seen this result occur to a remarkable extent. It is probably due to two things—(1) the way in which the muscles strengthen when the joint is put in a position to be used freely; (2) the removal of the leverage of the in-bent knee, which must have kept up a continual strain upon its internal lateral ligaments.

An exceedingly severe form of loose knee is sometimes caused by *tabetic arthropathy*.

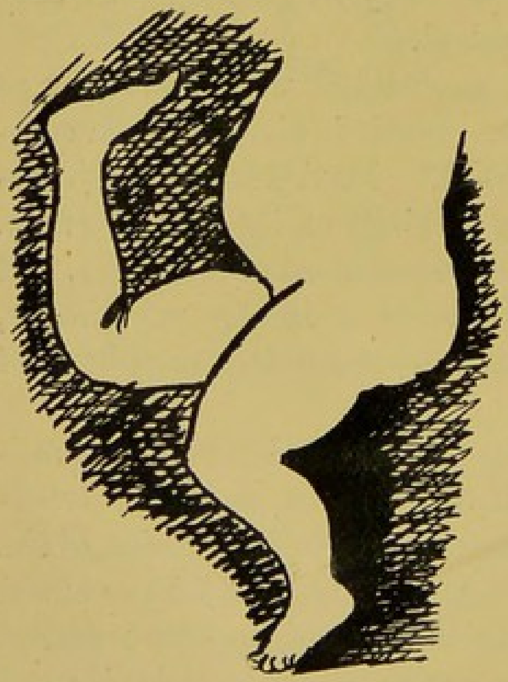


Fig. 24.—Congenital Genu Retrorsum. From a case which was readily reduced, but had a tendency to relapse, which lasted for some months.

Genu Retrorsum or Recurvatum

There are several different varieties of this comparatively rare affection. They differ so essentially that it is doubtful whether they ought to be considered together in the same chapter, or whether it would not be better to describe them each with the other affections of the joints which are analogous to it.

1. The most strongly marked, singular, and noteworthy kind of genu recurvatum is *congenital.*

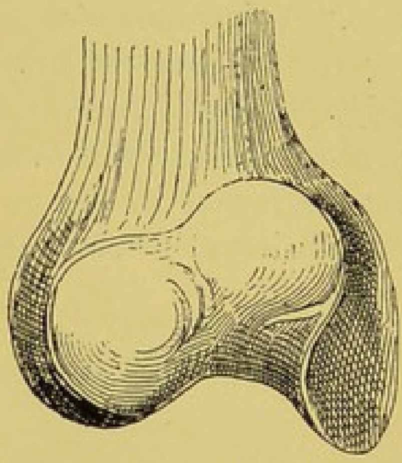


Fig. 25.—Congenital Dislocation of Knee. Front View of Lower End of Femur. (Albert, *vide* Hoffa, p. 571.)

In a typical case the knee cannot be flexed backwards, but, instead, it can be bent forwards to and beyond a right angle. The patella is usually very small, rudimentary, or even absent.

Great disability results.

Treatment.—Such cases as I have seen have been in young children, and their parents have been satisfied with crutches or with irons to stiffen the leg. But I think that great benefit might be obtained from the perfectly justifiable operation of supra-

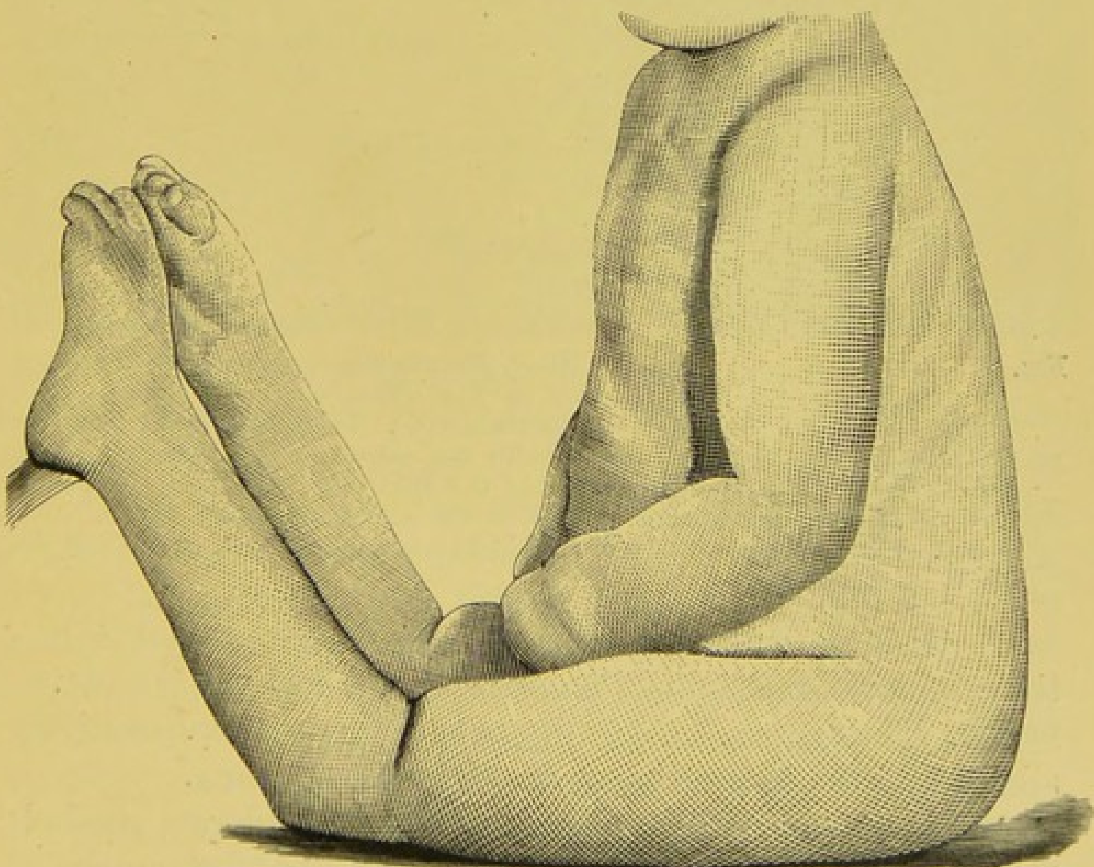


Fig. 26.—From Mr. Edmund Owen's 'Diseases of Children.'

condyloid division of the femur, followed by adjustment of the lower extremity of the femur more or less at a right angle to the shaft. This becomes the more likely from the fact that *the knee is sometimes found 'double-jointed' at birth; i.e.* the leg can be over-extended till it is nearly perpendicular to the thigh, a kind of sudden subluxation of the knee being quite perceptible as this over-extension begins. Such knees can also be flexed in the normal way. The treatment consists in preventing any recurrence of the over-extension.

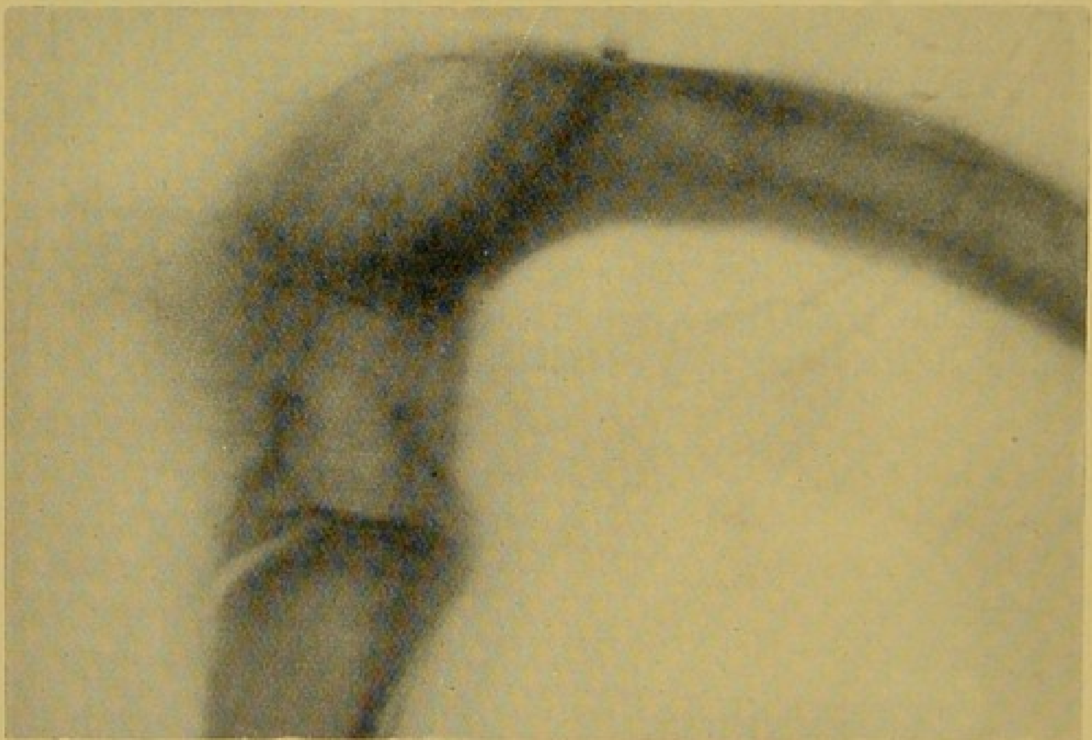


FIG. 27.—SKIAGRAM OF A CASE OF GENU RETRORSUM, SECONDARY TO NECROSIS OF THE FEMUR AND INFLAMMATION OF THE KNEE-JOINT, IN A GIRL AGED 6, A PATIENT OF DR. GREENWOOD'S, OF STAMFORD. (Skiagram by Dr. William Newman.) The femur is curved with the convexity forwards, just above the condyle. The upper epiphysis of the tibia is very oblique. The genu retrorsum does not appear plainly in the skiagram, owing to the acute contraction of the more or less ankylosed knee-joint and to so little of the tibia being shown.

A *third* variety of genu retrorsum is that which sometimes follows mal-united fracture of the lower third of the femur. The degree of deformity in such cases is comparatively slight, and the treatment, re-fracture or osteotomy.

Fourthly and *fifthly*, genu retrorsum of moderate grade is also sometimes the result of infantile paralysis and of unreduced dislocation. Such cases must be dealt with each on its merits. Whoever has mastered the principles of treatment of common orthopædic affections will have no difficulty in applying them to such rarities as these.

Cases of exceedingly loose knee-joint, the result of Charcot's disease, have also, improperly, I think, been described as 'genu recurvatum.' They might as correctly be called genu valgum or varum, because they will bend inwards and outwards as well as forwards.

A *sixth* variety of genu retrorsum is that in which the deformity is in the upper extremity of the tibia. I have often seen this in children with old chronic disease of the hip, knee, or ankle. An adult patient with old hip ankylosis attributed it to repeated over-extension in leaning forward to fasten his boots. It is sometimes a compensatory curve secondary to contraction of the knee. The anatomical cause is obliquity of the upper articular surface and of the upper epiphysial cartilage of the tibia. In either a skiagram or an anatomical specimen an appearance is seen as if a wedge with the base forwards had been sliced off the top of the tibia. As a rule no treatment is required. Osteotomy would be the only effective one.

Osteoclasis[1]

Before the second half of the nineteenth century many machines for breaking bones had been invented, and used chiefly for correcting the position of the fragments in mal-united fractures. Such were those old appliances with wonderful names: the 'scammum' of Hippocrates and the 'glosocomium' of Nymphodorus. But according to Fabrice de Hilden, quoted by Laugier, neither Hippocrates nor Galen refers to badly united fractures. Celsus advised, but timidly, the rupture of the callus. For many centuries this advice was repeated by scarcely any other surgeons, except Oribasius, Rhazes, Avicenna, Fabricius d'Aquapendente, and Heister. Ambrose Paré was a type of many surgeons who shrank from osteoclasis for fear of breaking the bone in the wrong place.

[1] The authority for most of the statements in this chapter, especially the historical part, is Poussin's *De l'Ostéoclasie*, Paris, 1886.

A second period, fruitful in mechanical contrivances, such as Œsterlen's 'Dysmorphostéopalinclaste,' Bosch's appliance like a bookbinder's press, and Purmann's wooden screw, occupied the eighteenth and the first half of the nineteenth century. In 1848 Rizzoli invented his 'machinetta ossifraga,' of which a picture may be seen in many German orthopædic books.

But perhaps the father of modern osteoclasis is Deloré of Lyons, the enthusiastic advocate of 'brisement forcé,' especially as applied to the cure of genu valgum.

Other surgeons of the Lyons school, Ollier and Daniel Mollière, took up osteoclasis; and their pupil, M. Robin, opened

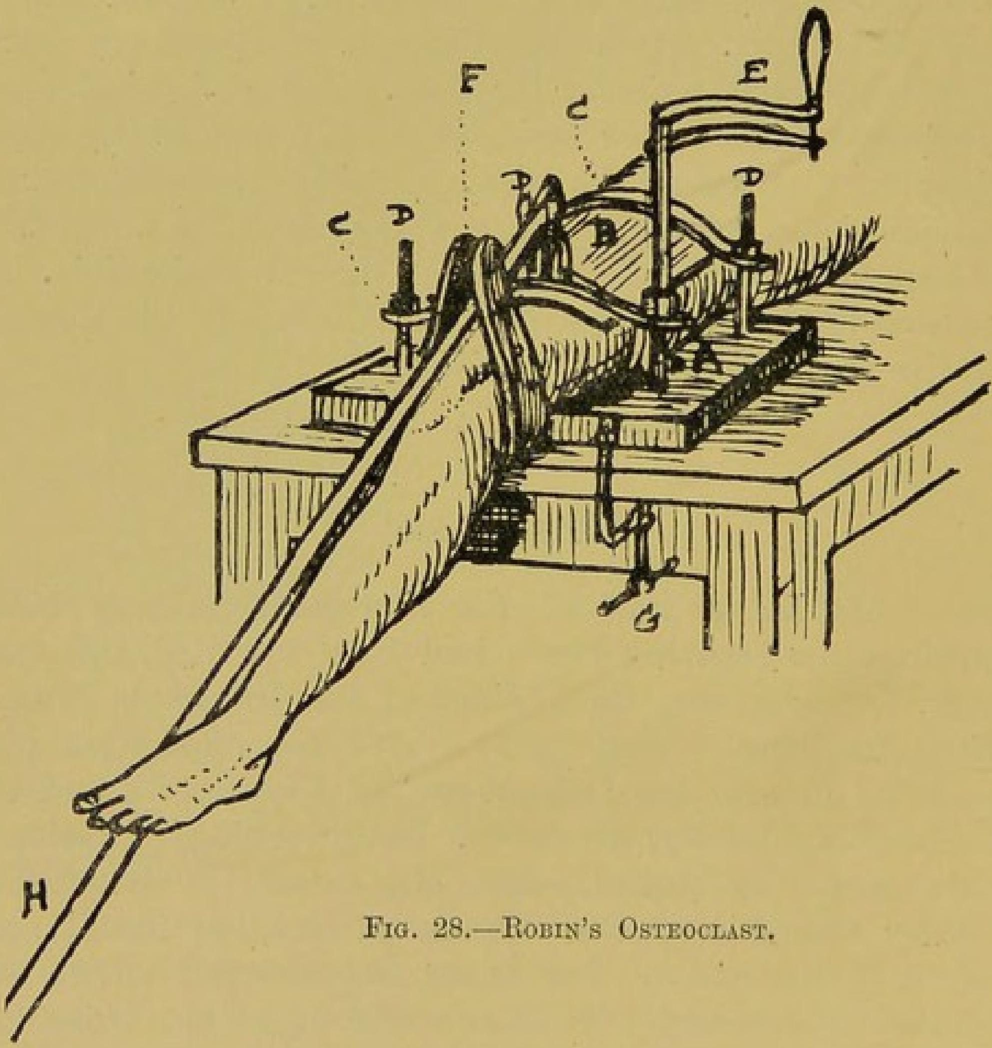


Fig. 28.—Robin's Osteoclast.

a new era for that procedure by the invention of his osteoclast. Its great merit is that it reduces to a minimum the leverage required, and thus, for example, enables the surgeon to break the femur just above the condyles, without throwing strain upon the ligaments of the knee-joint, provided that it is used by a careful and experienced person.

It consists of a wooden plank, A, to support the thigh (the patient lies on his back) ; of a metal plate, B, to lie on the front of the thigh, and therefore slightly gutter-shaped, with the concavity on the lower surface (that which touches the thigh) ; of two steel bands or hoop-segments, C, C ; of four screws, D, D, D, D ; of a leather collar, F, and a lever, H.

The plank is placed on the table in such a way that the whole length of the femur lies upon it, the patient being on his back. This disposition is absolutely necessary, for otherwise a movement of rotation, and a consequent oblique fracture, may be expected at the moment of operation. The plank is in two parts, which can be approached or separated, so as to adapt the appliance to thighs of different lengths. The plank is padded with leather, especially at the upper and lower edges. The upper (steel) plate or gutter is similarly padded. It embraces the upper surface of the thigh. It is not much arched downwards at the sides, lest it should interfere with the lateral expansion of the soft parts and imprison the limb too tightly.

The steel hoop-segments, C, C, are placed across the steel plate, B, one near each end, and are then screwed down towards the plank by four nuts working on the four screws, D, D, D, D. The nuts are driven home by the key E, which has a spring near the handle so arranged as to indicate when the screw force is sufficient but not dangerous.

It is absolutely necessary to screw the plate firmly down on the thigh, and thus fix the latter immovably. Otherwise a neat and precise fracture at the exact spot desired cannot be expected.

The compression process above described forces the femoral artery and the sciatic nerve towards the inner side of the femur, and does not compress either.

The knee must be extended before the screws are tightened, otherwise the skin will be dragged on.

The leather collar, F, is placed on the condyles, and its extremities, pierced with eyelet-holes, are hooked on to the runner of the lever H. The collar should be short, and the lever thus brought as near to the patella as possible. The popliteal vessels lie snugly between the condyles, safe from pressure.

Having thus adjusted each part of the apparatus, the surgeon grasps the lever and exerts an effort, continuous for a few seconds rather than violent, for he otherwise might exceed the degree of force just necessary to determine complete fracture. A simple mechanism permits the limb to be freed as soon as ever the fracture is completed.

An illustration of Collin's osteoclast is given at p. 23.

Immediate Effects of Osteoclasis.—Anatomical Lesions which it causes.—These have been partly determined by the experiments made on the cadaver by Aysaguer, by Demons (of Bordeaux) and by Poussin, and by observations of various surgeons on living subjects as well as post mortem. In young children about two years old the bones have such flexibility that complete fracture is not generally obtained. They bend and straighten like the fresh branch of a tree, and there is no solution of continuity in the periosteum. There is 'infraction,' not true fracture. At four or five years of age, and even older, there is almost always rupture of the periosteum and true fracture. This fracture is always simple, generally transverse, slightly dentated. The peripheral soft parts are constantly uninjured, presenting neither ecchymoses nor bruises. The rupture of the bone (tibia) always takes place at the spot where the thumbs (or the knee) are applied. In half the cases the fibula gave way at exactly the same level as the tibia. In the other half it was produced one or two centimeters above or below. But these observations apply to osteoclasis of the *diaphyses*.

When the manual 'brisement forcé' is applied with a view to curing *genu valgum*, the anatomical lesions are very variable, and sometimes considerable, to an alarming extent. At all events, such is the case when the patients are past the age of childhood. M. de Santi experimented on subjects between eighteen and twenty-two years of age, and in twelve limbs. There was no epiphysial separation, but nine times rupture or detachment of the external lateral ligament, and twice a bit of the condyle was torn away with it. Once the condyle was broken away bodily, making a fracture into the joint.

An osteoclast may be good enough to separate the epiphysis, and yet may, at the same time, produce other and undesirable lesions. Even the semilunar cartilages were displaced by

Collin's first apparatus. Loose joint and pseudo-arthrosis have been known to follow.

Possibly with Robin's and Collin's newer osteoclasts, skilfully used, such accidents may be avoidable.

That theoretically possible accident, arrest of growth as a consequence of injury to the epiphysial cartilage, has not once been observed.

There is a dearth of observations made years after osteoclasis. Lannelongue says that cases operated on manually afterwards suffered from an extreme sensitiveness in the knee-joint to change of temperature, and a tendency to the formation of osteophytes at the line of fracture or epiphysial separation. This most likely refers to adolescents and adults, as I have not observed it in the young children I have operated on myself. But I have not found the ultimate good in respect of obliteration of deformity equal, on the average, to what can be got from osteotomy.

Consolidation and bony union are rapid unless the fragments are displaced and overlap.

Both osteoclasis and osteotomy *ought to be* without danger when applied to limbs which, though deformed, are otherwise healthy.

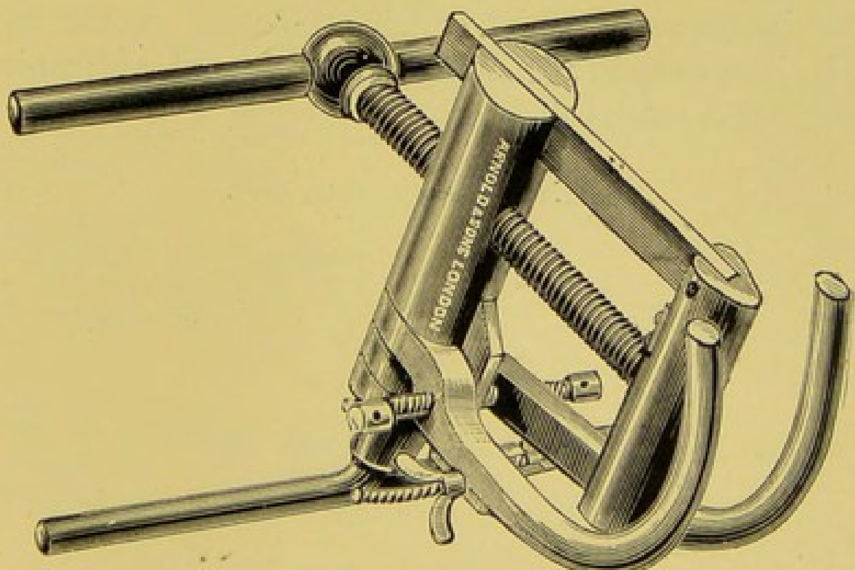


Fig. 29.—Grattan's Osteoclast.

When, on the other hand, there is reason to suspect the presence of tubercular foci, as in the case of many ankyloses, I think a wedge osteotomy done with as little violence as possible is the proper operation, and not an osteoclasis of any kind. There are, however, exceptions even to this rule; *e.g.*, when the suspicion of tubercle is extremely slight and the extent of osseous union small.

There are several simple forms of osteoclast, *e.g.* Grattan's, which can be relied on to fracture a long diaphysis correctly, especially in its middle third.

Dr. Burton Hopkins, of Philadelphia, has given the name of '*osteomoclasis*'[1] to a mode of combining osteotomy with osteoclasis. Strictly speaking, an ordinary osteotomy is usually a combination of this kind, as the osteotome is not made to cut the bone completely. But Dr. Hopkins breaks the bone in two with an osteoclast two or three weeks after cutting it half through with an osteotome, the skin incision being healed. If by any chance the wound has become septic, the *fracture* need not be produced at all. The plan involves two administrations of anæsthetic. The plan is justifiable in exceptional cases, especially when the operator is not experienced in either osteotomy or antiseptic surgery. Of course a person so inexperienced can seldom be justified in doing an osteotomy at all, at least in a civilised country. Another instance in which 'osteomoclasis' would be right would be in a case in which there was fear of awakening old, dormant, tuberculous disease.

[1] *Annals of Surgery*, July, 1898.

CHAPTER III

GENERAL CHAPTER ON RICKETS

RICKETS AND THE DEFORMITIES CAUSED THEREBY

I SHALL attempt here to give only the essentials of what is known on the subject of rickets, and shall select mainly such facts and reasonable hypotheses as have a more or less direct bearing on orthopædic surgery.

First, then, rickets is, of all the causes of deformities, the most important and the most extensive. Drunkenness does not contribute to the accident ward so much as rickets does to the orthopædic. In our large cities, paralyses, contractures, and congenital defects combined furnish a smaller contingent of cases than rickets alone. It is to be borne in mind—and it is, I hope, clearly demonstrated in this book—that not merely the distorted bones of childhood, but also nearly all the lateral spinal curvatures, genua valga, and possibly even the flat feet of adolescents, are due to the same or to a similar disease.

What, then, are the *causes* of rickets? In inquiring into these, the first obvious fact which has struck all observers is that it is both intensely rife and mainly found in large towns, and more especially the poorer quarters of them, where the struggle for existence is the fiercest, and where the poor are most crowded and worst fed. The natural hypothesis to frame was that rickets is due to insufficient and bad food, light, and air. Food has been especially blamed; but there are countries where the inhabitants are as badly off for food in their agricultural districts as in their towns, and yet with rickets common in the latter, but rare in the former. A strong reason for attaching importance to the theory under consideration is that rickets is said by Guérin and Trousseau to have been produced experimentally in animals by unnatural feeding. It may, however, be questioned whether sufficient and conclusive evidence has yet been given that true rickets can be produced by improper feeding. Friedleben was able to greatly reduce the proportion of calcareous matter in the bones of pigeons by experimental feeding, but never to produce the structural changes characteristic of rickets; and, of the various physiologists who have subjected animals to starvation diet, nearly all agree in not having observed such changes. Also, the exposure of young animals to cold and to darkness has caused cachectic and inflammatory changes, but not rickets. Rickets is less common among such of the poor as have abundant light and fresh air, but it is well known even among them. No sufficient evidence has yet been brought forward to show whether rickets is hereditary or not. It is certain, however, that the vast majority of mothers of rickety children are apparently free from it. On the other hand, a rickety or pseudo-rickety head is sometimes seen in both parent and child. The occurrence of rickets in brothers and sisters may be explained by any theory of causation which has been yet advanced.

One factor in the production of rickets is scarcely to be doubted. That is the influence of the mother. It has been repeatedly noticed by different observers—and the fact is easily verified—that a mother will bear a succession of healthy children, and then, perhaps, after failing in her own health, give birth to one or more rickety offspring in sequence. But even this fact admits of more than one explanation. It is perfectly consistent with the theory that the disease is the result of bad feeding, for imperfect health in a mother must deteriorate her milk. And an increasing family gives more mouths to fill, with, very likely, no more money to buy food. On the other hand, a larger family and worse health mean less capacity to give the new infants nursing and airing out of doors. And still again, it remains unsettled whether it is mere ill-health of any kind, or disease of some particular kind, which, occurring in the mother, brings about rickets in the child. It must be remembered that the question of the relationship of syphilis to rickets is not yet settled. With regard to the influence of epidemic disease, Macewen says that, 'out of 100 cases of deformity of the lower limbs in which the causation was minutely traced, 47 were the immediate sequence of epidemic diseases —measles, scarlet-fever, typhus, enteric, whooping-cough, chicken-pox, and sometimes one or more of these following each other very closely.' It had already been noticed that rickets and endemic diseases arise in the same localities. Chronic diseases seem frequently to precede rickets. Broca states that most infants who die from chronic ailments present rachitic lesions in their skeletons.

Severe injury in early childhood is sometimes followed by rickets.

Rickets may remain stationary for some years, and then, perhaps, under the influence of some intercurrent malady, advance again, possibly attacking another part of the skeleton. Macewen gives an instance occurring during childhood, and I have seen the same thing occur in rickets of adolescence. A girl who had long worn a high boot to compensate for shortening caused by a peculiar curve of the right femur, quite suddenly and with great rapidity developed a most severe lateral curvature of the spine. Elsewhere I show the impossibility of this phenomenon having had a merely mechanical origin.

Age in relation to rachitic deformities.—Rickets may be congenital, and there is rickets of adolescents as well as of young children.

Newly born infants occasionally, though rarely, show marked signs of rickets—*e.g.*, beaded ribs, bent limbs, and even broken bones. Fœtal rickets will be noticed at the end of this section.

But although it is exceedingly common for rickets to show itself in the first year of life in such symptoms as delayed dentition, restlessness, evident ill-health, sweating of the head, a tendency to kick the bedclothes off, and slight beading of the ribs or enlargement of the wrists, as well as a large belly and disordered digestion, nevertheless the deformities for which the surgeon is consulted are usually noticed only after the child begins to walk—*i.e.*, in the second or third year. But rickety deformities of the fore-arms are possibly an exception. According to my experience, they are commonest in infants, and are apt to cause the nurse to be unjustly suspected of having allowed the child to fall.

It is doubtful whether there is any period of youth, from birth to manhood, which is exempt from rickets. It is true that curving of the tibiæ is almost, as regards its commencement, limited to early childhood; but knock-knee will both commence, and still oftener increase, at any age of growth; and spinal curvatures frequently begin in the years before puberty and after those in which rachitic genu valgum is commonest. A very large number of the cases of scoliosis which are supposed to begin between the ages of fourteen and eighteen really commence between six and twelve. If any one doubts this, let him carefully examine the spines of the younger sisters of his scoliotic patients. He will not infrequently find in them the incipient stage of the disease, which in the elder is advanced to a degree forcing attention and demanding treatment.

There is nothing extraordinary in the fact that most of the patients who at a certain age develop rachitic scoliosis have never had bow-leg. Those in whom genu valgum develops first after the fifth or sixth year have seldom had bow-leg.

If there is one thing certain about rickets, it is that it shows itself by different effects at different ages, and affects different parts in different people. With regard to these features of the disease, all varieties of the common special deformities are found isolated, and also in combination; except, perhaps, such as would require that curvature of the *lower* parts of the shafts of the tibiæ should appear after childhood. It is very curious, but it is also highly probable, that the single and really insignificant fact that curved tibiæ are so rarely seen to commence in rachitics after the third year has been mainly instrumental in deceiving orthopædists as to the true nature of scoliosis and knock-knee of adolescents. They would surely have paused before explaining curved tibiæ by theories of muscular weakness, ligamentous relaxation, and even paralysis. But the knee-joint and the spine were complicated structures, which gave more material for the imagination.

With regard to *the relation of hereditary syphilis to rickets*, it is certainly often difficult to form an opinion as to whether a given case should or should not be ascribed to syphilis. In a very large number—according to some authors, the majority of cases of rickets—a syphilitic history can be obtained, at least on the father's side, although it is exceptional to get it on the mother's. Severe cases occur in which the diagnosis is usually allowed to be settled entirely by the history, so great are the resemblances of severe infantile rickets to congenital syphilis in the matter of symptoms. On the other hand, if rickets really is merely a manifestation of syphilis, it is strange that it should so often be the only sign discoverable in the family affected. And the pathological changes described in cases of unquestionable syphilis appear to differ considerably from those seen in connection with ordinary cases of rickets. Compare, for instance, the description of the one by Parrot[1] with those of the other by Broca.[2] M. Parrot, writing of what he calls 'syphilitic dystrophies of bone,' says the pathological changes vary somewhat, according to the age of the malady and to other conditions difficult to state. At first there are slight changes in the consistence and colour of the extremities (of the bones); later there are new layers on the surface, and, in the interior, near the epiphyses, atrophy, and softening to such an extent that solution of continuity may result.

Microscopically is seen an increase in volume of the chondroplasts, which assume a spheroidal shape. Signs of fatty degeneration appear, especially near the zone of calcification. Puriform matter may collect in irregular cavities in the spongy tissue. Eventually, after separation of an epiphysis has been brought about, true suppuration may occur.

Nevertheless, it is rare for hereditary syphilis to go so far. And it must be acknowledged that in children of rickety appearance and without anything else pointing to syphilis, separation of epiphyses with suppuration may occur. Such cases are usually put down as 'scurvy-rickets,' because they generally present changes in the gums suggestive of scurvy. And Broca and other authors have met with sequestra even of the diaphyses in rickets (Tripier).

It is when cranio-tabes is present as well as rickety (or pseudo-rickety) deformities of the limbs that syphilis should be suspected.

Whatever may be the truth about infantile rickets, it is difficult, if not impossible, to make out any connection between rickets at a later age and syphilis.

Nevertheless, a comparison of rickets with congenital syphilis awakes the mind to a set of facts which prompt the question, Is not rickets, like tubercle and syphilis, a definite disease, due to infection from without? Perhaps not to a single uniform organism, for, just as there are more than

[1] *Arch. de physiologie normale et pathol.*, 1872.
[2] *Bulletin de la société anatom.*, 1852.

one species of micrococcus which can produce suppuration, so there may be more than one organism (including that of syphilis) which can produce the change characteristic of this or that form of rickets—*e.g.*, syphilitic rickets, 'scurvy-rickets,' common rickets, rickets of adolescence, &c.; and these micro-organisms may be identical with some which produce very different symptoms and diseases, which go by quite distinct names when they attack persons of an age when bone-growth has ceased and all the epiphyses have united. Of course this is merely guessing at possibilities, and it is only given here for what it is worth.

Symptoms.—These may be roughly classified into three sets:—

1. Those which seem to point to a general illness and are often present at an early period of the attack, and especially noticeable in infants.

2. Those depending directly on the state of the bones, and including the conditions which chiefly concern orthopædic surgery.

3. Secondary illnesses, which are often of a serious nature, or even fatal. Sir William Jenner says of rickets that it is 'the most common, the most important, and in its effects the most fatal of the diseases which exclusively affect children.' It is to these secondary illnesses that the fatality is due.

A young child actually suffering from rickets (as distinguished from one which merely shows signs of the effects of past rickets) is grave in manner and has not the liveliness and love of play natural to a healthy one. This condition is sometimes exaggerated into one in which the child can scarcely bear the approach even of its own nurse or mother, and cries or whines at any offer to change its position, or even to feed it. Tenderness of the bones has been suggested as a possible explanation of this state.

The grave manner and the comparative indifference to the ordinary delights of childhood may persist for years after all acute symptoms have passed away.

There is a tendency to sweat, especially about the head. There is an apparent, and probably to a great extent real, muscular weakness. The head is allowed to droop, either forwards or backwards ; the spine curves forward when the child is made to sit; walking is either delayed, or, if it has commenced, is left off again for a period. As early symptoms, vomiting, diarrhœa, and some degree of fever, and occasionally, therefore, convulsions, may occur.

At the same time the commencement of the second set of symptoms may be noticeable, generally at the first glance, always upon careful inspection, especially the peculiar head, the beaded ribs, the large belly, and the enlarged epiphyses of the limbs.

All the bones of the body are liable to rachitic changes. Those which are most active in growth for the time being seem to suffer most.

Let us notice the different regions of the skeleton in order :—

The Head.—The large, square, projecting appearance of the forehead is familiar, and partly depends on diminished growth of the face-bones lying below it. The anterior fontanelle remains open till even the fourth year, instead of closing by the twentieth month at latest. The skull-bones feel thickened, and perhaps irregular, near the sutures, and sometimes as thin as parchment elsewhere, except at the five tuberosities (cranio-tabes). The head looks square and flat, and larger than normal, but is not always larger in reality. It is usually long—*i.e.*, dolichocephalic.

The face tends to be smaller than normal, and the mouth the reverse of prominent. The alveolar process of the small upper jaw turns outwards, that of the lower jaw inwards. Hence the teeth do not meet in the normal way. Indeed, if the upper front teeth are much turned out, and fall in front of the lower, the front teeth may scarcely meet at all. Authorities disagree as to the effect of rickets on the quality of the teeth. In view of the difficulty of always excluding the presence of syphilis it is necessary to write cautiously. Certainly many rickety children have defective teeth. But many others have the contrary. The crowns of the front teeth are actually fully developed at birth—*i.e.* before rickets usually appears to set in. It is certain and very important that *rickets delays dentition.* The particular teeth first delayed may give a clue to the time when the disease commences. An abnormal sequence of appearances of the teeth is sometimes seen. And it is said that imperfect development of the jaws sometimes crowds together and displaces the teeth.

The Ribs show the well-known 'beading' or enlargement at their junction with their cartilages. This is one of the commonest of all the signs of rickets, occurring in some degree even in the mildest cases. A perpendicular depression tends to appear on each side of the thorax, towards the front, and at the same time the whole chest, being somewhat flattened laterally, is deepened anteriorly; the so-called '*pigeon-breast*' results. The lower ribs are, as it were, pressed outwards by the enlarged belly. The depression above this out-bulging has been called '*Harrison's furrow*.' The sternum is pressed forward and arched or bent, so that the upper part looks more upward than natural. If scoliosis coexist, the ribs have the characteristic changes depending mainly on torsion. The dorsal boss on the side of the convexity trespasses usually a good deal on the lumbar region, and at the same time does not reach very high upwards, and it is apt to be extraordinarily prominent, and greatly out of proportion to any lateral curvature of the line of spinous processes. Hence, and perhaps also because the lung sounds are duller here than normal, it is sometimes mistaken by persons inexperienced in deformities for a tumour.

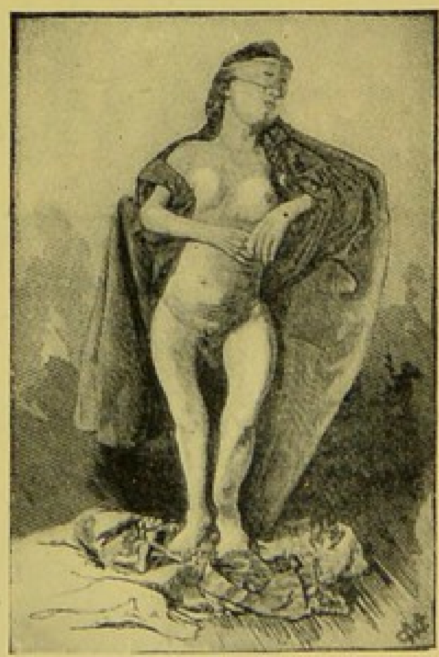


FIG. 30.—FROM A PATIENT ON WHOM DR. MURDOCH CAMERON HAD TO PERFORM CÆSARIAN SECTION.

The curves of the clavicles are made more acute and the bone appears thickened.

The Pelvis undergoes changes which in the female, when the age of child-bearing is reached, assume great importance.

They concern the obstetrician far more than the orthopædist, who has, indeed, little opportunity of accurately observing

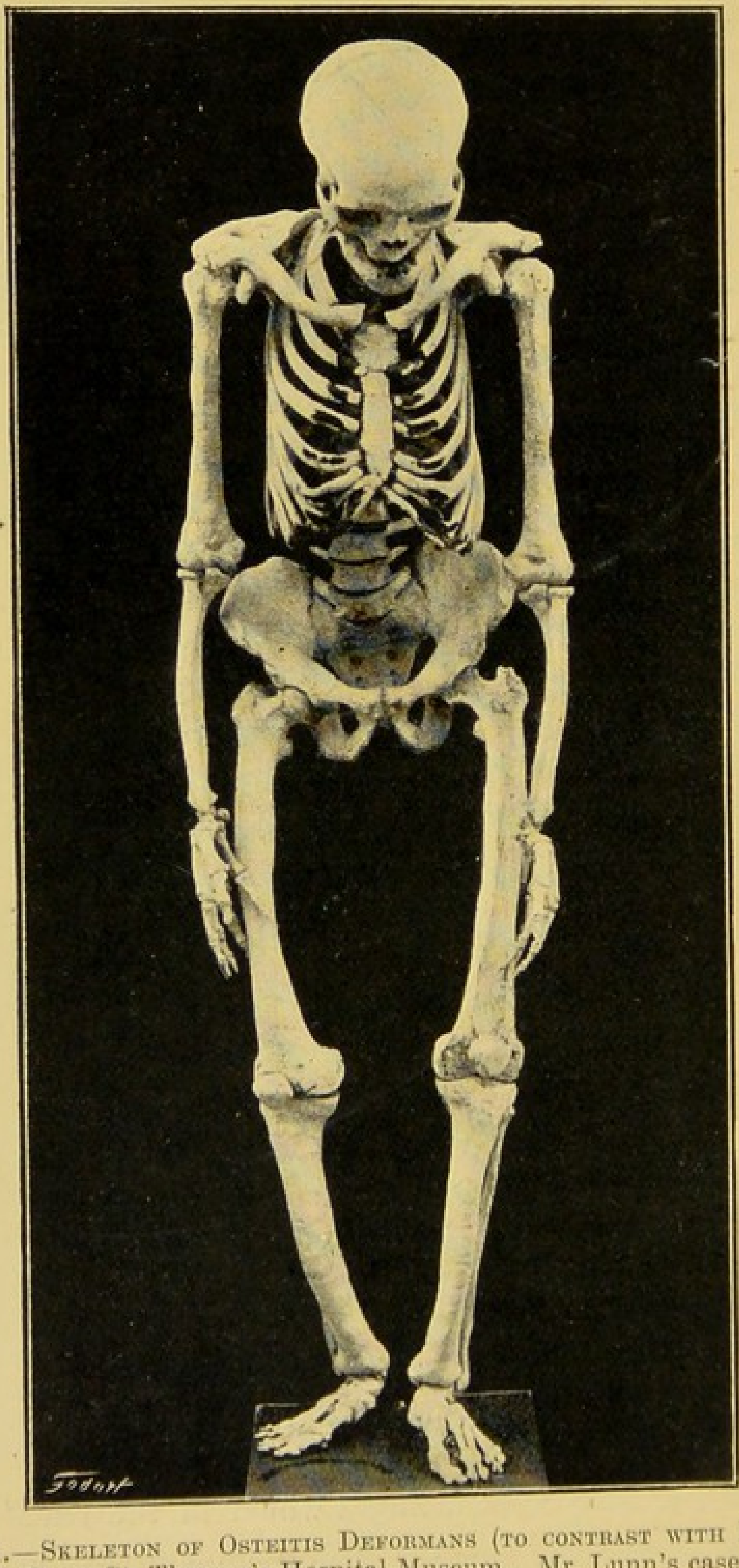


FIG. 31.—SKELETON OF OSTEITIS DEFORMANS (TO CONTRAST WITH RICKETS). (From St. Thomas's Hospital Museum. Mr. Lunn's case.)

them. In severe cases the pelvic inlet is greatly diminished antero-posteriorly by the forward projection of the sacral prominence, and that in spite of a frequent simultaneous beak-like deformity of the pubes.

The Vertebræ.—When rickets first attacks an infant, its back often appears very weak and bows, almost, indeed, collapses forward, especially in the dorso-lumbar region. Later a genuine rachitic kyphosis is sometimes seen, with its centre usually in the region just named. Sometimes the deformity is scoliotic, and it is then attended with the thoracic changes above described as depending upon 'rotation.'

The Limbs.—The great majority of rachitic deformities are the result of abnormal growth, but a few are due to fractures. The latter usually occur in infancy, and are usually also 'green-stick'—*i.e.* they fissure only one side of the bone, namely, that of the concavity. In other words, the rickety bone is more easily crushed than torn. Unless the force applied is severe the periosteum almost or entirely escapes. Little or no crepitus, and even little or no inconvenience, may occur, and therefore the patients, being young and uncomplaining, these injuries are apt to go for hours, or even days, unsuspected.

It is not improbable that all the long bones are equally liable to rickety curvatures. Certainly, in rachitic skeletons few or none are seen to entirely escape; but in life it is the very common curvatures of the tibiæ and fibulæ which attract most attention.

A child's long bone deformed by rickets is generally *deformed everywhere*, though not everywhere in equal degree. It is true that the most marked curves are those near the extremities of the diaphyses, but the macroscopic changes alter the whole bone as surely as do the microscopic.

The older the patient, the more does the rickets tend to produce curves of the limbs nearly exclusively localised near the diaphysial ends of certain bones, while the other bones of the body, or even parts of the same bone, entirely escape.

These facts appear to depend upon the relative activity of growth at certain points, and at certain points at certain ages. But they cannot be entirely explained so; because, *e.g.*, rachitic genu valgum may attack one leg and spare the other, and no difference in activity of growth can explain that. Such an occurrence is, however, the exception that proves the rule, and such exceptions are seen in even constitutional disorders, like syphilis, which are only roughly symmetrical, although their essence is undoubtedly a poison, presumably circulating in the all-pervading blood itself.

Certain *directions* of curves predominate, but none are universal. The vertebral column, when scoliotic, usually curves to the right, but not nearly so proportionally often in rickets of children as in 'rachitis adolescentium.' The lower epiphysis of the femur and the upper of the tibia are usually placed obliquely in such a way as to cause genu valgum. But sometimes the femoral epiphysis is placed so squarely that it permits a curve in the upper third of the tibia to cause genu varum.

At the elbow, valgus is more common than varus. In the fore-arm and in the leg below the knee, varus is more common than valgus.

Femoral curves are common enough, but more or less hidden by the thigh muscles. The upper epiphyses are as frequently misshapen as the lower, as Sir William Jenner long ago pointed out. The angle between the neck and shaft of the femur is often one of 90°. (See Chapter on 'Coxa Vara.')

Scarcely less noticeable than the curvatures, angular bendings, and green-stick fractures of rickets, are the enlargements of the epiphysial ends, especially of the wrists and knees. The condition of the wrists, when well marked, is almost pathognomonic. Although, of course, somewhat clumsy wrists occur in some healthy children, and diseased wrists in congenital syphilis and in tuberculosis, nevertheless it is so much the rule for non-rachitic children to have small wrists, knees, and ankles, that the stoutness of the limbs in contrast with the smallness of the joints is one of the common beauties of normal childhood.

Later in life is often seen, as a consequence of infantile rickets, a stunted growth of the bones once affected. These are generally the long bones of the limbs, but the vertebræ do not always escape. In the latter case an absolute dwarfing occurs; in the former, a disproportion between the short limbs and the long trunk. Almost always in such

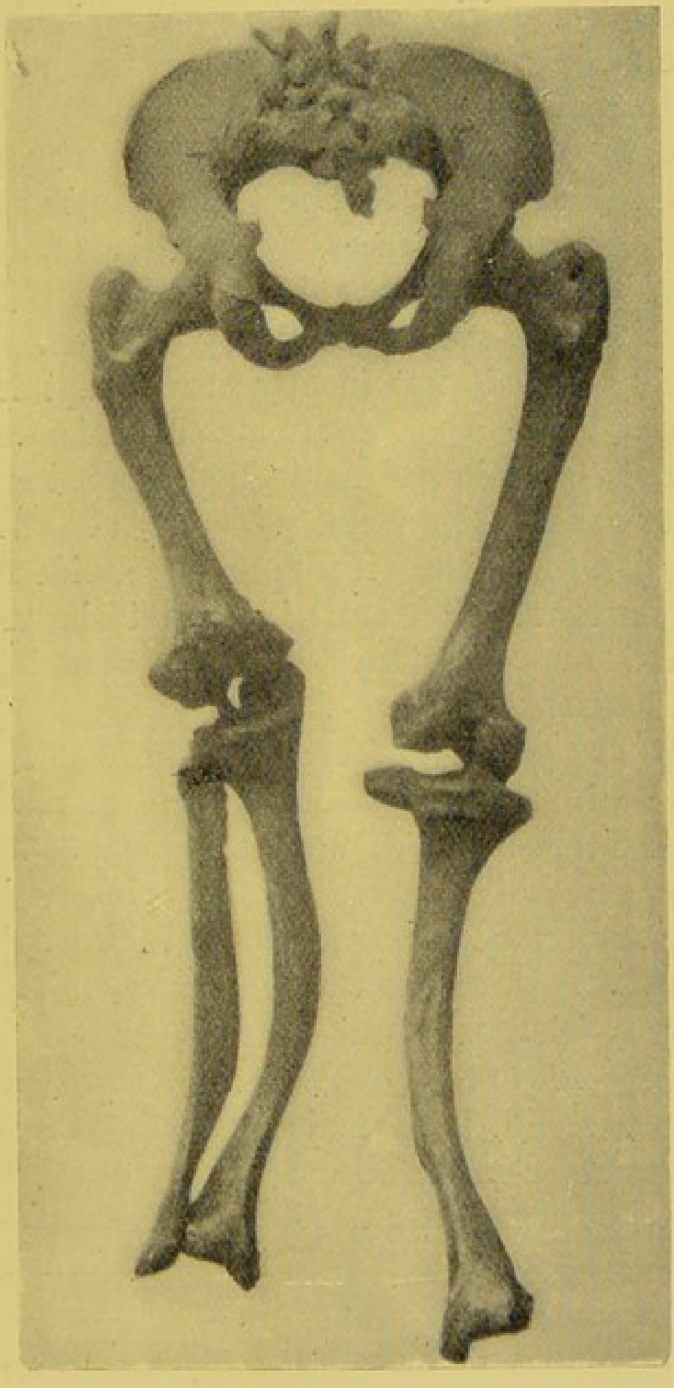


FIG. 32.—THIS SPECIMEN, FROM AN ADULT WHO HAD BEEN RACHITIC IN CHILDHOOD, SHOWS DEFORMED PELVIS, COXA VARA, CURVED FEMORA, TIBIÆ, AND FIBULÆ, AND OVERGROWTH OF BONE NEAR THE ENDS OF SOME OF THE BONES. Note how the curves compensate each other. (St. Bartholomew's Hospital Museum.)

cases the hands and feet and the head are disproportionately large.

Illnesses either secondary to Rickets or forming a more or less essential part of a complete clinical picture of that disease.—Certain complications, including diarrhœa in the early stage of the disease, bronchitis, emphysema, laryngismus stridulus, and slight enlargement of the glands, as well as more considerable enlargement, or apparent enlargement, of the spleen, and even of the liver, kidneys, heart, and thymus, are so frequent that they seem to form an essential part of a complete development of rickets. Convulsions are, of course, apt to occur in an affection which so seriously disturbs the digestive and nervous systems of young children.

The rickety child is not in any way exempt from tuberculous diseases, and is by some supposed to be specially liable to them. Both chronic and acute hydrocephalus are sometimes intercurrent. They are probably, at least usually, tuberculous, and sometimes, if not mostly, accidental complications. A purely rachitic head is liable to be mistaken for a hydrocephalic one, especially when it is seen in a feverish and restless infant.

Almost all the troubles of childhood are liable to be seen in association with rickets, and in the case of many of them not altogether accidentally, if we are to believe all that has been written on the subject. In fact, rickets is to some practitioners among the young an all-pervading spirit of evil, at the bottom of as much and as multiform mischief as the bogie of the physician of the middle aged—gout.

Pathology.—It is pretty well agreed that rickets is to be called a disease of nutrition, mainly affecting the bones, but not permitting other parts, such as the muscles, the skin, or the viscera, to go altogether unscathed. But this agreement does not carry us far. Paget calls inflammation a disease of nutrition, and Jenner says cancer is one also. There really are very few genuine diseases which do not affect nutrition, either generally or locally.

One thing it is pretty certain that rickets is not—namely, a mere deficiency of lime in the blood. Jenner remarks, one secretion from the blood—*i.e.* the urine—was found (in Marchand's experiments) to contain six times its normal amount of lime salts. However, Senator and Baginsky's observations do not agree that such an increase is the rule, and Seemann even found a decrease (F. A. Hoffmann). Nor is it a probable hypothesis that the removal of lime from the bones in rickets is due to excessive formation of lactic acid in the stomach. The lime salts, though removed from their normal situation, are often deposited in excess in abnormal positions. The experiments of various observers have yielded apparently irreconcilable results. That the lime salts in the bones are deficient all are agreed. But how they come to be deficient is a difficult question. One set of observers claim that they have produced a deficiency in the bones of animals by feeding them on food deficient in lime salts; others say they have tried and have not succeeded. Guérin even claimed to have produced the anatomical changes of rickets by experimental feeding. Friedleben and Tripier could obtain nothing of the kind.

Other experiments have been made on the administration of lactic acid with the food, and a similar disagreement in results has followed.

However, we must not forget that there is a good deal more in the pathological anatomy of rickets than the mere lack of lime salts in the bones.

If a rachitic bone be examined microscopically at the junction of one of its epiphyses with the diaphysis, the layer of cartilage in which the cartilage cells are grouped together in wavy, more or less parallel groups or columns, at right angles to the layer itself, will be found greatly thickened. This thickened layer, instead of being separated from the proximal layer beneath it by a simple plane, looking, in profile, like an unbroken line, is confused with it rather than separated from it by projections, serrations, and even islets of each layer, which trespass upon the other layer. The occurrence of these islets necessarily breaks up what should be a single, continuous centre of ossification into a multiple centre.

Normally the medullary spaces of the newly formed bone are formed by absorption of the calcified cartilage. In the rachitic bone they are formed before the cartilage has calcified.

The cartilage cells themselves are lengthened, fusiform, or corrugated; in fact, less regular than normal. The wavy lines of intercellular substance are thinned, or even altogether absorbed. Calcification takes place in the cells themselves as well as in the intercellular matrix, whereas normally the cartilage cells remain unossified, and seem ultimately to be transformed into corpuscles of the new bone. The calcified intermediate substance does not become arranged in lamellæ around Haversian canals by the deposition of concentric layers. On the contrary, it is irregular, spaces form in it, and absorption may even proceed to the extent of bringing the medullary canal of the diaphysis into direct contact with the epiphysial cartilage—*i.e.* with its so-called 'chondroid' layer. The layer of 'spongy,' soft, bone-like tissue between the cartilage and the medullary canal is, when in the state described, characteristic of rickets, is recognisable by the naked eye, is soft, impressionable, and reddish, and was first described by Rufz (in 1834), who likened it to a fine sponge. Hence its name of spongioid tissue.

Not less remarkable than the changes at the epiphyses are those at the surface of the diaphyses. The inner layer of the periosteum, that which is rich in cells lying in the meshes of a soft retiform connective tissue, is very greatly thickened in rickets. The groundwork of what should be the new bone of a growing diaphysis is probably built up partly by this and partly by the interosseous permeating medulla of the bone itself. In rickets the groundwork is formed, but not only is the deposit of calcareous matter delayed or altogether prevented, but even lime salts already deposited may be removed.

In the flat bones of the skull, the shoulder-blades, the sternum, and the pelvis, microscopic phenomena analogous to those in and on the diaphyses of the long bones are seen. The extent to which they may be affected is well shown by the crackling, parchment-like, thin parts of the skull-bones in cranio-tabes. The surfaces of bones thus affected are rough, as it were eroded, except where the bones are thick—*e.g.* at the frontal, parietal, and occipital tuberosities, and at the actual margins of the sutures and fontanelles. The periosteum becomes very adherent in the parts most affected, and when, as is sometimes the case, the bones are thinned to perforation, is attached to the dura mater. In places the bone is not only softened but thickened.

Sections of the long bones of the limbs show *to the naked eye*, besides the thickened epiphysial cartilages and subperiosteal layer and 'spongioid' tissue already referred to, the medullary canal narrowed in the middle and widened at the ends of the diaphysis. This canal is also seen to approach nearer to the surface on the convexities of curves, and to be separated by an extra thick layer of bone from the surface of the corresponding concavities. In the active stages of the disease, bones which would normally require a saw or chisel can often be cut with a stout knife. Later the soft contents of the bony interspaces tend to undergo a fibroid change, and still later the bone eburnates.

The *visceral changes*, such as the emphysematous state of the anterior margin of the lungs of young children with rickets, the albuminoid degeneration ('viz. infiltration with a homogeneous, firm, tough, transparent, glue-like substance') of the spleen, lymphatic glands, thymus, and even the liver, and perhaps of the brain, are fully and admirably described by Sir William Jenner in his lectures.

Diagnosis.—As the presence of rickets gives no immunity from other diseases liable to be confounded with it, too much weight should not be given to even indubitable signs of rickets occurring in a case the diagnosis of which is doubtful. It is true that it is far more common to mistake certain symptoms of rickets for Pott's disease, hydrocephalus, croup, and even 'congenital' dislocation of the hip and tubercular disease of the tarsus; but the reverse mistake is the more serious. When there is any doubt, the whole assemblage of symptoms in the case in question must be studied—a safer plan than going by some rule of thumb.

Prognosis.—Only the most severe cases of rickets in early childhood can directly endanger life. But indirectly the disease is exceedingly fatal, chiefly through bronchitis and emphysema. But, at the ages at which rachitic cases come under the care of the orthopædic surgeon, danger of death from any complication special to the disease has usually passed away. For further information about this subject the reader may be referred again to Jenner's third lecture.[1]

[1] *Med. Times*, 1860, vol. i. p. 465.

As regards the deformities, curves of the limbs tend to disappear partially with convalescence and time, bow-legs

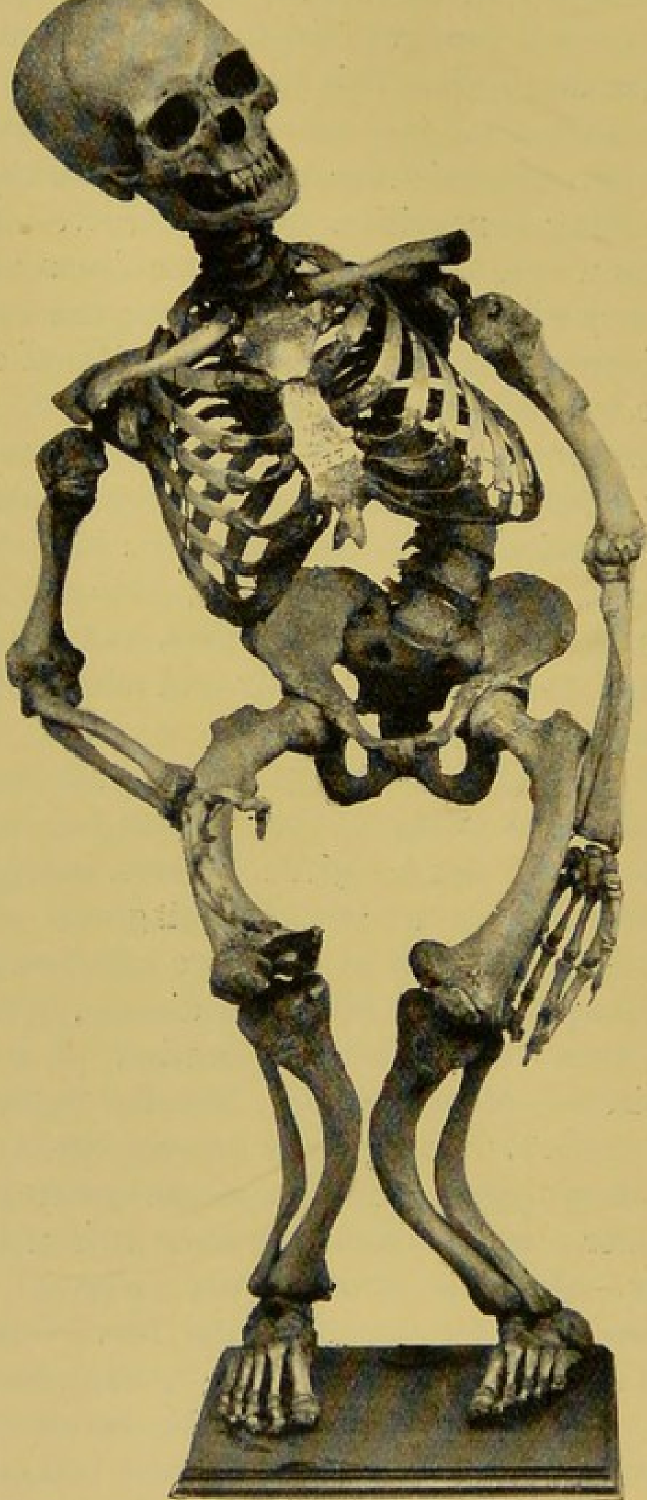


FIG. 34.—SKELETON OF AN ADULT DEFORMED AND DWARFED BY SEVERE RICKET IN CHILDHOOD. (From a block lent by Mr. F. Godart.)

more so than knock-knees. I have been assured by a friend that the same thing happened to a little patient of his with rachitic scoliosis while kept in bed, but I have not observed it myself. Probably no severe rachitic deformity entirely disappears with any amount of time or under any treatment, not operative.

By permanently injuring the cartilages of growth, rickets too often produces a deformity which persists throughout the whole period of growth, resulting in a stunted form, with dwarfed limbs, large extremities, and large head (fig. 34).

Treatment.—Bouvier remarked that every celebrated physician at every epoch had his particular remedy for rickets, and that all succeeded (Tripier). Most of them depreciated what their predecessors had praised so highly. History thus warns us not to have too much faith either in the statements of others or even in the apparent teachings of our own experience. Many of our poor little hospital out-patients recover under what is a mere mockery of treatment. Not only do the mothers often ignore our hygienic recommendations, but even the medicines may be administered irregularly or not at all. 'The child cannot take this' and 'will not take that,' they plead.

A theoretically complete treatment is hopeless of attainment in most cases. But we must endeavour to sketch one, if only as an ideal to be aimed at. The patient should have abundant and pure air, light, dryness, warmth, cleanliness, rest, proper food, and certain medicines.

Concerning the general hygienic measures, no more need be said than to emphasise their special importance in rickets, and to recommend such dry and bracing seaside places as Margate, Walmer, Yarmouth, Cromer, Skegness, Scarborough, remembering that there are inland localities not less fresh and dry, and nearly as beneficial—*e.g.* Woodhall Spa, Buxton, Harrogate, and the high parts of Tunbridge Wells.

Rest is especially needed by a child in the painful and occasionally feverish stage of the disease.

To keep the child off its feet by applying splints which project below its heels is a practice still frequent, and one recommended by Sir William Jenner. It may *possibly* tend to prevent deformity of the legs, but I have frequently been assured by mothers and nurses, and believe I have observed myself, that it often irritates the child, injures its appetite, and keeps it out of the fresh air. Now, of all the effects of rickets, crooked legs are the easiest to cure. On the other hand, stunted growth or a deformed thorax and spine is incurable, and may be aggravated by using splints in such a way as to lower the general health.

I believe the hygienic importance of cleanliness is often exaggerated. As Von Hebra pointed out, there are millions of people in Europe who practically never wash and have never been washed, and who are apparently not a penny the worse in health. The vigorous drying and friction which ought to follow the daily bath of a rickety (or any other) child are doubtless very beneficial. The daily cold bath was lauded almost as a specific by William Hunter. Concerning the comparative value of salt- and fresh-water baths, I know of no unbiassed and sufficient observations bearing on the question. But where salt baths are easily obtainable they are at least not counter-indicated. Proper and sufficient clothing should be worn, and especially the underclothing, boots, and night-dress should be satisfactory.

The food must, of course, vary to some extent with the age. Infants should not be weaned either too early or too late. As soon as the first teeth appear it is time to begin with small quantities of solid food, and not before. The milk of a healthy mother is best, next that of a wet-nurse, and then a mixture of 'cow's milk diluted with about a fourth part of lime-water and with a teaspoonful or two of cream added to the half-pint' (Jenner). The same authority adds: 'It is better not to add sugar to the milk—if sugar is used, it is said by some that sugar of milk is preferable to cane sugar, and I have fancied that it is.'

Farinaceous food should be given, either not at all, or else sparingly, and always well powdered; never in lumps.

Small quantities of meat, very finely divided, or beaten to pulp in a mortar, may be given. Some recommend it raw, but this has obvious dangers. One of my own little patients, the child of a medical man, was attacked with tapeworm after a course of raw meat. This occurred in India. But we really know enough now to beware of eating or recommending any raw food whatever.

Medicines are used in this complaint, either as regulators of the digestive organs, as tonics, or as possible specifics.

A dose of hydrarg. cum cretâ, of castor oil, or of rhubarb and soda, or more frequent doses of calumba and soda, are occasionally indicated by the state of the tongue, breath, temper, and bowels. Of other drugs, iron, phosphates, quinine, phosphorus, and cod-liver oil, are those in everyday use, especially the combined phosphates of lime and iron with soda and potash ('Parrish's chemical food'). The dose of the last, for an adult, is about two drachms, and for children, half to one drachm. Iron is frequently administered in the form of vinum ferri, which should not be given too carelessly. Even cirrhosis of the liver is said to have been produced by it. About a drachm is a sufficient dose for most small children with rickets.

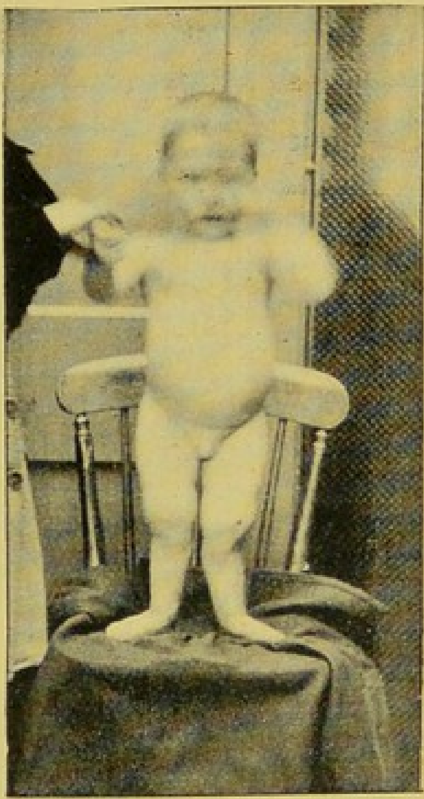


Fig. 35.—Rickets.

Phosphorus was strongly recommended by Kassowitz some years ago (see 'Medical Annual,' 1887–88, and also 'Wiener Med. Wochenschrift,' 1889). 'He administered phosphorus in gradually increasing doses, beginning with the most minute, and found that the compact portion of bone was increased at the expense of the cancellous tissue; but he further ascertained that this increase was due to a shrinking of the medullary spaces, and not to fresh deposition of bony plates.' He gives one to two teaspoonfuls daily of a solution of strength 1 to 100,000. Many medical men have confirmed Kassowitz's observations (*e.g.* Wegner and Hagenbach), but as many (*e.g.* Monti, Baginsky, and Comby) deny their correctness, and some even accuse the drug of having done mischief.

The remedy about whose value we are most agreed is cod-liver oil. Probably various other fish-oils are also beneficial; and animal fats in general, including butter, are sometimes recommended, especially for those who cannot or will

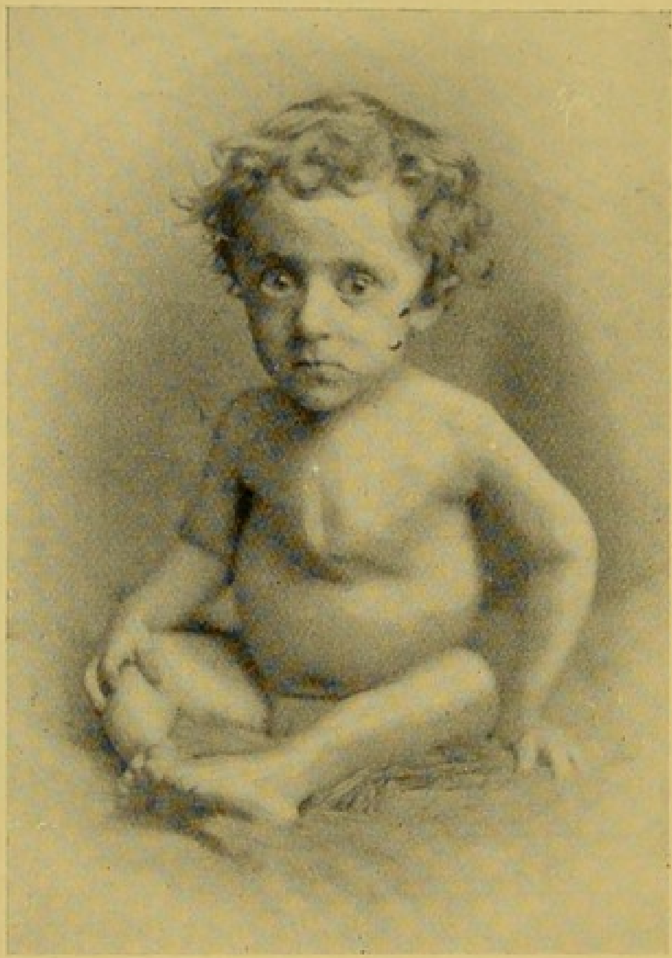


FIG. 36.—CONGENITAL RICKETS. (From a Case of Dr. Bromet's.) From birth this child's bones were very fragile, and in a short time it suffered from no fewer than eleven fractures.

not take cod-liver oil. The possible presence of the tubercle bacillus should not be forgotten in prescribing butter for children.

Syrup of iodide of iron is occasionally used.

Some of the above drugs, especially phosphorus, can conveniently be given in combination with the oil.

The mechanical and operative treatment is dealt with in the special sections, such as that on 'Genu Valgum.'

FŒTAL RICKETS

This is a subject which has always remained in obscurity, but some degree of light seems to have lately dawned upon it. For two centuries it was scarcely supposed to exist. Glisson noticed only one case; Chaussier found only 2 in 23,193 still-born fœtuses left at 'La Maternité.' As Bouvier and Bouland remark, if all these autopsies were made, most were probably performed very superficially.

Since then many cases have been recorded, but diverse views expressed as to their real nature. For instance, Stilling[1] tries to differentiate a class of cases under the name of 'osteogenesis imperfecta' from cases of true fœtal rickets. Hoffmann doubts whether the difference is essential. H. Müller, in a treatise which the last-mentioned author describes as 'classical,'[2] and which is based on observations of similar and very common conditions in the calf, says that there is an unmistakable resemblance, not only externally in the large, soft, cartilaginous masses of the epiphyses, but also in relation to the entire absorption of these in the process of normal intra-cartilaginous ossification, and, lastly, in that the periosteal and the preceding medullary ossification can be observed at the same time. On the other hand, the thick proliferating layer of cartilage next the line of ossification, with the independent transformation of the osseous bridges which remain between the medullary spaces, as well as the deficiency of lime salts both in the cartilage and in the osteogenetic substance, are absent. He considers the disease to be allied rather to cretinism than to true rickets.

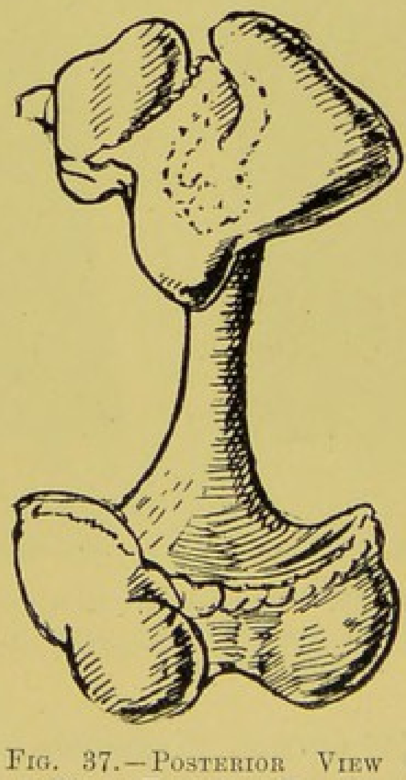


FIG. 37.—POSTERIOR VIEW OF RIGHT FEMUR OF KAUFMANN'S CASE OF CHONDRODYSTROPHIA HYPERPLASTICA.

There is a beautifully illustrated account of the pathological anatomy of one form of so-called fœtal rickets, by Dr. W. Kaufmann, of Breslau, in Ziegler's 'Beiträge z. Pathol. Anat.,' Bd. 13, H. 3, p. 33 (1893). He says that three forms of 'fœtal rickets' have

[1] Virchow's *Archiv*, Bd. cxv.
[2] Würzburg, *Med. Zeitschrift*, Bd. i. 1860, p. 221.

been distinguished, and the following names given to them :—

Group I.—Chondrodystrophia hypoplastica.
Group II.—Chondrodystrophia malacica.
Group III.—Chondrodystrophia hyperplastica.

As the name implies, in Group I. the cartilaginous base of the undeveloped skeleton is rather deficient in growth; in Group II. its dominant feature is abnormal softness; and in Group III. the cartilaginous epiphyses are greatly overgrown, as, *e.g.*, in the specimen illustrated.[1]

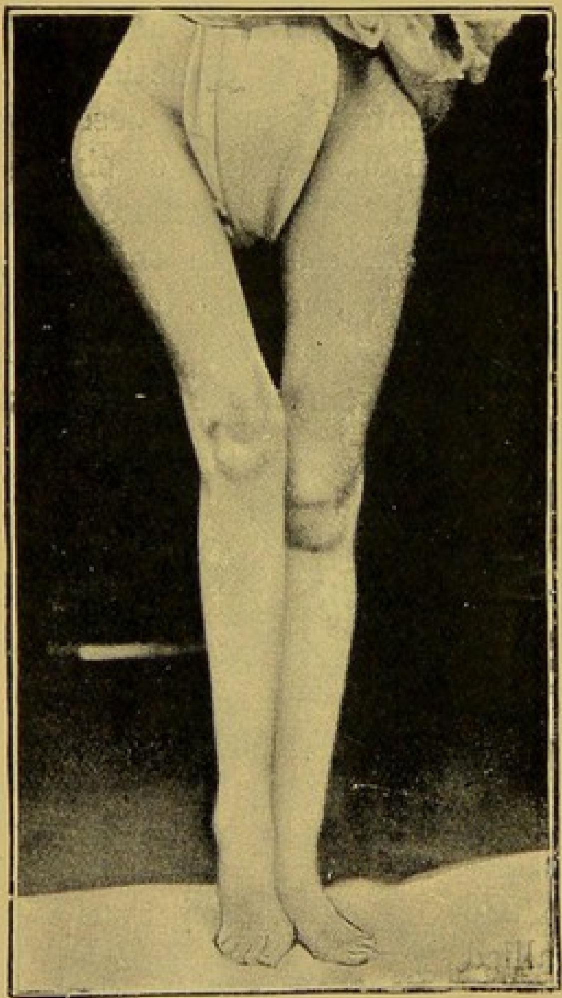


Fig. 38.—Coxa Vara. Girl aged 20. Note the compensatory knock-knee and talipes equinus.

The fœtus, a male, from which this femur was taken, had never breathed. Its death, which took place just before birth, was due to an accident to the cord. It presented several fresh fractures, and various parts of the skin were marked by cicatrix-like thickenings.

The bones were too short, the diaphyses straight, the cartilaginous parts enormously enlarged, and the epiphyses, therefore, very deformed, and often almost 'fungiform.' The normal arrangement of the cells in columns near the proximal edge of a section of the epiphysial cartilage was wanting.

[1] The anatomy of a fœtus belonging to this group was described in detail by Tamplin (' On Deformities,' 1846).

Late Rickets (Rachitis Adolescentium)

As long as rickets has been known at all it has been admitted that occasionally elder children, and even adolescents, are attacked ; but until some fifteen years ago it was held that this occurred very exceptionally. Hence cases were from time to time described in periodicals as rarities, and sometimes with an admission that they might really be examples of osteomalacia.

In 1879, Miculicz contributed to V. Langenbeck's 'Archives,' Bd. xxiii. 3, 4, a long and very important study of the anatomy, &c., of genu valgum of adolescents, and showed the essential resemblance of that affection to genu valgum of confessedly rachitic children. Since then it has become more and more admitted that the great majority of spontaneous deformities of bones commencing not only in infancy, but throughout the period of growth—so long, indeed, as the epiphyses remain ununited—are as truly rachitic as the common bow-legs, knock-knees, and curved spines of infancy. Rachitis adolescentium attacks preferably the femora and tibiæ (causing genu valgum), the tarsal bones (causing flat-foot), the ankles (causing in-ankle), and the vertebræ (causing true scoliosis). It contrasts with rickets of young children in generally leaving the head, face, and fore-arms comparatively free and the shafts of the long bones comparatively straight, excepting that the latter often present moderate compensatory curves—*e.g.* the compensatory varus curve of the lower part of the tibia in genu valgum.

Moreover, rickets of adolescents occasionally attacks severely that extremity of a bone which in infancy would have comparatively escaped—*e.g.*, the trochanteric region of the femur.[1]

For the diagnosis, prognosis, and treatment, see articles on 'Genu Valgum,' 'Flat-foot,' 'Scoliosis,' 'Coxa Vara,' &c.

[1] See *Illustrated Medical News*, 2, 88, p. 7.

CHAPTER IV

BOW-LEGS—CURVED TIBIÆ—RACHITIC ARM-BONES

The commonest kind of deformity produced by rickets is the ordinary bow-leg. This is mainly due to curvation of the tibia and fibula near the junction of their shafts with their lower extremities, and sometimes, also, to a similar excurvation towards the upper ends of the shafts.

The bow-legs of osteitis deformans cases have been noticed under the heading of 'Genu Varum.'

Bowed tibiæ may be accompanied by either genu varum or genu valgum. Most commonly it is genu valgum (fig. 39), if the cases be excepted in which the state of the tibiæ gives a general appearance of outward bowing to the whole lower extremities.

Prognosis.—Of all the rachitic deformities of the lower extremities, this is the one which offers the best hope of cure without the need for operative measures. Indeed, there is often seen a tendency to spontaneous amendment sufficient in the course of time to reduce a marked degree of bowed leg to a state in which little more than an indication of the deformity remains. There is, therefore, every reason to expect excellent results from suitable and careful treatment. However, the children of the poor are placed under conditions which often put careful treatment, or at least its continuance over the necessary length of time, quite out of the question. Even then the administration of suitable internal remedies, which it is usually possible to get even neglectful mothers to attend to, and the spontaneous tendency to improvement will often bring about a satisfactory result.

If, however, the affection reach a certain degree of severity, and months of patience bring no encouraging signs of amendment, the question of osteotomy presents itself. The operation is a safe and effective one when done carefully and aseptically.

Fig. 39.—A Brother of the Child with Genu Varum shown at Page 39.

Treatment.—On no account should the rickets itself be neglected. It is only too common to see such neglect, and attention entirely concentrated on local appliances. The mere fact of the latter being expensive of time and money is enough to give them an enhanced value in the eyes of the patients, who would not be human if they did not value highest that which costs them (or other people) most. *Remember always* that in young rachitic children the head and trunk deformities and diseases, *and, above all, the danger of checked growth*, are far more serious than any degree of bow-legs or genu valgum, because so much less remediable; and it is better to leave the legs entirely without local treatment than to do anything which might interfere with recovery from the main disease.

Appliances may be roughly classified into (1) splints and (2) irons.

Splints.—It is a frequent practice of some surgeons to apply splints mainly with the object of preventing the little patients from standing, and thus aggravating the deformity by the pressure downwards of their own weight. Theoretically this seems excellent; but I cannot say that the results which I have seen have really been good enough to set against the bad effects of deprivation of exercise. The latter are often most marked, and the former invisible. When it is *not* intended to prevent the patient from standing, two splints are applied to each limb. They extend from just above the knee to below the ankle. The outside one is placed well forwards, and the inside one rather backwards. Webbing straps, and not bandages, should be used to fix the splints. It is best to bring elastic pressure to bear in some way or another. Care has to be taken to prevent the children from wilfully displacing the appliances. This precaution applies to most orthopædic apparatus worn by children of a certain age.

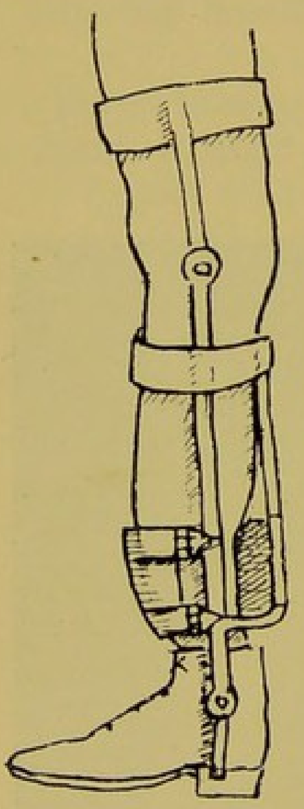


Fig. 40.—Irons for Curved Tibia.

Irons.—Those which I have been in the habit of using extend from the middle of the thigh to the boot-heel, being fitted to a socket in the latter. They lie on the inner side, and have a second perpendicular iron behind, parallel to the inner iron. A broad well-padded leather strap passes over the convexity of the curved tibia, and braces it backwards and inwards towards the two parallel iron rods. There are simple joints at the knee and ankle.

Operative Treatment. There are two methods—(1) the ordinary 'wedge osteotomy,' (2) simple osteotomy.

1. *Wedge osteotomy of the tibia.*

Instruments.—Chisel, small osteotome, mallet, retractors, bone forceps, periosteum rasp, &c., antiseptic appliances, sand-cushion, Esmarch's tourniquet.

The wedge must have its base towards the convexity of the tibial curve, and its upper surface should be at right angles to the axis of the tibia, above the curve, its lower surface at right angles to the axis of the short portion of the tibia, below the curve. Some surgeons take an outline of the deformed bone, and then set out on the paper the size of the wedge. This would be a better plan if the wedge were to be removed in one piece ; but, as a matter of fact, that is seldom the case. I prefer to adjust my cut surfaces to the bony parts I leave whole, rather than to the wedge, which is taken away in fragments.

The incision.—It should be longitudinal and about an inch and a half long, and should go right down to the periosteum. The cutaneous and subcutaneous structures are easily slid up and down or from side to side, and thus a comparatively small hole will permit a large wedge to be removed through it in pieces. An assistant with two blunt hooks retracts the lips of the incision while the chisel is being placed transversely in position to commence the wedge-cutting. I have already said that the wedge is cut out in several slices. They should involve nearly the whole thickness of the bone. For safety's sake the first slice need not be cut quite so deep as the others. When the first slice has been removed you can see better what you are doing. The wedge operation has to be done thoroughly in severe cases, or the surgeon will, after all, only half straighten the bone, and there will be another case of 'relapse' after osteotomy. On the other hand, bone must not be removed recklessly, as non-union has followed this operation. It should not be forgotten how near the tibial arteries are to the bone. It is better and cleaner to osteotomise than to break the fibula. Mere breaking is sometimes very difficult, considering the slimness of the bone, and, by cutting, the bone can be made to give way in exactly the right place. A very narrow osteotome suffices. Insert it through a small incision over the front of the bone, exactly at the angle of the curve. Press the osteotome towards the tibia, at the same time *directing* it rather away from that bone, so as to cut into the fibula from before backwards and a little outwards, and cut the bone obliquely. In a transverse division the osteotome is apt to get jammed, as the bone is very springy. The chisel used for the tibia should be small and very sharp, and the leg must be firmly embedded upon the sand-pillow. Neglect these precautions and the bone, if hard, will break in two before you have cut out your wedge—a troublesome occurrence. Apply pressure before taking off the Esmarch. There is no necessity for putting ligatures into any ordinary osteotomy wound; their insertion can only increase the chances of suppuration or delayed healing. A short period of sponge pressure usually suffices to check oozing. If wood-wool pads be used, they may be applied at once; the elastic pressure which can be got by bandaging over these pads will suffice, but always during the first twenty-four hours keep the limb raised (at first nearly to the perpendicular). With regard to splints, they should be removable during the first fortnight and immovable afterwards. I used to fix in plaster of Paris at once; but that plan in the long run involves waste of time, and, moreover, waste of time at a very inconvenient moment, namely, while some other patient is waiting to be operated on; moreover, it is not right to keep on for more than a day the pressure often necessary to check hæmorrhage; also, the thick first dressings, when removed, leave such a space in a primary plaster-case that it no longer fits, therefore I postpone fixation in plaster for a fortnight. By that time little or no dressing is required, the wound being healed, or nearly so. A large wood-wool cushion does itself serve for both splint and dressing during the first fortnight in some cases; if not, it can be supplemented by an ordinary wooden box-splint or a trough of poroplastic, or almost any other simple and quickly applied contrivance. When the plaster-case is applied, the greatest pains must be taken to obtain perfect position; five weeks, dating from the day of operation, usually suffice to obtain firm union. During the whole of the time the patient should be kept in hospital, unless a private case. Whoever attempts to deal with these cases in the out-patient depart-

Fig. 41.—Slight Rickets simulating Talipes Varus.

ment must not be surprised to find, sooner or later, something very foolish and unwarranted done by some parent out of control.

A *simple transverse osteotomy* of the tibia with oblique division of the fibula will suffice if the curve is not very severe.

Rachitic Deformities of the Upper Extremities.

They are seldom marked, except in the radius and ulna, and then those bones are usually affected near the wrist; curvatures near the elbow, analogous to genu valgum, are extremely rare. The only marked instance I can call to mind followed an injury, and I do not think it was truly rachitic at all. The subjects of rachitic curvatures of the arms are usually infants with pronounced rachitic deformities elsewhere. For all that, the arm affections are not unfrequently mistaken for green-stick fractures, from which it is not always easy to distinguish them certainly. But the deformities are usually symmetrical in position, if not in degree.

There is a great tendency to spontaneous improvement, which can be seconded by the use of splints. The child's hands must be left free, and it must be encouraged to carry things. Extreme cases may require osteotomy. Both bones will then have to be divided at the angle of curvature. But such cases are most exceptional. The infancy of the patients and the statical conditions are greatly in favour of recovery without operation.

The child should not be allowed to crawl. Suitable splints are such as would be used for fracture in the middle of the fore-arm.

In some instances *brisement forcé* is applicable, but the fatness of the infantile limb and the shortness of the segment below the point of curvature make it less easy than might be imagined. The surgeon must, above all, not be too meddlesome in dealing with these affections. If, by any careless measures, he produced a cellulitis among the muscles and tendons of a right arm, he would do more harm in a month than he could remedy in a lifetime in this branch of orthopædics.

CHAPTER V

INFANTILE PARALYSIS AND THE DEFORMITIES CAUSED BY IT

The name 'anterior poliomyelitis' indicates the anatomical seat of the nervous lesions which lead to the deformities of individuals suffering from infantile paralysis. That is to say, when a subject of the disease under consideration is examined *post mortem* the anterior cornua of the grey matter of the spinal cord are found in a state of chronic inflammation or degeneration. There is reason to believe that the disease is due to infection; *e.g.*, remarkable epidemics of it have occurred, and its primary symptoms are not unlike those of an acute but brief fever. Most of the sufferers are infants or young children; but it is occasionally seen even in adults. It is much more common in summer than winter. Though the surgeon is concerned more particularly with the results of the disease than with its immediate manifestations, he will do well to bear in mind its nature when dealing with any case, especially a recent one. There can scarcely be a doubt that many opportunities of doing medical good to recent cases of this spinal affection are thrown away.

The paralysis has usually a paraplegic form, although often affecting mainly only one lower extremity. Sometimes it is hemiplegic ; more rarely it affects all the four limbs. Not only is it often confined to one limb alone, but to a limited

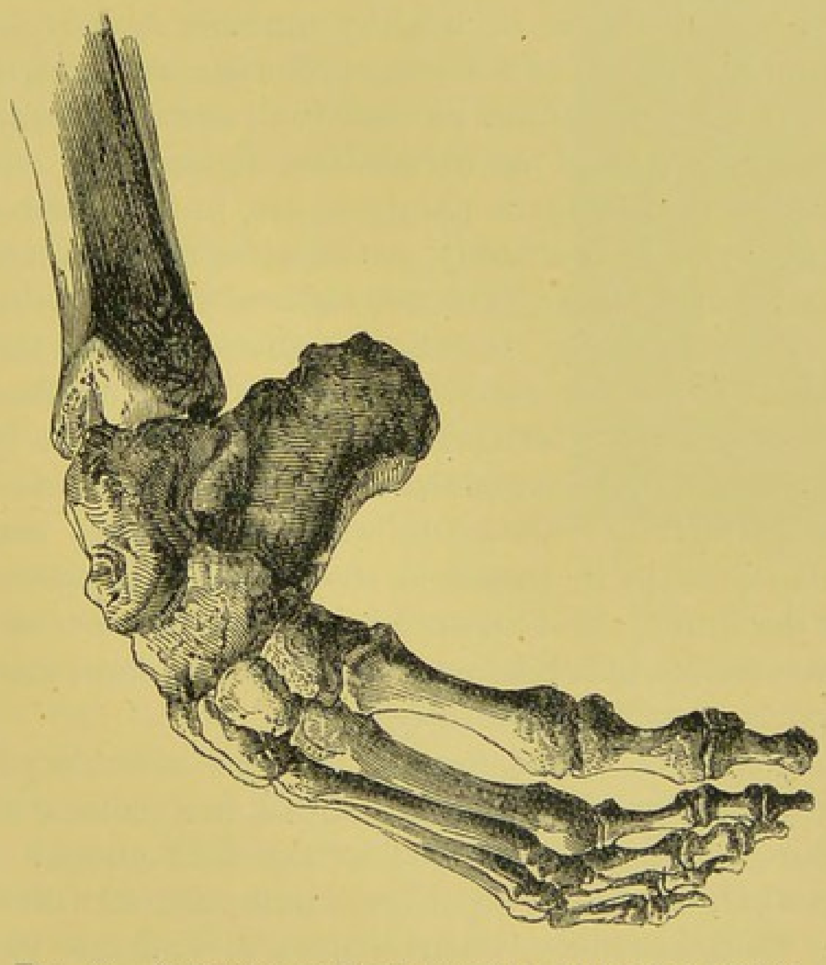


Fig. 42.—Skeleton of Foot affected with very severe Paralytic Equinus. (After Hoffa.)

portion of the limb, and the part attacked most is usually, though not always, the distal part. Sometimes the arm of one side and the leg of the other are affected. The paralytic parts are wasted, cold, often to lividity, with the skin roughened, and dry, except on the palms and soles, which may be unduly moist. These signs are more marked in winter than in summer. Chilblains are common. The bones, as well as the muscles, are usually more or less atrophied, though seldom to anything like an equal degree. The muscles are deteriorated in quality as well as in size, being the subjects of more or less complete fatty degeneration. The prognosis depends greatly on the extent to which this has taken place. It is the thickness, and not the length, of the muscle which the disease directly tends to reduce. Under certain circumstances of frequent occurrence the length becomes actually increased. When shortening does occur, it is brought about just as it sometimes is in healthy muscles, namely, by continued approximation of the points of origin and insertion.

By an easy transition we pass from the consideration of these points to that of the deformities themselves; for these, in the subjects of infantile paralysis, are, in the first instance, almost always, all but entirely, muscular or musculo-tendinous in nature. For instance, take two cases of equino-varus apparently of equal severity, but the one congenital and the other paralytic. The latter would present no osseous changes to parallel those of the former. Osseous changes are present often enough, and I have already said so; but at first they have comparatively little to do with most of the coexisting deformities, except in so far as they cause shortness or slimness of the limb. The cases of lateral curvature of the spine which are due to infantile paralysis probably form exceptions to this rule, as will be presently shown.

Diagnosis.—A limb deformed through infantile paralysis is usually cold, flaccid, and loose-jointed, in a manner to make the nature of the case obvious at the first glance. Let us suppose that, as usual, it is a lower limb affected with equino-varus. That deformity, when congenital and not paralytic, may be accompanied with muscular wasting, but not with coldness, flaccidity, and ligamentous laxity. Equino-varus from other causes has usually a history sufficient to identify its nature, besides being destitute of the special features of infantile paralysis.

It will have been noted that the history of a case of infantile paralysis is itself usually a very characteristic one, especially as regards the suddenness of its onset, the absence of loss of sensation, even when the motor incapacity is most marked, and usually the happy tendency to retrogression of the paralysis, at least up to a certain point. But in very young and carelessly nursed children it is surprising to what an extent these striking phenomena may be overlooked by nurses, not to mention parents, and even medical men. Hence the history sometimes fails to determine the date of onset of the malady, and leads to its being confounded with some congenital affection.

When the knee or hip, as well as the ankle and foot, is affected, the diagnosis becomes, if possible, more positive still.

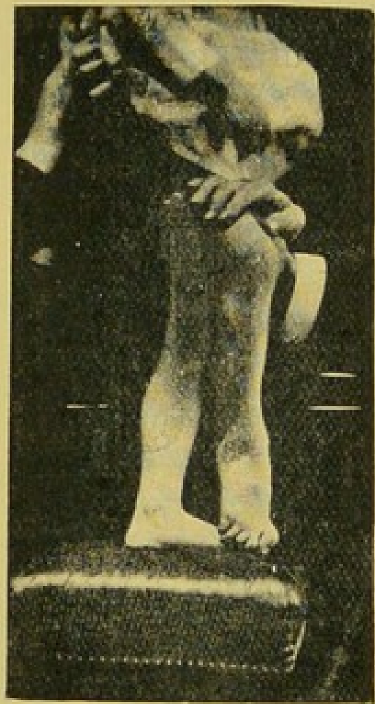


FIG. 43.—PARALYTIC EQUINUS.

Infantile paralysis of the distal half of the upper extremity ultimately produces the unmistakable 'main en griffe,' accompanied by the usual cold blue-red skin and by wasting, without loss of sensibility. There is almost always a coexistent paralytic club-foot to confirm the diagnosis. When it attacks the muscles about the shoulder, that joint rapidly shows signs of great relaxation, and although the head of the humerus can be easily replaced, it as constantly drops down from its proper position.

All the reflexes of the part paralysed are usually weakened and the tendon reflexes absent. The nerves do not react to electricity nor the muscles to the interrupted current if paralysis is complete, although they are excited by a weak galvanic current. A stronger contraction follows the closure of the current at the anode than at the kathode. This is expressed by the formula A.C.C. > K.C.C. (anodal closure contraction > kathodal closure contraction). In normal muscle the reverse is the case. Ultimately—*e.g.* after years—galvanism produces a slow contraction at either the anodal or the kathodal closure. These phenomena constitute '*the reaction of degeneration.*'

As the paralysis is sometimes limited to one or two muscles, there are many irregular cases as well as the usual types. Infantile paralysis usually selects for attack the cervical and lumbar enlargements of the cord, especially the latter.

Localisation.—The muscles paralysed vary greatly in different cases. It is not always possible to obtain precise accounts of the parts paralysed at the first onset; but,

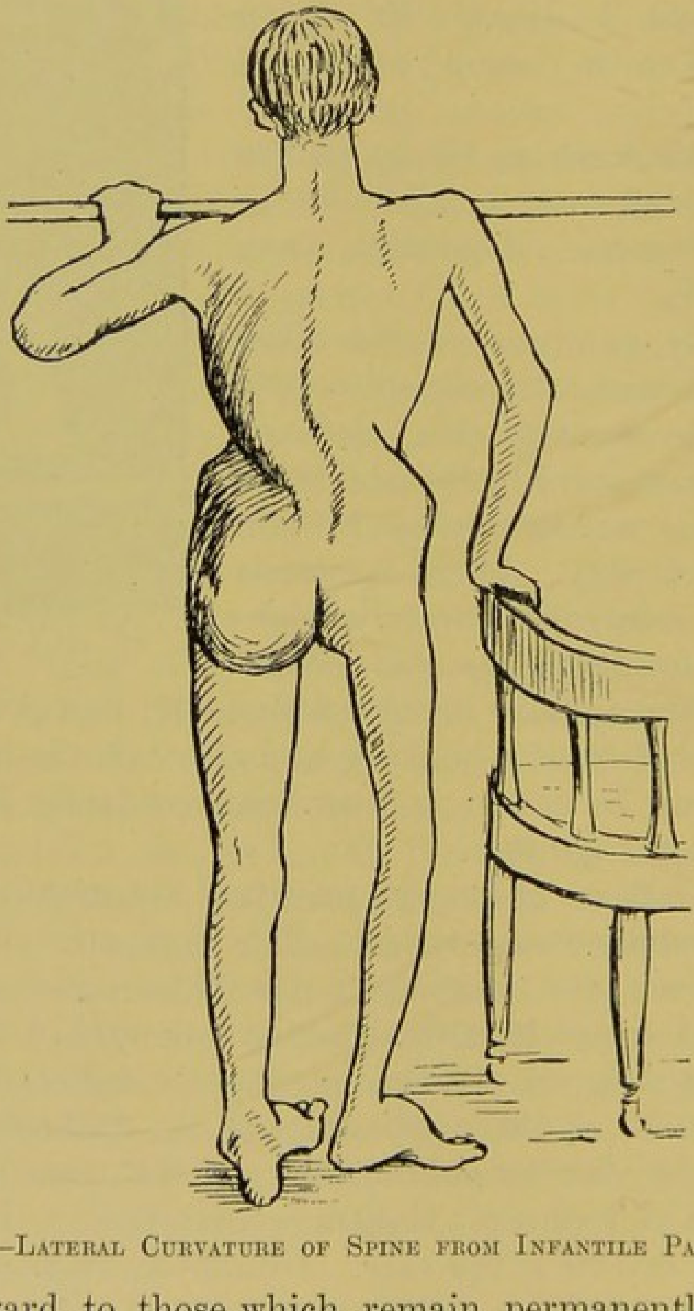


Fig. 44.—Lateral Curvature of Spine from Infantile Paralysis.

having regard to those which remain permanently affected, in most of the cases only one lower extremity is affected—the left leg twice as often as the right—and, in about one-fourth of the total, both legs. Less frequently cases of infantile paralysis of only one arm present themselves to the orthopædic surgeon, as well as instances of hemiplegia, of crossed paralysis, of paralysis of three or of all four extremities. But many cases which when seen by the surgeon are monoplegic have been originally paraplegic, or diplegic, or even more extensive, and often permanent traces of the original extent of the attack can be discovered by careful search.

In all except the most severe examples it is merely a limited number of the muscles of each limb which are attacked, and even these are not always affected in an equal degree.

The arm is attacked more commonly above the elbow than below it. When *the upper arm and shoulder* are extensively affected, the limb hangs loose, with the shoulder-joint greatly relaxed (fig. 50); when the lower arm and hand, relaxation also exists for a long time, but eventually, in some cases at least, the flexor tendons shorten, and the hand becomes more or less claw-like. Sometimes the adductors of the thumb suffer so much that the latter ceases to oppose or be opposable to the fingers, and falls back into the same plane with them.

When the *serratus magnus* is affected, the corresponding scapula projects in a wing-like manner.

When the *trunk muscles* are affected, curvature of the spine may result. Sometimes this takes the form of lordosis, sometimes that of scoliosis.

When *the gluteal and other muscles about the hip-joint* are attacked, there results sometimes dislocation of the hip, with more or less fixation in the new place; *e.g.* the case of Kate C——, described elsewhere in this book, where the head of the bone lay near the obturator foramen. But more frequently a condition not distinguishable from ordinary cases of congenital dislocation of the hip (rightly or wrongly so called), with more or less flexion of the hip and associated lumbar lordosis, is seen.

Of *the thigh muscles*, the extensors suffer far more frequently than the flexors. But once (at the Surgical Aid Society, in a child aged three years, named Elizabeth Moore) I found inability to flex up the right knee, combined with ability to straighten it. In walking this child kept the right knee extended, but flexed the left easily.

The *knee* is frequently in a position of *valgum* (fig. 45), and is sometimes more or less contracted, but more frequently loose and capable of being over-extended. This hyper-extension of the knee is the paralytic form of *genu recurvatum*, which must be carefully distinguished from (2) the congenital, (3) the rachitic, and (4) the osteitic. It is increased, if not caused, by the patient's habit of fixing the knee by pressing with the hand on the lower and front part of the thigh while walking.

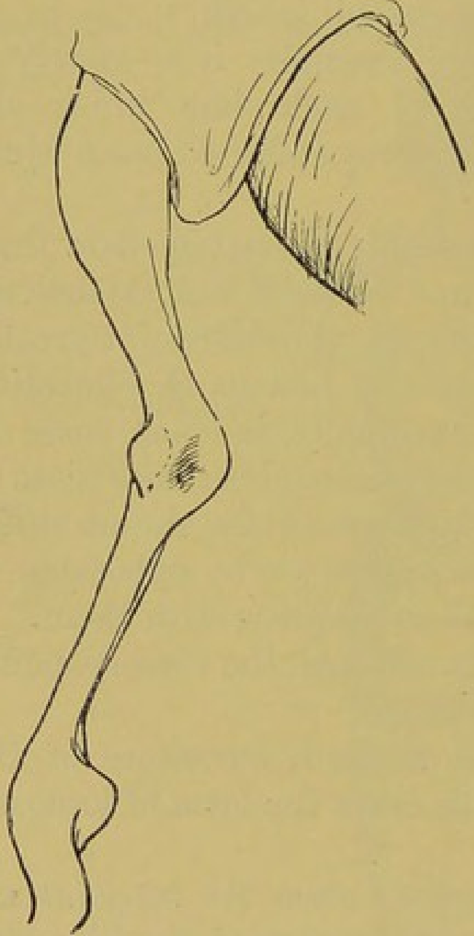


Fig. 45.—Severe Old Paralytic Deformity (Infantile Paralysis). Displacement of Patella. It can be readily replaced into the intercondyloid groove (which is shaded in the sketch). Equino-Varus of Foot.

If the *leg* is paralysed, the *foot and leg are everted.*

The *foot deformity* is *usually* one of *equinus* or of *equino-varus.* Less frequently *valgus* is seen, and even then it is usually ankle valgus rather than valgus of the foot, and is usually associated with a lax ankle and a dangling foot. With the same loose and valgus ankle is commonly found *pes cavus*, the heel being down and the anterior part of the foot horizontal. But pes cavus is more commonly associated with a tight tendo Achillis, and, in fact, with ordinary paralytic equino-varus.

The way in which Deformities are caused by Infantile Paralysis.—This is a subject of very great interest and importance. It is erroneous to explain the deformities of infantile paralysis by the theory that voluntary muscles have a kind of tone like that of involuntary muscles, and that the normal state of a given joint depends directly upon the tone of the muscles which act upon it in one direction being accurately balanced by the tone of the muscles which oppose them. This is the so-called 'antagonistic theory' of Delpech, and the one commonly set forth in British text-books and special treatises. Though vigorously attacked forty years ago by Werner of Königsberg, this hypothesis held its ground until Hüter and Volkmann controverted it.

The main influences which determine the nature and extent of the deformities resulting from infantile paralysis are the following:—

1. The force of gravity.
2. External pressure.
3. The inability of muscles to extend *themselves* completely after an ordinary contraction.
4. The normal law of growth, by which muscles and other structures undergo nutritive shortening when their extremities remain for a long time approximated.
5. Trophic changes, due partly to disuse and partly, more directly, to the nervous lesion. These act differently according as they attack the soft parts or the bones.

Let us take, one by one, types of the common deformities produced through the agency of infantile paralysis, and see how they can be brought about by the influences above enumerated.

To begin with paralytic equino-varus. A little patient is suddenly attacked with paralysis of the muscles which act upon the joints of his ankle and foot. Months elapse before there has occurred sufficient improvement to enable him to walk about on the foot. In the meantime he is obliged to either lie, or sit, or crawl, or be carried about, or perhaps use a crutch, supposing his arms and the other leg to be strong enough. When he is lying down, the helpless foot falls naturally into a position of equinus, with more or less varus. The influence which brings this about is surely that of gravity. It is the position assumed by the foot during sleep and during ordinary rest, as, for example, when a man throws himself carelessly down on the sofa; it is the position into which the foot falls in the relaxation of death.

Again, when the little patient is carried or sits on his chair, gravity still weighs down the anterior part of the foot and tips up the heel, so all day and all night, month after month, the same or nearly the same attitude being preserved, necessarily and naturally nutritive shortening takes place; the gastrocnemius and other muscles whose ends are approximated by the position of equinus or equino-varus grow shorter; the ligaments and other soft structures behave in a similar way. Thus the deformity becomes fixed.

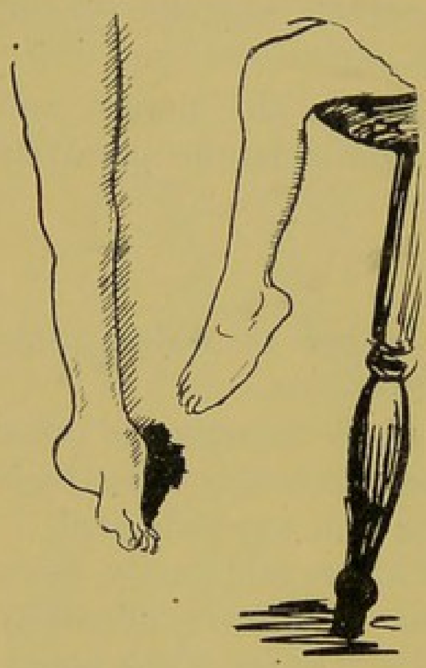


Fig. 46.—Infantile Paralysis. Talipes Equino-Varus.

When the patient is in bed the weight of the bedclothes acts in co-operation with that of the foot itself.

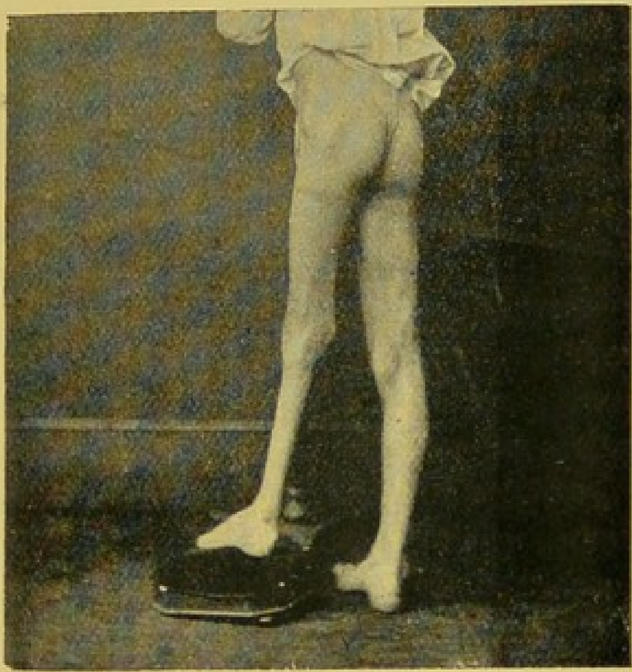
When the patient crawls about, the counter-pressure of the floor against the dorsal surface of the foot and toes acts also to the same end.

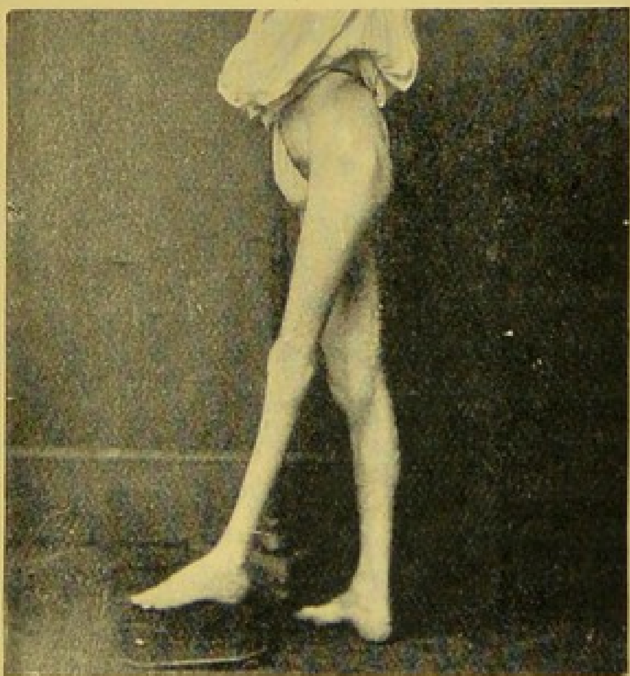
This mode of explaining the immediate origin of common paralytic equino-varus was due to Hüter and to Volkmann.[1] I will show now how the pointing of the toes forward and the hollowness of the foot may be at least partially explained in an analogous way. (See fig. 49.)

Gravity, forcing downwards that part of the foot which lies in front of the ankle-joint, at the same time uses this anterior segment of the foot as a lever to tip up the posterior segment—namely, the heel. If there were no medio-tarsal joint, the action we are referring to would be complete and unmodified. But there is such a joint, and though its normal range of movement, as compared with that of the ankle-joint, is too small to prevent altogether the tipping-up action, it is yet sufficient to limit it. At first this limiting action is small; but the persistent action of gravity is to extend the dorsal ligaments of the medio-tarsal joint, and ligaments readily yield when the surrounding muscles have been attacked by infantile paralysis. So that the degree to which the heel can be flexed on the sole of the foot continually

[1] *Sammlung klinischer Vorträge: Chirurgie*, 2.

increases. In the meantime forces are at work to depress the heel. When the foot hangs down, gravity pulls at the heel just as at the front of the foot, though to a much smaller advan-





FIGS. 47, 48.—INFANTILE PARALYSIS IN A YOUNG MAN, AFFECTING THE LEFT LOWER EXTREMITY. PARALYTIC DISLOCATION OF HIP. The head of the femur lies directly in front of the great trochanter, and its position can be plainly *seen* in the second figure. The appearances are practically identical with those presented by a 'congenital dislocation.' Of the two white patches on the hip, the lower and posterior is the skin over the great trochanter, the upper and anterior the skin over the femoral head. (From a patient of Dr. Andrew Elliot's.)

tage, owing at once to the shortness of the heel and the comparatively narrow range of motion of the medio-tarsal joint. When the patient is in bed, the friction and pressure against the bed itself oppose the leverage action of the front of the foot. These influences, small as they seem, tell eventually, the medio-tarsal joint yields, and the foot becomes strongly flexed on the heel in the manner indicated in the sketch. If, at the same time, the muscles in the sole of the foot escape paralysis, after each occasion when these act to approximate the heel to the toes there is no force to separate the heel from the toes again.

In paralytic talipes, as Mr. Adams long ago pointed out, the heel is never really raised so much as the general appearance of equinus would suggest. In this there is a contrast with congenital talipes.

The position of the toes is due to—

(1) Their extensor tendons being put on the stretch by the falling downwards of the foot; and

(2) Their being pushed forwards out of the way when the patient proceeds to walk; because in walking he bears on the metatarsal bones, and not on the weak and unresisting phalanges.

When the patient never gets to walk or bear on the foot, the extensor tendons gradually stretch and allow the toes to dangle.

As soon as a certain degree of varus is formed, if the patient walks on the foot, his weight, as in the case of congenital talipes, acts to increase the deformity.

The next type to be explained is the exceedingly common one of *talipes calcaneus with abnormally loose ankle-joint.* Now it is the common practice to speak of the muscles in infantile paralysis as if the disease had some direct and singular effect of making them abnormally long. The arguments advanced in favour of this view do not seem to me very conclusive. A far simpler explanation of the lax muscles is usually at hand if a given case be taken and studied. Moreover, if such a change took place, why does it never overstep the limits within which it is, so far as I have seen, always confined? For example, when an inch, or an inch and a half, is cut out of a very lax tendo Achillis, why will not the severed ends come together even with the heel dragged down to the lowest possible point? In short, the length of the muscle is, as far as I have been able to judge, not greater than corresponds with the range of motion of the joint. The legitimate inference is, therefore, that the two are related. Now, if the condition of the joint be assumed to be the governing factor, it is easy to understand why there should be a limit, for purely mechanical reasons; but what is there to pull up so abruptly an intrinsic tendency of a muscle to grow mischievously long? Moreover, what should be the effect of such tendency in those cases in which the growth of bones in length is seriously arrested? Should not the muscles go on growing and, so to speak, leave the bones behind? Moreover, admit an intrinsic power of growing too long, and what becomes of the only tenable theory of the causation of paralytic equinus?

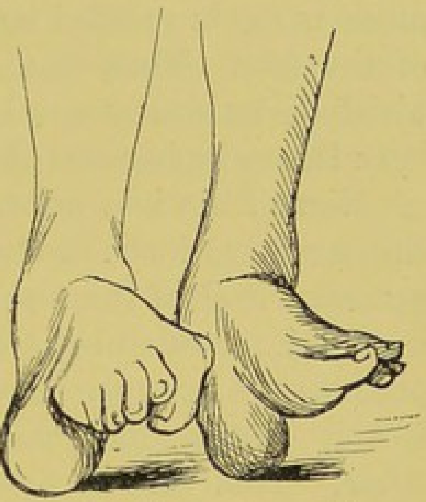


Fig. 49.—Paralytic Talipes Calcaneus, with the Pes Cavus which usually accompanies it. (After Wm. Adams.)

In paralytic calcaneus we do not see the front of the foot actively drawn up and the heel firmly held down. The condition is far from being the exact opposite of paralytic equinus. If regard be had simply to the foot itself, and the leg be for a moment ignored, very similar, if not identical, modifications are often seen in both equinus and calcaneus. For example, in both, pes cavus is usually marked, and in both the arching of the foot and the contraction of the plantar structures have been brought about by the same influences.

But how is it that in calcaneus the tendo Achillis has come to be so long and the ankle-joint so abnormally movable in every direction?

When a child is attacked with paralysis in only one lower extremity, or when in two but not in both severely and extensively, it soon attempts to walk again. Now its paralysed muscles will neither fix its ankle firmly nor raise the drooping anterior part of the foot out of the way. The child therefore everts the limb considerably, and, as it were, *tosses* the foot out of the way in walking. Bringing it down to the ground with a lateral pressure, in pushing off from the ground the ankle is again pressed laterally in consequence of the eversion of the foot. Thus the lateral mobility of the ankle-joint, which is naturally not inconsiderable, becomes increased by both the swinging and the pressure.

Now, if the foot were brought squarely to the ground and the weight of the body made to press down the antero-posterior arch of the foot every step, there would be a powerful mechanical influence at work to prevent pes cavus, or even to produce pes planus. But it is not so. As we have seen, the foot is continually pressed towards either one side or the other. This lateral pressure tends rather to lock than to open the medio-tarsal joint; therefore most of the very considerable amount of passive movement caused by every step falls to the share of the ankle-joint. Therefore it frequently happens that the effects of gravity, pressure, &c., acting in the intervals of rest, are not seriously counteracted during exercise, except as regards the ankle-joint.

Further, when these children play, roll about, and kneel, their feet being helpless and passive, or nearly so, get bent and twisted in every direction of which they are capable. Soon comes a time at which the heel has come down far enough for it to be possible for the child each time it takes a step to toss up the front of the foot and come down upon the back of the heel, towards the point of insertion of the tendo Achillis. But this trick is not practised, nor is it, indeed, possible, at first. I therefore think Volkmann must be wrong in regarding it as the *complete* explanation of paralytic calcaneus. The heel has to come down first, but in the later stage of the affection it is probably the most important factor in keeping up and greatly intensifying the calcaneus.

Hüter and Volkmann were probably too mechanical in their explanation of the etiology of deformities. Their teaching has never been fully accepted in this country or in France, and a reaction set in some years ago in Germany, led by Seeligmüller, who argued in favour of what he called the 'antagonistic mechanical theory.' This corresponds to Werner's exposition (forty years ago) of the way in which the disfigurements due to facial paralysis arise.

I have referred to it above as the *third* cause of deformities due to paralysis—viz. 'the inability of muscles to extend themselves completely.' This obviously comes into play as soon as ever there is put into action, by the will or otherwise, a muscle whose natural antagonist is paralysed, provided other influences like gravity do not interfere. There can be no better example than that of facial paralysis. When one side of the face is paralysed, every time the patient smiles or otherwise moves the sound side, there being no muscle on the paralysed side to pull back the mouth, &c., into symmetry, more or less of the obliquity remains, and is gradually fixed by nutritive shortening.

But Volkmann acknowledges all this—indeed, helped to recall attention to it and to the neglected Werner. But he is led to conclude, he says, by careful clinical observation that, in infantile paralysis, such disturbing influences as gravity *do* commonly enter and overwhelm such a force as that which has free play in ordinary facial paralysis.

And although I think Volkmann somewhat overrode his hobby of mechanical etiology, I think he was nearer the truth than some of his living German critics. For instance, Hoffa writes, in leaded type, that 'at all events the proposition is indisputable that paralytic contractures are induced in the first place through voluntary contractions of unparalysed muscles.' There are many and weighty exceptions to this rule. Contractures occur in limbs which are wholly paralysed.

I do not think that *sufficient* weight has hitherto been attributed to the joint-relaxing effects of infantile paralysis.

The healthy muscles surrounding a joint are themselves in effect ligaments, and of course something more. Paralysis takes away this 'something more' instantly, thereby destroying them as muscles, and it rapidly, if gradually, weakens them as ligaments by its remarkable effect on their nutrition. It at the same time damages the nutrition of the ligaments proper, as well as that of the fasciæ and the skin, and, in short, all the soft parts which hold the joint together. Hence the rapid relaxation. This in many instances deserves to be ranked as the prime immediate cause both of loose and of contracted joints. In the former case especially the trophic changes play a leading part. Without great help from them it is not likely that a joint like a flail could be produced so rapidly as it sometimes is. To produce contractures other influences must, of course, co-operate.

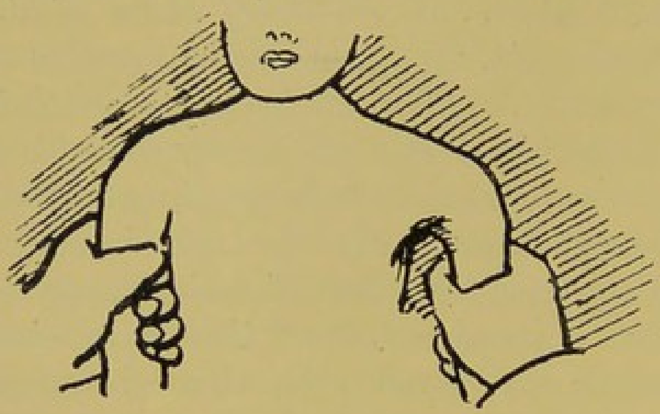


Fig. 50.—From a Child only a few months after the Left Shoulder and Upper Arm were attacked by Infantile Paralysis. Both arms are being pulled outwards. Note how the ligaments of the paralysed shoulder are already so lengthened that the head of the humerus leaves its socket.

It should be pointed out that in the case of paralysed joints the ligaments lose the co-operation or *backing up they get from the involuntary action of healthy voluntary muscles*. Although the latter may not possess tone in the sense in which involuntary muscles possess it, yet they are always on the watch to resist any attempt to stretch them, such as would occur if a ligament yielded ever so little. We know what occurs when we attempt to reduce a dislocation without an anæsthetic.

Lastly, paralyses which attack in childhood *may cause deformity by checking the growth and development of the bones themselves*. In the *limbs* this results, practically speaking, merely in *shortening*; but in the case of the *spine*, if hemiplegia checked the growth of the corresponding side of the vertebra, it is clear that *curvature* would result. (See fig. 44.)

In studying paralytic varus and valgus it is necessary to distinguish carefully between varus of the ankle and pes cavus, and also between valgus of the ankle and pes planus. In paralytic cases the chief seat of varus or of valgus is usually the ankle-joint. This, of course, contrasts a little with the pathology of congenital cases, as well as with that of common flat-foot, which depend more on the shape of the tarsal bones and on the condition of the astragalo-scaphoid joint.

Paralytic deformities of the hands and wrists, as well also as a considerable number of those of the lower extremities, are probably of similar immediate origin to the deformity caused by ordinary facial paralysis—that is to say, flexion (or extension) of the joints affected occurring either through the contraction of muscles unaffected, or at least not wholly paralysed, their paralysed antagonists leave the parts in the position thus given to them. Then nutritive shortening fixes that position, and deformity results.

Prognosis.—With regard to the paralysis itself, it has already been stated that there is a marked tendency to retrogression from the point of severity reached at the first onset. But this is almost always partial only, and the extent to which it goes depends greatly on the degree of paralysis, as measured by their electrical state, reached by the muscles concerned. Later on it depends also upon the amount of fatty degeneration present. But these rules are not absolute; and it is hardly going too far to say that no muscle or set of muscles stricken with infantile paralysis can certainly be pronounced in an absolutely hopeless state until months of careful treatment have put the matter to the test of experiment. Duchenne and others have published remarkable cases confirmatory of this view. On the other hand, the slightest response to the interrupted current should be regarded as absolute encouragement to persevere in thorough treatment.

With regard to the *deformities*, they can almost always be corrected with the greatest possible ease and safety. Many of them—*e.g.* the so-called paralytic calcaneus—are not so much deformities as 'laxities,' and do not, therefore, form true exceptions to the rule just laid down. More concerning them under the section on 'Treatment.'

Similarly, also, the 'main en griffe' stands by itself as regards prognosis. Nothing is easier than to place the member in a normal position, but the disordered muscles will not keep it right. It would be more correct to call this condition 'a tendency to distortion' than 'a deformity.' A corresponding state of affairs in the foot is easily dealt with by the application of a rigid appliance. This is a less convenient proceeding in the case of the hand. *But even the 'main en griffe' will sometimes yield to persevering faradisation of the interossei* (Duchenne). More also about this under the head of 'Treatment.'

Treatment.—In a work like this, wherein it is impossible to say all one would like to say while retaining it within reasonable limits, one ought, perhaps, to be always strict in not letting the fascinating questions which lie around tempt us from the subject of the deformities themselves. But I cannot pass by in absolute silence the treatment of the prime disease which causes the deformities now under consideration. First, because I wish to impress on the surgeon that he must never lose sight of it, however mechanical may appear the duties which lie straight before him in a given case, partly because, somehow or other, these poor little patients seem so often to slip, as it were, between two stools. All the diseases which lie on the borderland between medicine and surgery are apt to furnish instances of this misfortune.

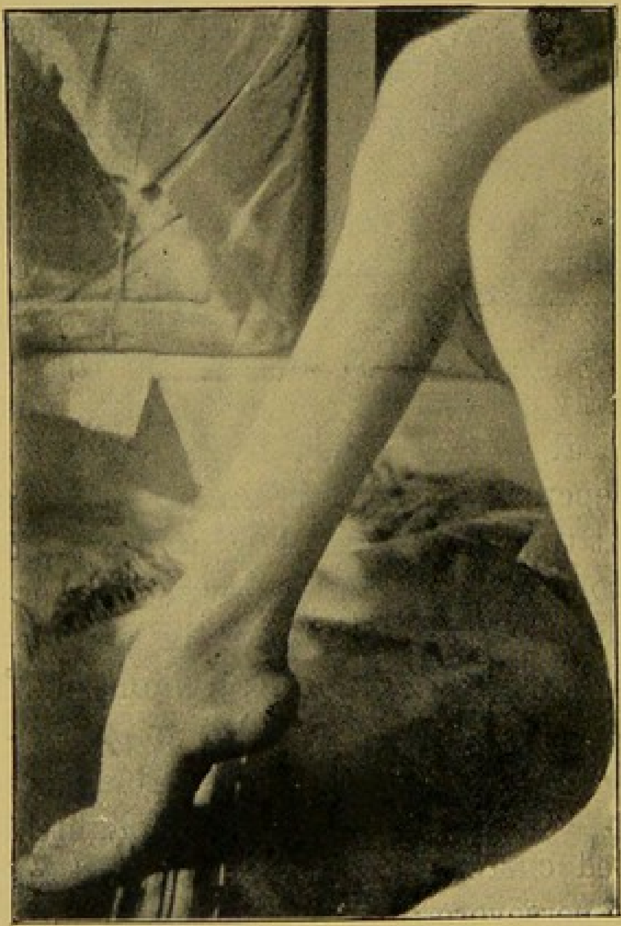


Fig. 51.—F., aged 18 Years. Right Talipes Equinus (Paralytic). (From a Photograph of Dr. H. O'Neill's.)

The local application of warmth, and still more the protection from cold and conservation of such natural warmth as the limb possesses, are points of great importance in the treatment. Two pairs of stockings, one over the other, are to be strongly recommended. They are more efficient than a single thick pair.

Appliances for the addition of warmth have to be used with care, lest chilblains or even burns be produced. But as sensation is almost always preserved in infantile paralysis, there is far less danger of burning or scalding than in cases of paralysis from some other causes—*e.g.* division of a nerve.

Fig. 52.—Right Foot and Ankle Five Weeks after being forcibly corrected with Thomas's Wrench. (After Dr. H. O'Neill, Belfast.)

A wooden box can be made, open at one end but with a lid. This box should contain room for the limb or limbs to lie upon and between warm bags, or bottles, or tins containing water or sand. The limb should be separated from these by several layers of blanket, and should also be covered and packed in with blanket. If the cutaneous sensibility of the patient be normal, it will suffice to apply just such a degree of heat as may be grateful to him. Otherwise, the water or sand should be, with rigorous care, tested by the thermometer and not allowed to exceed 130° ; and it must be remembered that two or three layers of blanket must still intervene between this heat and the limb. At first the limb should remain only five minutes in the box. The time should be increased five minutes more every day till it reaches one hour, and then, if the patient is doing well under the treatment, two hours a day will not be too much. I repeat that this treatment requires great caution. It should receive the personal attention of the mother, and not be left to the average nurse-maid.

In order to preserve the heat in the bottles the box should be thickly lined with pads of blanket stuffed with cotton-wool.

At night the feet should be well rubbed, and then placed in warm woollen socks before the patient goes to bed.

In winter, chilblains should be watched for and promptly treated the moment they appear. In many instances no amount of care will entirely prevent them, but carelessness will aggravate them to an extraordinary degree. Among the best local remedies to ulcerated chilblains is iodoform mixed with balsam of Peru, and applied on lint or cotton-wool. Sometimes ordinary zinc or boracic ointment is very effectual. The boots should fit well, and should be thick and wide enough in the sole to keep out damp. The uppers should, of course, be also kept in good condition. The paralytic children of the poor suffer terribly in these points.

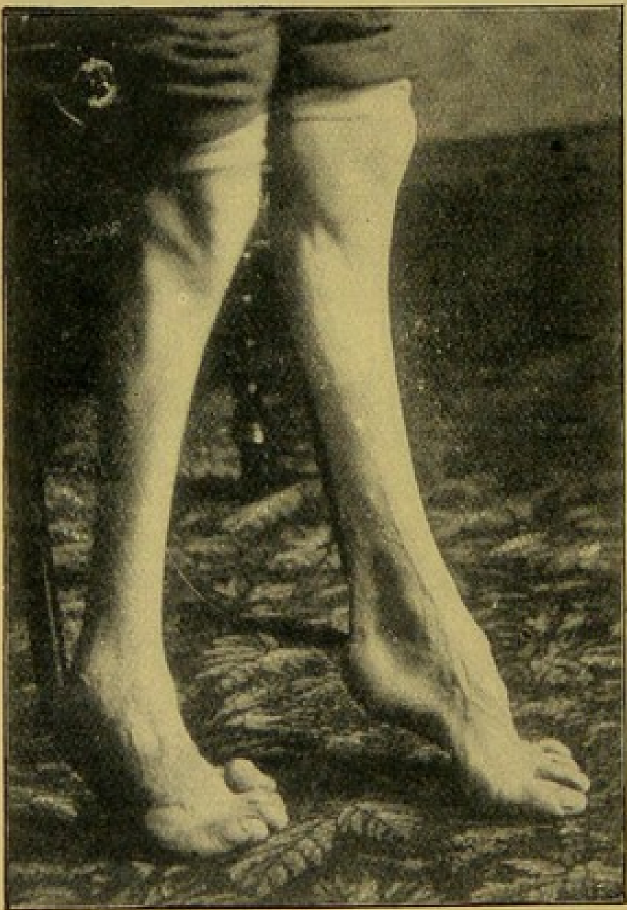


Fig. 53.—H. R., aged 27 Years. Double Talipes Equinus. (From a Case of Dr. H. O'Neill's.)

Exercises and Mechanical Measures. — To prevent the development of deformities in a patient with infantile paralysis, care must be taken to oppose the action of gravity and such forces as the weight of the bedclothes in keeping the limb for long periods in one inconvenient position. Moreover, regular passive movements should be applied to the joints, and especially to those of the foot and hand. It has already been shown how greatly paralytic deformities depend on the tendency to nutritive shortening of muscles kept for long periods in a position in which their ends are approximated.

To prevent equinus the leg and foot may be placed on a well-padded, simple, rectangular wooden back splint, and fixed thereto with a flannel bandage, which should on no account be tightly applied. Every morning, on taking this off, the ankle-joint should be several times gently flexed. Steel or iron splints are cold unless very well padded, and as wooden ones for night use do not need to be very strong, they can be made light. As soon as ever a marked tendency to drag the foot is observed an appliance should be used. What is the good of allowing the little patient to continue confirming the bad habit of everting the foot to get it out of the way in walking? Some surgeons of position do this, and think themselves supported in so doing because they can point to cases which improved under this ‘treatment,’ or ‘neglect,’ as I think it. Of course the cases often improve. The natural tendency to retrogression of the paralysis has been noticed, but that is no argument whatever against protecting the patient against the certain acquirement of a bad habit and the considerable risk of getting a deformity requiring operative treatment.

To deal *with the lower extremity first*, the abnormal conditions may be divided into *three classes. In the first the affected joint or joints can be moved by the patient in one direction, but not in the opposite. In the second they cannot be spontaneously moved in any direction, or, at least, there is not sufficient power of motion for any useful purpose, but the range of passive mobility is excessive. In the third, not only spontaneous, but passive, mobility is limited in every direction.* The first class of cases are the most common; the third by far the most rare. They are the cases in which marked contractures have taken place. The best examples are to be found in severe paralytic cases of equino-varus, the stiffened joints being rather those of the foot itself than of the ankle-joint.

The commonest examples of the *first class* are those in which the foot is 'dragged' in walking. The power of pointing the foot to the ground is often, in these cases, retained almost to a normal extent. Perhaps I should rather say 'recovered' than retained. On the other hand, the power of the extensors in front of the leg has been almost entirely lost, and the patient can scarcely, or not at all, raise the foot from the pointed position.

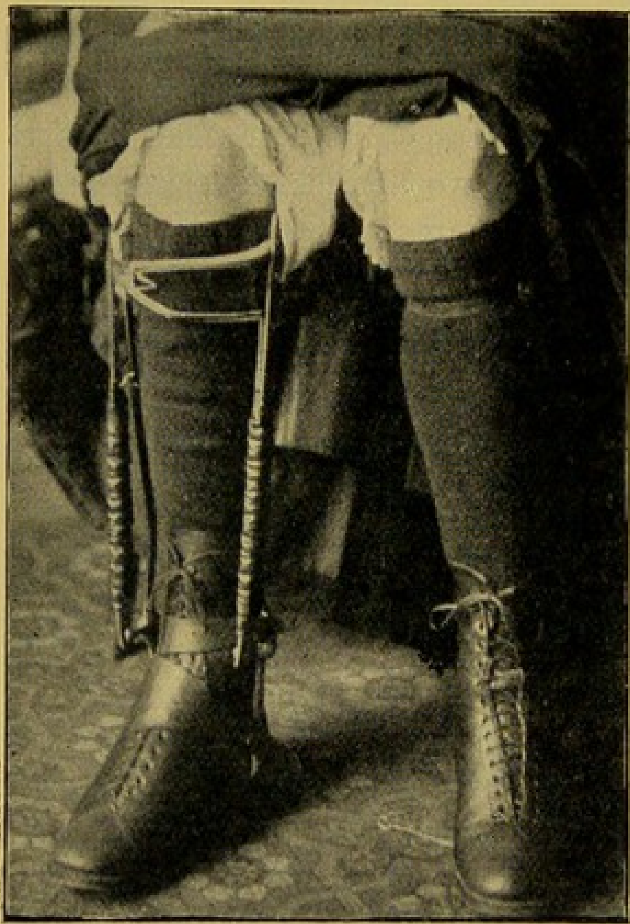


Fig. 54.—Talipes Equinus, Right. Steel Anterior Rubber Accumulator and Boot. (From a Case of Dr. H. O'Neill's.)

Now, for these cases an appliance is indicated which will aid the helpless extensors by elastic force, and at the same time permit the flexors to act sufficiently to preserve or even improve their tone.

The instrument which I like best and believe to be most effective is that in which the elastic force is supplied by an anterior rubber accumulator. (See fig. 54.)

It is not absolutely necessary to have irons on *both* sides of the leg, but it is better to put the same amount of steel into two lateral uprights than into one. The ankle is better supported and the foot kept square. The irons reach to a height just between the calf and the knee. A half-hoop of steel behind and a strap and buckle in front there grasp the leg. There are simple joints at the ankle. The instep and sole of the boot should be made thoroughly rigid. Instrument-makers have a great tendency to neglect this point. Then the rubber accumulator simply acts to bend the waist and sole of the boot, especially if, in addition to this, the common mistake is made of placing the stirrup of the accumulator too far forward.

The lower end of the accumulator may be attached to a small arm projecting from the iron below the ankle-joint, instead of to a leather stirrup. In this case two accumulators are sometimes used, one on each side of the leg. (Fig. 54.)

Again, by attaching the accumulator towards one side or other of the stirrup, instead of to its centre, a tendency to varus or valgus can be opposed at the same time as the equinus. At the upper end of the accumulator should be a strap with holes. The degree of tension of the accumulator can be regulated by altering the particular hole placed on the hook. It should be just enough to put the foot, when passive, at right angles to the leg.

The rubber part of the accumulator may be either a ring or a straight tube. The latter is perhaps the more elegant. Sometimes, instead of a rubber accumulator, a steel spring acting on the ankle-joint of the irons is used. This is less conspicuous than the rubber, but it is scarcely in the power of the surgeon or patient to regulate the degree of force used, unless the spring is made undesirably expensive and complicated.

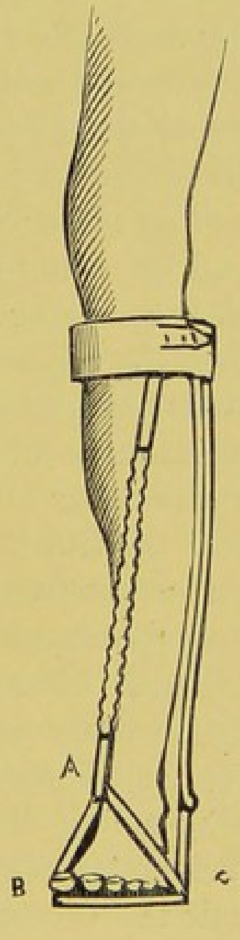


FIG. 55.—DIAGRAM OF ANTERIOR INDIARUBBER ACCUMULATOR WITH OUTSIDE IRON JOINTED AT ANKLE. NOTE.—According to the position of A in the stirrup B A C the pull has an inverting or everting action.

Exactly the same principles may be applied to the knee as to the ankle in paralytic cases, as well as the same materials and analogous mechanical arrangements. But there is not the same indication for them at the knee as at the ankle.

The force of gravity only acts to drag down the leg when the knee is swung forward, and that very act carries the limb clear of the ground. In the ordinary motions of walking, therefore, it is surprising how well many paralytics can dispense with any substitute for the quadriceps extensor. Almost all patients who are supplied with an elastic extensor for the ankle are delighted with it. On the other hand, those who get an elastic extensor for the knee are at first indifferent, and afterwards may cease to use it. The exceptions are those in whom the paralysis above the knee is so extreme that they have scarcely learnt to walk with the leg at all. And these get on better with a perfectly rigid knee, such as can be produced by a ring-bolt at the knee-joint of the irons, by a stiff leather case, or by arthrodesis.

When the hip as well as the knee is seriously affected, the patient either does not use the limb for walking at all, simply letting it dangle while he swings along with a crutch, or he adopts a peculiar and almost characteristic trick. He places his hand on the thigh, and so forces the limb into a stiff position of extension at each step. In cases like these the irons must extend at least up to the waist, and must be supplied with arrangements by which the patient can lock every joint when he is about to walk, and unlock it when he is going to sit down. The arrangement employed is generally the 'ring-bolt.' When the paralysis affects both sides the same principles may be applied as when it disables only one. As a rule the two sides are not affected in an equal degree, so that the apparatus are not required to be symmetrical. Even the most extreme cases are not beyond the reach of benefit from mere appliances. But such cases are specially suitable for *arthrodesis*.

Let us now turn our attention to what we have termed *the second class* of cases, namely, those in which *the range of passive mobility is in all directions abnormally great, but the active muscular control insufficient in every direction*, especially when the excess of passive mobility is considered.

The type of this condition is to be found in certain extreme forms of *paralytic talipes calcaneus* (see fig. 49).—It is the usual practice in such cases to fix the joint by some appliance, and usually the best form is that of side-irons, without any joint at the ankle. These are less expensive than irons provided with joints at the ankle, checked by what is called a front stop. When there is no power of either extending or flexing the foot at the ankle, it is a useless expense to provide a joint in the irons to permit motion in any direction. These observations, of course, do not apply to those cases of calcaneus in which there is some power of extending the foot, though not quite sufficient to keep the sole down and the heel up in walking. To these the principles already enunciated in treating of the first class of cases must be applied. For example, they may be supplied with a back stop at the ankle and a *posterior* rubber accumulator.

A different state of things obtains at the knee and ankle respectively in the second class of cases, now under consideration. The exigencies of the sitting position scarcely permit a rigid, jointless iron at the knee; a ring-bolt must be used. Arthrodesis may be performed.

There remain *the third class* of cases, namely, *those in which both active and passive mobility is limited in every direction.* This condition is not nearly so common as the others. The joints most liable to be thus affected are those of the foot. A minor degree is sometimes seen at the hip.

Even in these cases very important distinctions have to be made before deciding on treatment. Take, for example, the case of F. R. (see fig. 45). Is it really worth while to submit the patient or his friends to the expense of a complicated appliance, or himself to the inconvenience of preliminary operations to remove contractures, when the ultimate result will perhaps be that crutches will still be relied on and the limb disused as before?

In such cases the question of *arthrodesis* arises with regard even to *paralytic contraction of the hip.* The proper treatment is not instrumental, but operative. But the cases in which the limb is not so severely paralysed and not sensibly shortened are very suitable cases for instrumental treatment.

Operative Treatment in Infantile Paralysis.—Almost the only operation commonly practised for the relief of the deformities caused by the disease under consideration is tenotomy. Occasionally, but very rarely, a simple osteotomy may be indicated, or even a tarsectomy. In very severe cases amputation has been performed; and recently arthrodesis and tendon transplantation have come into fashion.

In the majority of instances of paralytic equino-varus, either a mere appliance with elastic force suffices, or, if operative measures are required, they stop at tenotomy of the tendo Achillis and of the extensor proprius pollicis. Sometimes the long extensor of the other toes is equally contracted. But it is generally advisable to refrain from dividing all these tendons. There is not enough to be gained by it. Sometimes the effect of an anæsthetic on these cases is very great, so that tenotomies which have seemed to be indicated are found to be quite unnecessary, as the foot is easily put into good position and fixed there; even severe cases yield to Thomas's wrench. For a month plaster of Paris may be used to effect fixation; afterwards, one of the appliances described elsewhere.

Another mode of operating applicable to the relief of certain paralytic cases must not be forgotten. Its object is to *shorten tendons* which are too long or relaxed. I do not know who first attempted this, but Mr. Willett certainly made a great stride in advance when, in 'St. Bartholomew's Hospital Reports' for 1880, he described the plan of cutting out the resected piece obliquely, and then, as it were, splicing the separated portions together.

In 1885 I performed an analogous operation on the muscular belly of the quadriceps extensor cruris.[1] As I have also had a fair experience of Willett's operation, and as the introduction of buried sutures has put this operation on a rather better footing, I shall take the liberty of describing my own way of doing Willett's operation, in preference to that originally described by him. The sole differences depend on the use of buried sutures instead of silver ones intended to be removed.

Operation.—First asepticise the foot. The patient being anæsthetised and prone, an assistant grasps the leg and foot,

[1] *Brit. Med. Journ.* 1885, vol. i. p. 880, on 'Buried Sutures.'

and holds the instep firmly down on the edge of a thick cushion. Every antiseptic precaution must be employed. Another assistant is ready to retract and sponge. Make a longitudinal incision an inch and a half long over the tendo Achillis, reaching down to about the same distance from the os calcis. Cut down to the tendon, which in these cases is exceedingly narrow and thin. The assistant should now flex the ankle as much as possible; then the surgeon fixes the tendon with a pair of artery forceps, or with a sharp hook, while he cuts from behind forwards and from above downwards, as obliquely as possible, right through the tendon. Next the assistant extends the ankle-joint, and the surgeon cuts, with as much accuracy as he can, through the lower segment of the tendon, in a plane exactly parallel to the first cut. Mathematical accuracy is far from attainable. I do not doubt but that if the tendon were simply divided transversely, and then the posterior surface of one segment and the anterior of the other carefully freshened, every purpose would be answered; but the connections of the tendon with its surroundings should be disturbed as little as possible.

The two ends, thus prepared for splicing, should now be united by three sutures of fine green (chromicised) catgut. The deep fasciæ should be united by finer sutures of the same material. Lastly, the skin should be sutured, the foot extended, and the dressings applied. If the wood-wool pad dressing be used, it will serve for a splint, but it must be thick enough and applied in such a way as to prevent flexion of the ankle. Esmarch's bandage facilitates the operation.

Resection of the Quadriceps Extensor Cruris in Cases of Infantile Paralysis with Inability to extend the Knee.—The steps of this operation are precisely analogous to those of the operation just described. The muscle being much broader and thicker than the tendo Achillis, the incision through the skin and fasciæ must be proportionately longer, and the number of sutures used to unite the muscle segments more numerous. The incision in the deep fasciæ should be closed with buried sutures. Dress as for resection of the tendo Achillis. Put up on a back splint, and keep the leg well elevated for a week; this prevents recurrent hæmorrhage from distending the wound, or any part of it, or soaking through the dressings, and also relaxes the muscle operated on. A month after the operation the use of electricity should be commenced.

It was afterwards attempted to reach the aim of this operation by displacing the tuberosity of the tibia, and with it, of course, the attachment of the ligamentum patellæ downwards.

Treatment of Paralytic Equino-Varus, &c., by Cross-splicing Tendons.—An ingenious operation was performed by Nicoladoni in 1882. The tendons of the tibialis anticus and posticus were made to reinforce the tendo Achillis by being sutured to it after being cut away from their own insertion.

Ten years later (October 8, 1892) Parrish described, in the 'New York Med. Journal,' a case in which he attached the proximal end of the extensor proprius pollicis to the distal of the tibialis anticus. In the same year, Drobnik, of Posen, published an analysis of sixteen cases of tendon grafting, and, as F. S. Eve says, in an excellent paper in the 'Brit. Med. Journal' for October 15, 1898, established the operation on a firm basis.

The operation of cross-splicing tendons for the relief of paralytic talipes has lately been practised by many London surgeons, *e.g.* Eve, Muirhead Little, Openshaw, and Tubby. The results, as far as I have had the opportunity of seeing them, have not been particularly good.

Perhaps this may be due to the fact that in severe cases the paralysis and mal-development are rarely confined entirely to one set of muscles. For example, in a well-marked case of paralytic equinus the gastrocnemius and other flexors of the ankle are generally weak and small, as well as the extensors. The best results may be expected when the paralysis is traumatic, and therefore strictly localised.

The improvement which takes place is brought about in several ways (Eve, *loc. cit.*).

1. By the muscular reinforcement given.
2. By the grafted tendon acting as a supporting band.
3. By weakening the antagonists (when the graft is taken from them).

And even when the patient cannot voluntarily put the displaced tendon into action, it will sometimes act involuntarily as soon as placing the foot on the ground gives a general stimulus to the muscles of the leg.

The operation can be varied in many ways according to the case, *e.g.* :—

Extensor proprius hallucis to extensor longus digitorum (for equino-varus).

A strip of the tendo Achillis to peronei (for equino-varus).

The latter operation may be combined with transplanting the tibialis posticus into the extensor longus digitorum.

Or the inner third of the tendo Achillis may be attached to the tibialis anticus, the outer to the peroneus longus (Vulpius).

The tendon of the tibialis anticus to the peroneus brevis, and that of the tibialis posticus to the extensor longus digitorum (Eve: case of equino-varus).

Peroneus longus to tibialis posticus (Openshaw: case of paralytic valgus).

Tibialis anticus and peroneus longus to tendo Achillis (myself: for paralytic calcaneus).

The exact procedure in each instance should be settled after a full consideration of the electrical reactions and other symptoms.

If part of a shortened tendon be taken for the graft, the remainder can be simultaneously by a simple operative procedure.

Operation.—Longitudinal incisions should be made over the points where the graft is to be cut free, and where the grafted tendon is to be reinforced, respectively. A small but sufficient longitudinal slit may then be made in the latter tendon (Goldthwaite's plan), and the transplanted tendon passed through this slit and secured with several catgut sutures. A way for it is, of course, made previously by some blunt instrument through the subcutaneous cellular tissue, and the tendon must be freed for some distance.

Analogous procedures may be employed in the upper as well as in the lower extremity. In the case of a hand in which the soft tissues had been burnt off the palmar aspects of the fingers, I amputated the ring-finger and transplanted the tendons, &c., of its dorsal aspect *en masse* to the palmar side of the middle finger. The case promises well, but not sufficient time (only two months) has elapsed to test the operation thoroughly.

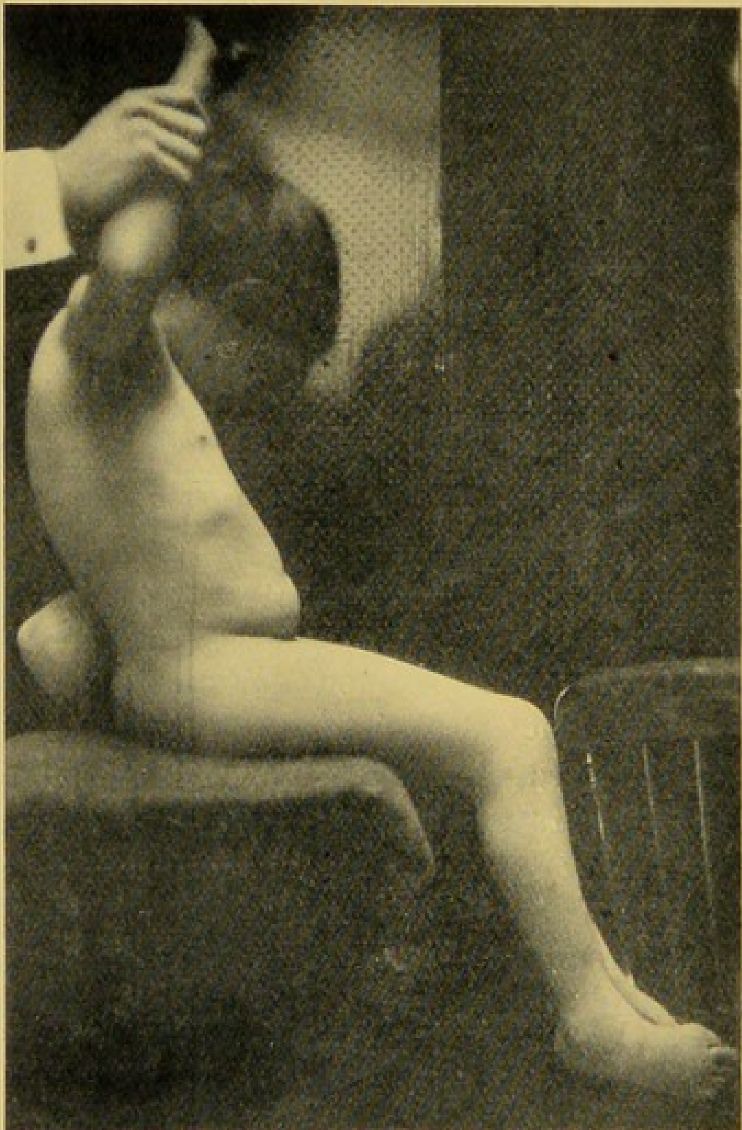


Fig. 56.—Talipes Equino-varus with Spina Bifida. Arthrodesis was performed in right ankle, after correction. On the left limb half the tendo Achillis was transplanted into the tibialis anticus, and the remaining half lengthened by zigzag slitting and sutures.

Indeed, a considerable time has usually to elapse after this class of operation before the results can be finally determined.

To *lengthen a short tendon,* in cases where mere tenotomy is thought to be attended with risk of non-union, a slit should be made down the middle of the tendon, and then one half of the tendon cut across transversely at one end of the slit, and the other half at the other end. If the two free ends are now sutured together, the tendon will be lengthened by the length of the slit, minus the overlapping caused by the suturing.

The upper extremity is more difficult to treat usefully for paralytic troubles than the lower, because it is easier to give artificial stiffness than artificially improved mobility.

All such appliances as leather shoulder-caps are useless. The strain upon the relaxed ligaments of the *shoulder* should be, as far as possible, taken off by a sling. But this indication is not an easy one to follow in practice, especially if, as usual, the patient is a young child.

If the muscles between the trunk and shoulder-blade are intact, arthrodesis of the shoulder-joint may be indicated.

When the extensors of the fingers are affected, a dorsal splint of leather, with joints opposite the natural articulations and connected by springs, is sometimes very useful. These springs may be of indiarubber, but are usually made of steel, either spiral or plain.

It is especially in dealing with the hand and fore-arm that it is worth while to spend a great deal of time on electrical treatment, even if the ultimate result is comparatively small. Even a slight gain may here be of considerable value.[1]

Arthrodesis is an operation which has, I believe, been but little practised for paralytic cases in this country until recently, except by Mr. Robert Jones, of Liverpool.

It may be defined as the artificial production of ankylosis for the purpose either of (1) stiffening a joint which is not held sufficiently rigid by its muscles, or (2) fixing in a convenient position a joint which some influence tends persistently to place in an undesirable one. Arthrodesis was invented by Professor Albert, of Vienna, in 1878, and may be said to have been introduced into this country by Professor Ogston when he devised his well-known operation for flat-foot.

It does not seem to me that there is any sufficient ground

[1] For Mr. Robert Jones's treatment of drop-wrist, see Appendix.

for removing from the class of arthrodeses operations which technically resemble excisions. The test of the nature of such proceedings is their immediate and remote object, not the greater or lesser amount of bone removed.

Nevertheless, when used without qualification, the term suggests the removal mainly of cartilage—the *refreshing* of the joint surfaces, in fact.

At first Albert used to wire the constituent bones together. But he does so no longer, and, except in certain cases, especially knee arthrodesis, wiring is superfluous. The only object served by wiring, pegging, nailing, or pinning is to preserve proper adjustment. None of these procedures usefully stimulate ossification, as they were once supposed to do.

Whatever be the joint concerned, in arthrodesis the following *operative technique* is generally followed :—

(1) The joint surfaces are reached by incisions similar to those for arthrectomy or resection.

(2) The ligaments are sufficiently divided to make visible the whole or greater part of the articular cartilage.

(3) This cartilage is removed. In so doing a sharp spud (or chisel curved on the flat at one end) will be found very convenient.

(4) Any bone which would interfere with proper adjustment is gouged or chiselled off.

(5) All fragments are carefully picked and douched out.

(6) *If necessary* for retention in correct position, wires or pins are inserted.

(7) The wound is completely closed, ample dressings, compressive bandages, and splints or plaster of Paris applied, the limb elevated (the foot of the bed if the joint be the hip), and the Esmarch's tourniquet removed.

Rochard, who gives an admirable account of arthrodesis, with references, in the 'Revue d'Orthopédie' for 1890, p. 115, says that Albert and Hoffa both recommend that the wound should be made to suppurate! Certainly Hoffa would not make such a recommendation to-day.

Before a joint can be fixed in a good position it has often to be placed there. Hence, especially in the joints of the lower extremity, arthrodesis is *often merely the final operative step of a series.* For instance :—

The head of the femur has to be brought forward and downward from a displacement in the reverse direction.

The knee-joint surfaces have to be so cut as to obliterate a genu valgum or a flexion.

At and below the ankle a club-foot or a flat-foot has to be reduced.

In the toes, a hammer-toe or a hallux valgus has to be corrected.

These special procedures will be noticed under heads to which they more particularly belong; *e.g.* 'Congenital Dislocation of the Hip.'

Concerning *the indications for arthrodesis* opinions are greatly divided.

It is wrongly stated that it does not interfere with growth, even when done in childhood, for much of the growth of the epiphyses takes place from the articular cartilage, though perhaps not sufficient to materially shorten a limb. Again, it is a serious loss even to a paralysed limb to lose the capacity even for merely passive extension or flexion. And excellent fixation can usually be got from appliances.

On the other hand, appliances wear out, break, and are a great source of trouble to the poor and of expense to the charitable. There are cases for which they are not particularly well adapted. Sometimes the tendency of deformities to relapse is too strong for them. And there are patients and parents of patients who cannot, or will not, do justice to appliances. Also, arthrodesis is not a dangerous operation.

When both lower extremities suffer from infantile paralysis, it is very advantageous to secure firmness in one of them by arthrodesis of the knee and ankle, and of the hip also in some cases.

In a case of this kind with very loose hip-joints I tried to produce anthrodesis by removing the cartilage from tbe acetabulum and femoral head. Osseous ankylosis did not take place, but there was increased firmness of the joint, possibly from adhesion of the bone to the capsule, and the patient benefited greatly by the operation, to my own surprise.

CHAPTER VI

SPASTIC PARAPLEGIA,[1] INFANTILE HEMIPLEGIA, AND OTHER PARALYSES AND CONTRACTURES OF CEREBRAL ORIGIN, OCCURRING BEFORE BIRTH, AT BIRTH, OR BEFORE ADULT LIFE.

General Remarks.—Spastic paralyses attack also adults, but as most of the cases which come for orthopædic treatment have commenced in childhood, and as the cerebral paralyses of childhood are of special interest, they should have separate consideration.

The common type of a spastic paraplegia may be described as follows :—

A child with

(1) An expression of head and face itself almost diagnostic—open, amiable, smooth, simple—doubly childish in fact. The term 'rabbit-faced,' which has been applied to it, is not inapt, but suggests something a little repulsive, whereas the look is rather pleasing than otherwise to those who do not know its significance.

[1] Sometimes called 'Little's disease,' especially by the Germans, after the late Dr. W. J. Little, who published a very graphic description of it.

(2) A difficulty in walking amounting often to total inability—a variety of cross-legged progression, the knees dragged stiffly round one another, the heels raised, the feet turned somewhat inwards, the knees generally bent.

(3) Spasticity,—the 'lead-pipe contracture,' as Weir-Mitchell calls it. The surgeon finds great involuntary resistance when he attempts to move the joints. This resistance can be overcome without causing pain (except when permanent shortening of tendons, &c., has taken place), but the limbs quickly return to their former positions. The adductors of the thighs and the muscles of the calves are chiefly affected.

(4) The reflexes are increased, except when strong contracture of the opponents has supervened. Then the muscles may respond sharply, even though the joint itself does not move.

(5) Post-paralytic movements may occur in the limbs, though they are more noticeable in the face or in the upper extremities (in diplegic and hemiplegic cases). Epileptiform convulsions are common.

(6) In many cases the intellect is weakened, either slightly, or severely even to idiocy.

Scarcely less important for the completion of the picture are certain negative details:—

A. There is rarely any true atrophy, although, as might be expected, the affected limbs do not usually develop quite to their normal size. In very exceptional instances hypertrophy has been observed (Gowers, Sachs).

B. The electrical reactions are normal.

C. Micturition is rarely affected.

D. The stiffness disappears under chloroform, except, in some cases, at the ankles when the calf muscles have undergone shortening.

The lesion is either congenital or has begun in early infancy, or, less usually, in later childhood.

Although the *cerebral origin* of such cases was long ago inferred from clinical data, it is only in the last fifteen years that strong pathological evidence has accumulated. Ætiologically, these cerebral infantile paraplegias have to be studied in connection with similar diplegias and hemiplegias.

The following scheme may be quoted from Sachs,[1] who goes very fully into the whole subject :—

Classification of Infantile Cerebral Paralyses, with Notes of the Pathological Conditions.

GROUP I.—Prænatal paralyses	Gross cerebral defects (true 'Porencephalien'). Hæmorrhage of intra-uterine origin (softenings ?). 'Agenesis corticalis.'
GROUP II. — Birth paralyses	Meningeal hæmorrhage. (Rarely intracerebral hæmorrhage.) Sequelæ: chronic meningo-encephalitis. Sclerosis. Cysts. Atrophies ('Porencephalien').
GROUP III. — Acute (acquired), *i.e.* post-natal paralyses	Meningeal hæmorrhage. (Rarely intra-cerebral hæmorrhage.) Embolism. Thrombosis (in marasmic conditions, and especially in syphilitic endarteritis). Consequences of these vascular lesions : Cysts, softening, atrophy, diffuse and lobar sclerosis. Chronic meningitis. Hydrocephalus (rarely the sole cause). Primary encephalitis (Strümpell) ?

In other words, Sachs, after a careful and extensive inquiry, concludes that the causes of acute cerebral paralyses in childhood do not essentially differ from those of the apoplexies of adult life.

Concerning the second group, it may be noticed that Little, many years ago, called attention to the occurrence of infantile cerebral palsies as a sequel of delivery by forceps, although he seems to have somewhat exaggerated the relative frequency of the action of this cause. Some of the birth palsies, indeed, may as reasonably be attributed to difficult labour itself and to the non-use of forceps. Sachs's observations go to prove this.

[1] 'Die Hirnlähmungen der Kinder,' Volkmann's *Klin. Vortr.* 46, 47, 1892.

In very few instances indeed is the paralysis noticed till long after birth, and then, of course, the cause can only be inferred.

A few positive observations of the occurrence of meningeal hæmorrhage in connection with delivery by forceps have been made, the first by Sarah McNutt.[1] *Post-mortem* examinations by Abercrombie and others point to an embolic origin in the cases reported by those authors. Gowers believed thrombosis to be more common.

Cysts, softening, atrophy, and sclerosis are doubtless secondary conditions, and have been often observed.

Lastly, there is the question of 'primary encephalitis.' It appeared to Strümpell, and to others also independently, that a rational hypothesis would be that most of these cases differed only from infantile paralysis in the seat of lesion, and that they really arose from the same primary infectious disease which is so liable to attack the anterior cornua of the spinal cord. The main argument against this theory urged by Sachs, who is strongly opposed to it, is the rarity with which cerebral palsies have been noticed in connection with epidemics of anterior poliomyelitis. I think the force of this argument is a little discounted by the possibility, or rather probability, that the first stage of such a cerebral affection would be more frequently overlooked or incorrectly diagnosed than the first stage of infantile paralysis. Complete loss of power with rapid wasting more quickly strikes the eye of the parent, or even the medical man, than spasticity without wasting; and convulsions are so common in infancy that, to the same observers, they suggest grey powders or a hot bath rather than reference to a specialist. Sachs himself quotes a report by Möbius,[2] in which two children in the same family were attacked simultaneously, one with typical poliomyelitis, the other with typical spastic cerebral paralysis.

The question I would ask is, May not most of these cases of spastic infantile paralyses be due to infectious brain disease of some kind, not necessarily identical with the cause of ordinary infantile (spinal) paralysis? The syphilitic cases

[1] *American Journ. of the Med. Sci.* vol. i. 1885.
[2] Schmidt's *Jahrbuch*, 1884, cciv. S. 135.

are obviously of such a nature. Mere presence of signs of old meningeal hæmorrhage is far from being a positive proof of traumatism, or, at least, of traumatism pure and simple. The history of these cases is generally obscure, and often unreliable, reminding one of the account frequently given by parents of the origin of tuberculous and other lesions now positively known not to be purely traumatic in origin.

In 225 cases Sachs found the localisation as follows :—

—	Boys	Girls	Total
Right hemiplegia	51	30	81
Left "	40	35	75
Diplegia	21	18	39
Paraplegia	22	8	30
	134	91	225

The disproportion between the sexes has not been found in some other collections of statistics.

The *hemiplegic cases* are at first sight so different from the others that the really close relationship is far from apparent.

In the former the observer is struck usually with—

(1) The dragging and stiffness of the affected leg.

(2) The awkward and constrained position of the arm, with elbow bent, fore-arm pronated, and fingers clasped over the thumb in the palm of the hand.

(3) The facial expression, and, in many cases, difficult speech.

(4) (Frequently) choreiform movements of the face and hand.

But the increased reflexes, the spasticity, the electrical reactions, &c., as well as pathological observations, demonstrate the nature of such cases.

The hemiplegias have two great advantages over the paraplegias and diplegias—they get about better, and they are not so liable to severe mental complications—*i.e.* to idiocy.

A peculiarity about the reflexes in hemiplegics is that they may be exaggerated on the sound as well as on the paralysed side.

Diagnosis.—Hemiplegias and diplegias of cerebral origin and commencing in infancy can scarcely be mistaken for any other affection, unless the paralysis almost wholly disappear and spasmodic movements lead to diagnosis of true chorea, or epileptiform convulsions to one of true epilepsy, or unless idiocy becomes the preponderating condition. In almost all cases of epilepsy, and in many cases, apparently, of chorea, one should search carefully for signs of old paralysis, for exaggerated reflexes, slight contractures, defects of speech, &c., and go carefully into the history, remembering the possibility in question.

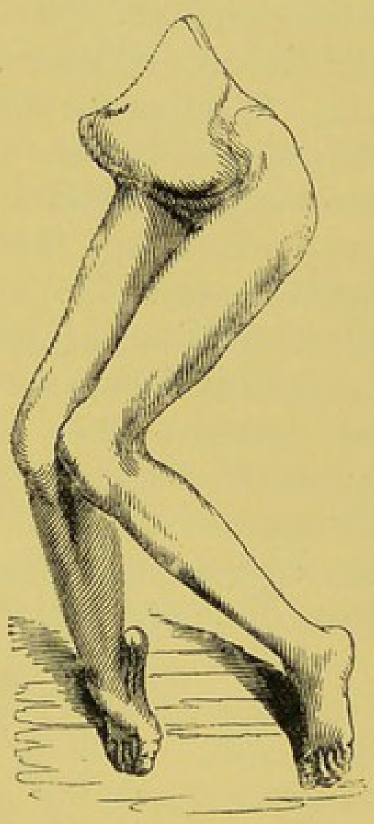


Fig. 57.—Illustrating Mode of Progression in an Adolescent with Congenital Spastic Paraplegia. (After W. J. Little, 'Lectures on Deformities.')

To give the diagnosis from infantile spinal paralysis would be simply to repeat the whole catalogue of symptoms, which form a contrast rather than a resemblance. Only in exceptional cases can there be difficulty. Then it is best to rely on the state of the reflexes.

Prognosis.—This concerns (1) life, (2) the paralysis, (3) the intelligence, (4) fits. Many young infants with cerebral paralysis die in a few months or years in a state of marasmus. Older children are in much less danger.

The paralyses, except in congenital cases, often diminish greatly, and even in part disappear; but some of those which remain, especially, as has been stated, those of the flexors of the leg and ankle, and, it may be added, those of the flexors of the elbow, the pronators of the fore-arm and the flexors of the hand, &c., are apt to give rise to contractures, which, when real, do not disappear under chloroform as the original spasms do.

The earlier in life the attack, the greater the risk to the mind; but it must not be forgotten that the diplegics and paraplegics suffer more in this respect than the hemiplegics.

Sachs's observations, which are in agreement with those of

Gaudard, Osler, and Wallenberg, indicate that about 45 per cent. of all infantile cerebral palsies are attacked with convulsions, that nearly 50 per cent. of the hemiplegias, 36 per cent. of the paraplegias, and 29 per cent. of the diplegias suffer in the same way. The Jacksonian type is rare, a fact which has an important bearing on our next section.

Treatment.—Of radical cure in these cases there is at present no hope. Nor can there be in the future, except from the very earliest diagnosis and the most prompt treatment. Whether we are within measurable distance of these it is not easy to say. Given the case of an infant which, after a difficult birth or instrumental delivery, shows signs of intracranial injury, it is likely that a careful study of it might lead to complete cure by operation. Of late years I have met with only one such case myself. A distinct cranial depression was present. Forceps had been used, but the surgeon was quite positive they had not been applied to the part depressed. Presumably, therefore, the injury was done by the narrow maternal passages themselves. I was only deterred from operating by the advanced stage of marasmus which the child had reached, and of which it died in a few

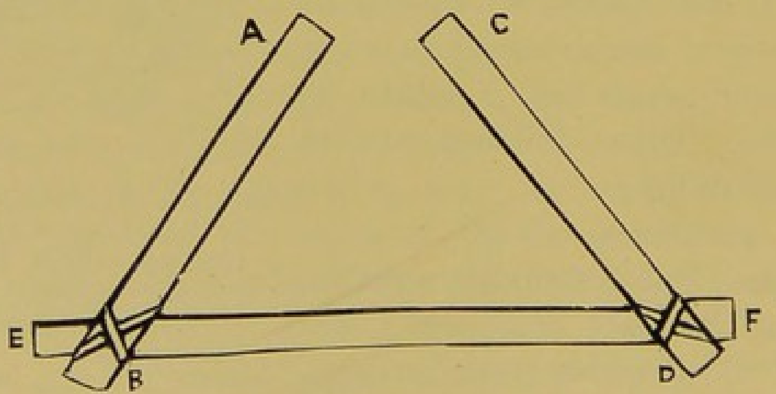


Fig. 58.—AB and CD are two Back Splints, each with a Footpiece, at B and D. EF is a Third Splint lashed to the others.

days after it came under my observation and a few months after its birth.

Apart from such considerations, it is practically convenient to deal with the treatment of paraplegias, hemiplegias, and diplegias separately.

Spastic paraplegias benefit by orthopædic treatment more than many persons think. The indications are to overcome contractures by tenotomy and myotomy, and to educate the affected limbs.

The adductors of the thigh and the tendo Achillis should be divided, and often the flexor tendons in the popliteal space. The last should be done through an open incision, the others subcutaneously.

It is not necessary to apply any special apparatus immediately after operation. The following arrangement suffices:

Place each limb on a back splint, which should reach upwards to the fold of the buttock, and have at the lower end a foot-piece.

Keep these back splints wide apart by lashing, strapping, or bandaging them to a third splint, in such a manner that the two back splints form a widely open inverted V, which the third splint converts into an A. Leave these splints on for a week. Then take them off, dress, and remove the sutures from the popliteal wounds, and commence daily exercises, replacing the compound A splint upon each occasion. At the end of the second week discard splints altogether and increase the time given to exercising.

The exercises should be as follows: The patient lies on his back. All the movements should be slow. The surgeon or nurse deals with one leg at a time. First he straightens it out completely in every joint. Then he flexes it in every joint. Then he abducts the thigh as far as the patient can bear it. Then he repeats these movements again and again. And he keeps urging the patient to watch carefully what is taking place, and to endeavour to assist the movements with his will. For a long time this endeavour will be made in vain; but the object of the exercises is precisely to make it ultimately successful. Experience has shown that this object can often be in a great measure obtained by perseverance.

Massage, properly so called, and electricity, are, to the best of my belief, of small value in these cases.

The patient must be supported and assisted while endeavouring to walk. When first put on his feet after operation he may seem more helpless than before. But by persevering in the educating process above described he will ultimately get over the weakness and begin to profit by the tenotomies he has undergone.

Months of patience may be required, but it is worth while to persevere.

Hemiplegias generally require orthopædic treatment of a somewhat different kind, and are more easily benefited by instruments, by massage, and by electricity. Contractured joints should be loosened by tenotomies, &c., and by manipulation they should be exercised in the manner just described; and either weakness or tendency to re-contract combated by appliances of the ordinary kind used for infantile spinal paralysis (*q.v.*).

Troublesome *choreiform movements*, of the hand and arm especially, may be advantageously checked by light leather splints and straps, which must be arranged to suit each particular case.

Diplegias and *monoplegias* require treatment on the same principles.

There are numerous transitional forms of these paralyses. In deciding on treatment, the degree of paralysis in each limb requires prime consideration. A diplegic case may be so little affected on one side as to be practically hemiplegic; or the upper limbs may have recovered so far as to reduce the case practically to paraplegia. Or the case may be so bad, either from degree of paralysis or from complications, especially of a mental kind, as to make orthopædic treatment hopeless.

The question of operation on the primary seat of disease itself arises occasionally, in hemiplegic cases chiefly, and is then usually brought forward by repeated epileptiform attacks.

A great deal, of course, depends on the probable or possible pathological condition. Defined and comparatively superficial lesions, such as cysts and cicatrices immediately on or beneath the dura mater, are specially suitable for operation. Gross cerebral defects, atrophies, and scleroses, are quite the reverse. There are, however, considerations which modify the hopes we may cherish of benefit, even in the former class of cases. A cyst implies a cavity in which it lies, and a cicatrix a deficiency of the part destroyed. An American surgeon has well said that where the lesion is a hole not much is to be hoped from cutting that hole larger ; and, further, the trouble which excites to operation is often due not directly to anything in the primary and cerebral seat of disease or injury, but indirectly to secondary degeneration descending from it, and altogether beyond the sphere of operative surgery.

Nevertheless, the universal indication remains to remove causes, especially if the secondary degeneration shows signs of being progressive ; and the experience of various surgeons, especially of Horsley in this country, shows that benefit does sometimes follow operation. What, unfortunately, still remains doubtful is how long such improvement may be expected to last.

The operation.—As a preliminary, the careful consideration of every point in the case indicative of the localisation of the lesion is imperative, and, it ought no longer to be necessary to add, the strictest preparations for guarding against septic infection. Horsley's method of exposing the cranium by turning down a flap should be preferred, and the flap should not be too small. In some of these cases an effective operation demands the exposure of almost the whole of that part of the motor area of the cortex which lies on the upper and outer surface of the hemisphere.

Apparatus for searching out or testing precisely the position of motor centres by excitement with the faradic current should be at hand, and the needles or poles should be scrupulously clean and aseptic.

This experimental localisation can sometimes be made with fair accuracy before the dura mater is reflected, and will then obviously help to determine the position and extent of that reflection.

The bone is removed either by the surgical engine, or by commencing with a large trephine and following up with cutting forceps, the chisel and mallet, and the occasional use of a Hey's saw. Free removal is essential.

The first indication with regard to cysts and cicatrices is to dissect them carefully out and remove them. But in the case of large cysts this may not be possible. They should then be emptied, and packed gently with iodoform gauze, which should have been preserved in 1–20 carbolic, and immediately before use should be pressed out in 1–2000 sublimate solution. This packing serves the objects of (1) possibly modifying the surface of the cyst, so as to check re-formation of its contents, and (2) preventing hæmorrhage. Whether iodoform gauze packing be used or not, the reflected flap or flaps should be replaced, a sufficient and valvular aperture being left for the removal of the gauze. In the absence of packing, the dura mater and the periosteum should be each closed by buried sutures of fine catgut, without drainage, and the scalp flap by sutures of silkworm gut. With packing, the suturing must be done several days (about three) after the operation. If sufficiently sharp needles be used, an anæsthetic will scarcely be necessary.

The dressings should be firm enough to support without pressing heavily, and should be kept accurately in place by the use of strapping *beneath* the bandages. Where strapping has to pass over hair, a single layer of bandage should intervene.

Cases occur in which, no definite lesion, such as a cyst or cicatrice, having been found, bone may be removed freely from the surface of the motor area and not replaced, in the faint hope of benefit from simple diminution of pressure.

Congenital Spastic Rigidity of the Limbs

Children are sometimes born with the limbs in a condition of spastic rigidity. This has been attributed by Erb and other neurologists to sclerosis of the lateral columns of the spinal cord. I do not suppose that much can be done in such cases, except to prescribe passive exercise and, in syphilitic cases, mercurial inunction.

CHAPTER VII

PSEUDO-HYPERTROPHIC PARALYSIS

Subjects of this affection are occasionally brought to the orthopædic surgeon, who often can do nothing for them, or at least nothing which is worth doing, if regard be had to the general

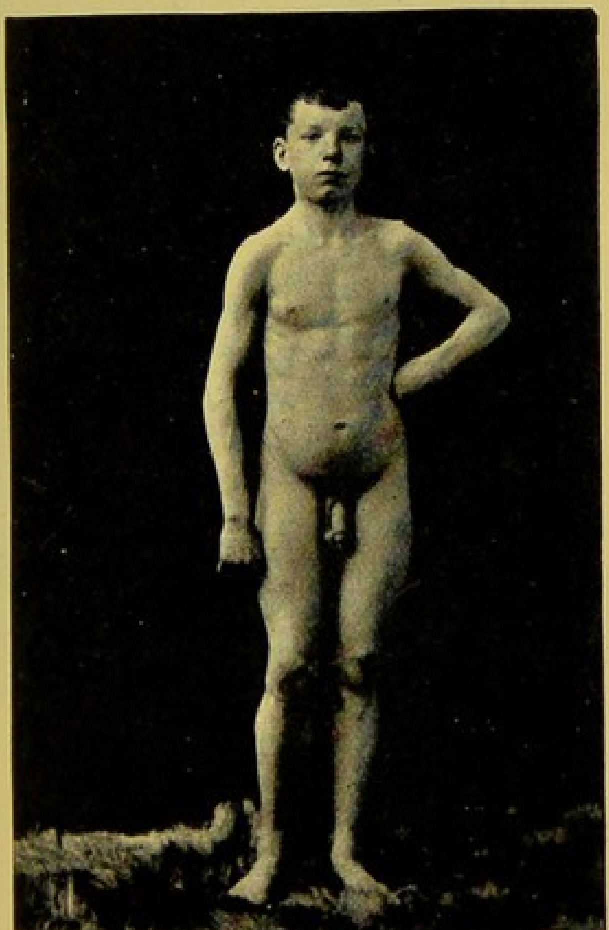


Fig. 59.—James R. (aged 16).

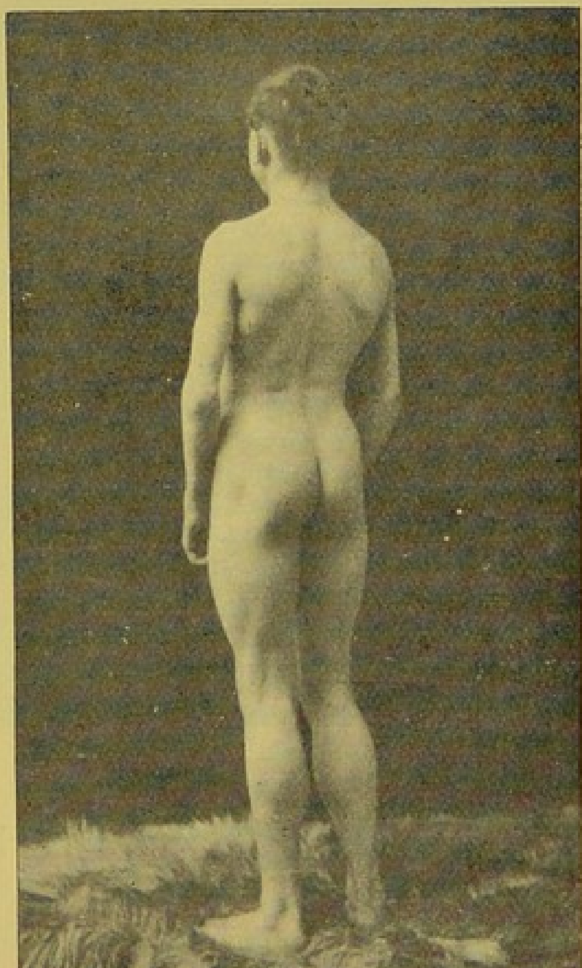
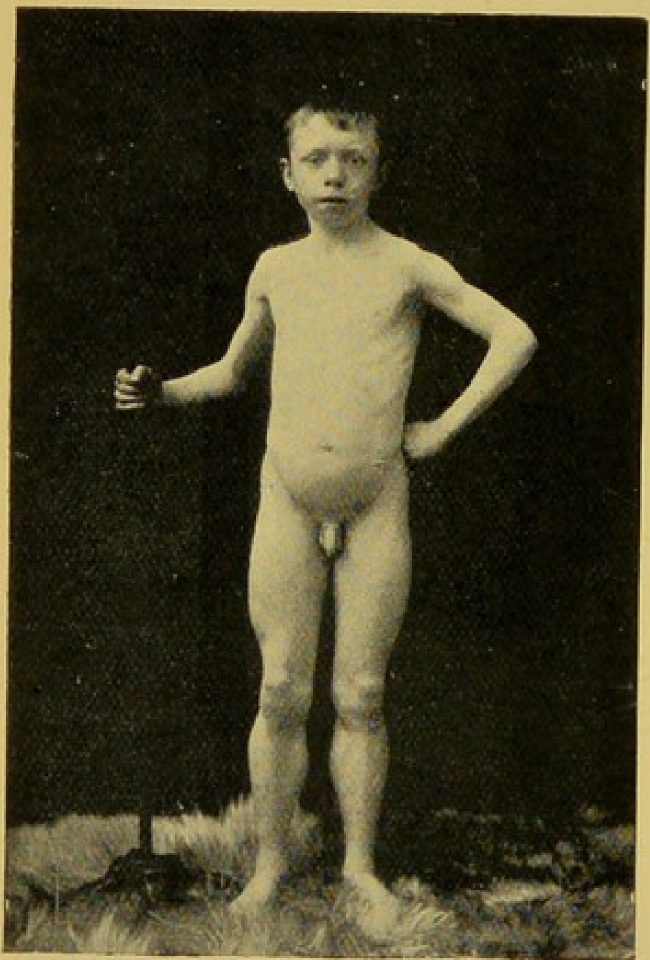


Fig. 60.—James R.

prognosis. Still, in some cases it is right to correct disabling contractures by tenotomy and myotomy. And, in almost all, massage and systematic movements and exercises may make the limbs more useful until the final stage arrives. And extremely rare cases have been reported in which arrest of the disease, and even cure, is said to have occurred.

The characteristic of this affection is loss of power in various muscles, combined with a pseudo-hypertrophy in some of them. Very commonly the calves are enlarged, while the pectoralis major and latissimus dorsi are wasted. The



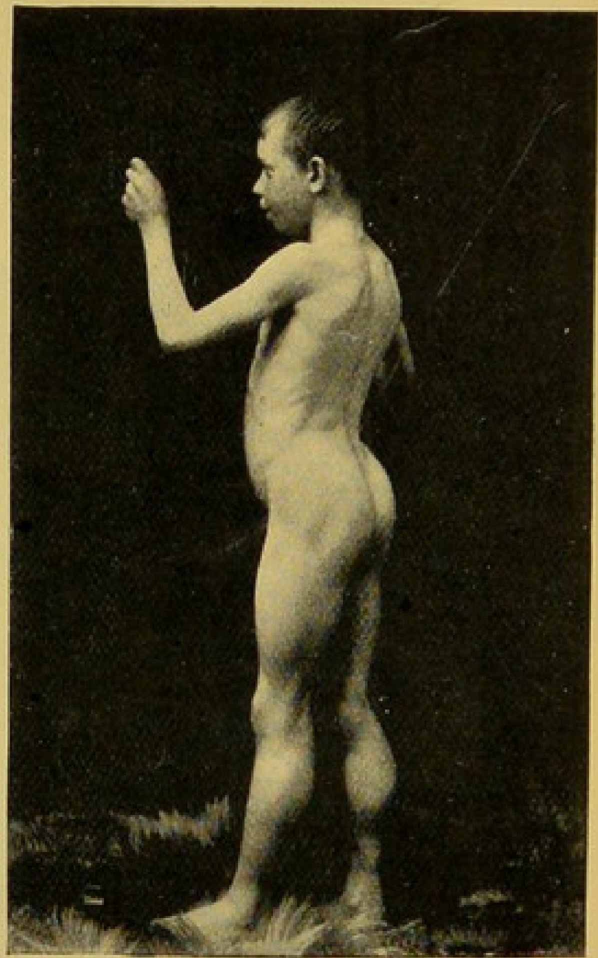


FIG. 61.—TOM R. (AGED 11). FIG. 62.—TOM R.

These four illustrations are from a very interesting and concise account of 'A Pseudo-hypertrophic Family,' by Dr. F. C. Coley, of Newcastle, in the 'British Medical Journal' for 1894, i. 399. (Photos by Messrs. Taylor.)

infraspinatus is one of the muscles often enlarged. Pseudo-hypertrophy of the infraspinatus with atrophy of the pectoralis major and of the latissimus dorsi is very significant.

The patient walks—if able to walk—with his legs apart, is apt to fall frequently, and rises again in a curious and well-known manner. First he gets on his hands and knees; then he straightens out his legs, thus raising his knees from the floor ; then he puts one hand on the corresponding knee, then the other hand on the other knee, lastly pushing himself up-right.

The reflexes are not increased, and contractures do not occur till the later stages. There is no spasticity.

Frequently more than one member of the same family is affected.

In the first paragraph of this brief notice it has been implied what the surgeon can do for some of these cases. He can ameliorate matters by dividing contracted tendons, and he can recommend passive exercises, assisted exercises, and massage.

CHAPTER VIII

FLAT-FOOT (TALIPES VALGUS)

This familiar affection often receives the name of talipes valgus, which was originally given to it with the idea that it constituted the direct antithesis of talipes varus. But the vast majority of cases of talipes valgus have no resemblance either in origin or essential nature to the vast majority of cases of talipes varus. While the latter are almost all either of congenital or of paralytic origin, paralytic flat-foot is comparatively uncommon; and though congenital flat-foot is found frequently when it is looked for, yet cases of it severe enough to require treatment come under the surgeon's notice very rarely in comparison with the frequency of flat-foot which has been acquired.

Flat-feet may, first of all, be divided into non-congenital and congenital. The former are sometimes called 'acquired,' or 'static,' or 'inflammatory;' or even the physical appearance of the foot is ignored in their nomenclature, and they are named 'tarsalgia,' or 'tarsalgia of adolescents.' All the above terms, except 'acquired' and 'non-congenital,' convey a one-sided, if not a false, idea of the nature of the disease, as will be shown presently.

Congenital Flat-foot

The arch of the foot varies in individuals, in families, and even in races. About a comparatively flat-foot thus inherited there is nothing pathological. The term 'pes planus' is often applied to this condition, and the Germans speak of it as 'der platte Fuss,' calling the more serious, non-congenital condition, 'Plattfuss.' Certainly the negro, and possibly the Jewish race, are comparatively flat-footed; but well-

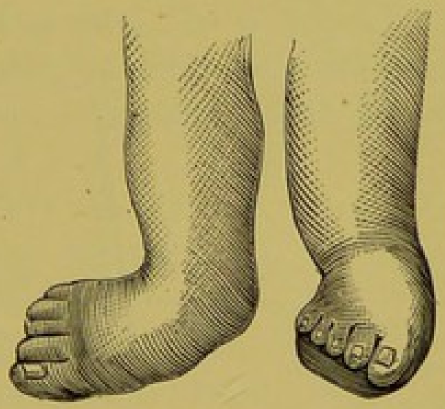


Fig. 63.—Congenital Flat-foot. (After William Adams.)

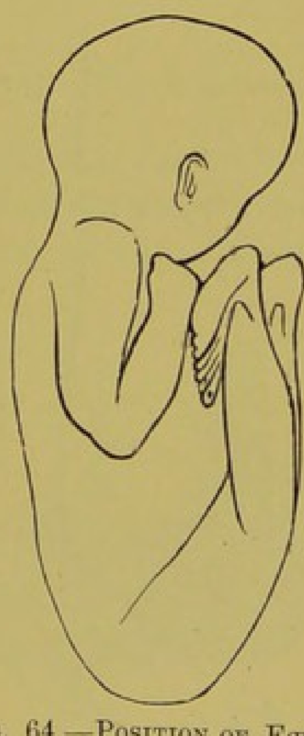


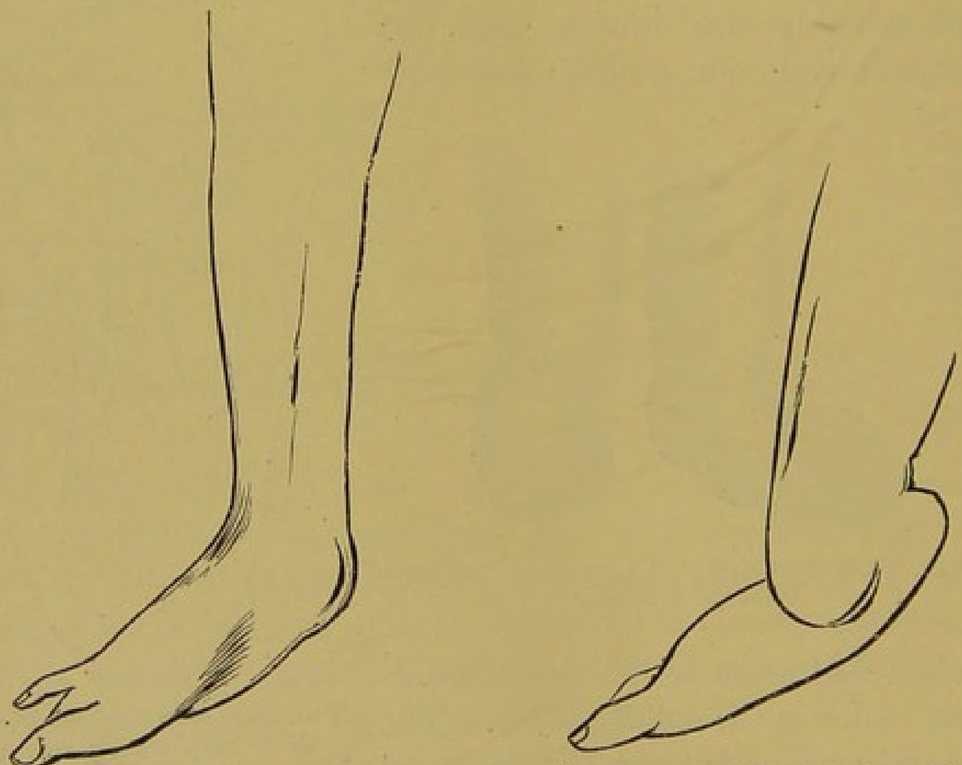
Fig. 64.—Position of Fœtus in Utero which may lead to Congenital Talipes Calcaneus with Flat-foot. (Parker and Shattuck.)

arched feet seem to me not uncommon among London Jews. The general opinion is that in almost all infants at birth the foot is flat. But Dr. John Dane,[1] who took tracings of the footprints of 400 children, of ages ranging from nine days to fourteen years, writes that 'there seems to be, on the contrary, a distinct arch in the feet of most infants, better formed in one foot than the other,

[1] *Boston Med. and Surg. Journ.*, October 23 *et seq.*, 1892.

and persisting until they are about eighteen months old. In this period the difference in the arch of the foot between males and females is not noticeable. After eighteen months there begins to be a distinct breaking down of the arch, which in most cases is wholly lost, the two feet suffering equally. For the next year and a half the feet remain distinctly flat; yet even during this period isolated tracings appear in which the arch is never lost.' Such cases are 'always females.' 'During the third year the arch is slowly rebuilt, one foot improving before the other, and the females considerably earlier than the males.'

The value of these very interesting and remarkable observations is diminished by the number of infants and very young children examined not being given, and by the fact that they



FIGS. 65 AND 66.—CONGENITAL FLAT-FOOT WITH DEFICIENCY OF FIBULA AND OF TOES. Note the mark on the front of the shin, where the toe is said to have lain at birth.

all belonged to the poorest class, staying in hospitals, nurseries, and orphan asylums, while many probably suffered from rickets. Dr. Dane says the rachitic foot seems to have an inner arch quite as high as the normal, and an outer arch much higher But that is only one form of rachitic foot.

The skeleton of the infant's foot is so thickly covered with soft tissues as to make the correct determination of its form difficult.

The most marked cases of valgus of the foot and ankle of the newly born occur in conjunction with either talipes calcaneus or with rudimentary development of the fibula (see figs. 65, 66, and 88).[1] In a case of the latter described by Volkmann about 1872 or 1873, seven out of thirteen members of the same family were affected.

A curious feature of the cases with rudimentary fibula is the mark on the inner and front part of the shin. It is said to have been caused by the toe lying there in utero.

Holl[2] says that congenital flat-foot is sometimes due to cartilaginous union between the os calcis and the scaphoid.

Acquired or Non-congenital Flat-foot (Pes Valgus)

Symptoms.—In a typical, well-marked case, the hollow of the instep is obliterated and the foot lies flat upon the ground from heel to toes. The posterior half of its inner border, instead of being straight, is convex, bulging strongly at the seat of the astragalo-scaphoid joint, *i.e.* below the front of the inner ankle. The head of the astragalus and the tuberosity of the scaphoid form a prominent and solid projection, which not unfrequently leads the inexperienced into a diagnosis of 'disease of the tarsus.' The toes are extended and straight, unless hallux valgus coexists, and, in marked cases, the heel tends to be raised (forming a kind of equino-valgus). The

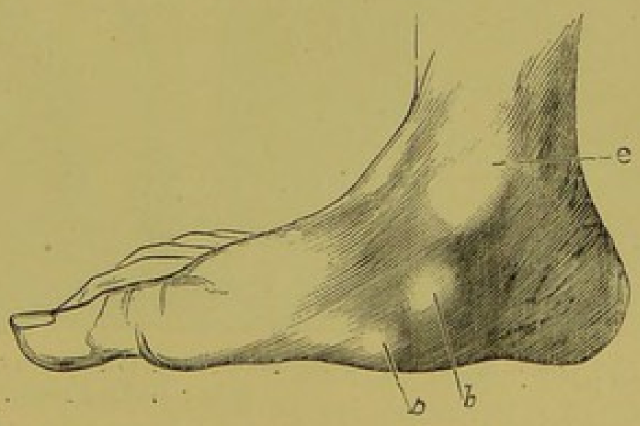


Fig. 67.—Non-congenital Flat-foot (Schreiber). *b*, head of astragalus.

[1] See also Wagstaffe's case, *Journ. of Anat. and Physiol.*, 1872; and Bidder, *Langenbeck's Archives*, 1888, p. 582.

[2] *Med. Record*, 1881, p. 113, and *Langenbeck's Archives*, xxv. 925.

front of the foot is flattened out, and often broad-looking. The inner ankle is prominent.[1]

The sufferer walks without elasticity, something like a person in a pair of slippers down at heel. He turns his toes out—out of the way, as it were. He soon tires.

The foot is generally colder than normal, and the veins of the leg are large—sometimes varicose. The association of

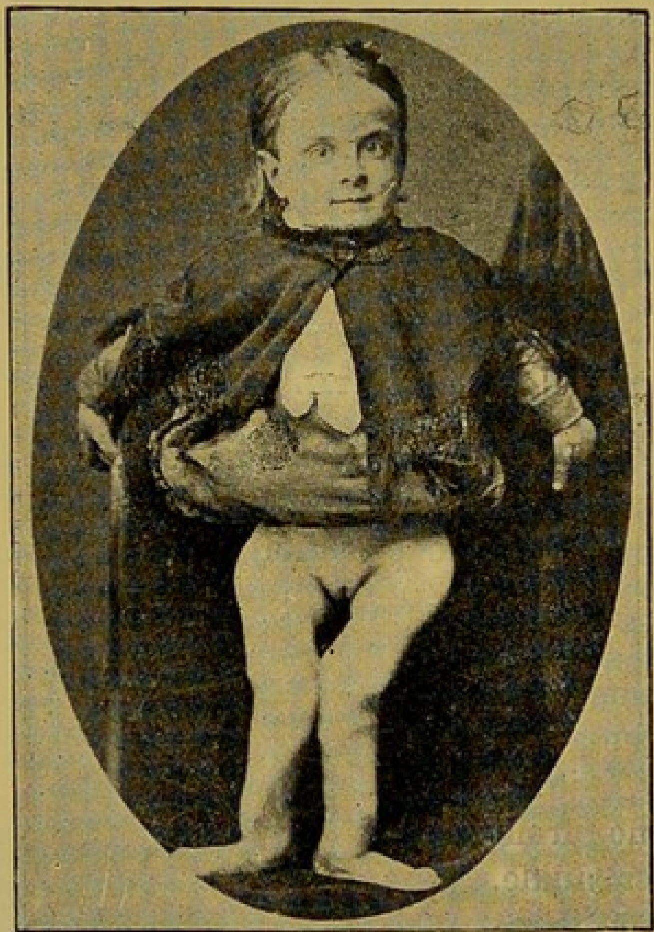


FIG. 68.—RACHITIC FLAT-FOOT IN A CHILD WITH SEVERE GENERAL RICKETS (after Luke Freer).

varicose veins with flat-foot was pointed out by Stromeyer. The calf of the leg is wasted, because so little use is made of its muscles.

The amount and position of the pain are variable, according to the stage as well as the degree of the affection. The pain

[1] Talipes valgus must not be confounded, as it often is, with the distinct, though frequently associated condition, valgus of the ankle. The latter may coexist with either talipes valgus or talipes varus, or with an almost normal foot.

and weakness are so great while the complaint is actually progressing that, as above mentioned, flat-foot is sometimes named 'tarsalgia.' But the stage of pain will often disappear spontaneously, and often not return until the patient's weight, increased by age and obesity, throws a further strain on his feet. The commonest seat of pain is not the sole near the calcaneo-scaphoid ligament, but rather that part of the

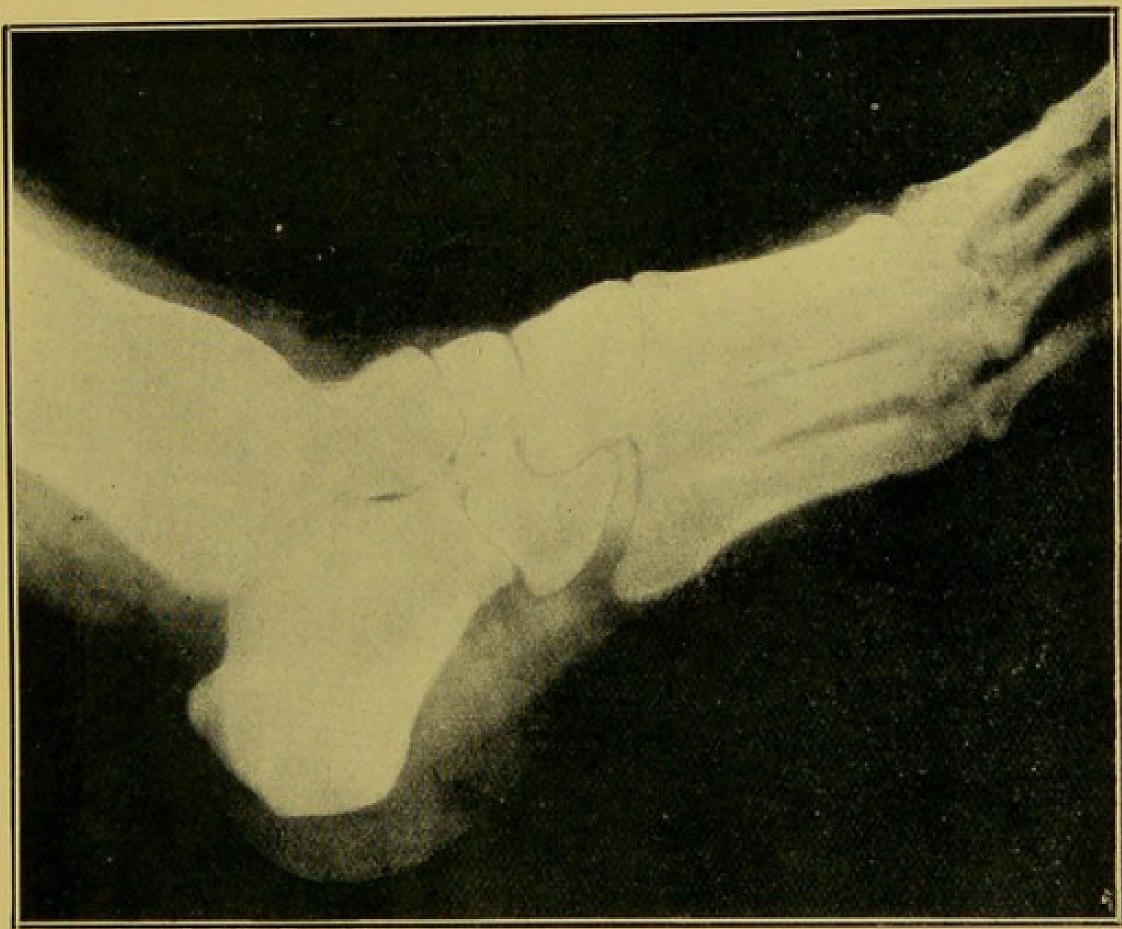


Fig. 69.—Skiagram of Normal Foot (taken by Dr. F. H. Low). Note the well-marked outer arch (*i.e.* angle formed by the calcaneum with the cuboid and base of metatarsus).

dorsal and outer aspect of the foot adjacent to the outer malleolus. Lücke says that the pain usually shows itself first in the astragalo-scaphoid joint. However that may be, I am satisfied that more patients, when they come for treatment, complain of the other situation. Pain is sometimes felt near the metatarso-phalangeal joints. The most curious situation is the heel, and there are cases where pain is felt nowhere else but there. The surgeon must then beware lest he fail to recognise the true nature of the case.

The character of the pain is usually a typical 'ache,' seldom a 'burning.' Whether its exact seat is in osseous or fibrous structures, and, if the latter, which (*e.g.* ligaments, aponeurosis, or tendons), cannot be determined.

The range of motion of the various joints, including the ankle, becomes lessened. In the severest cases ankylosis

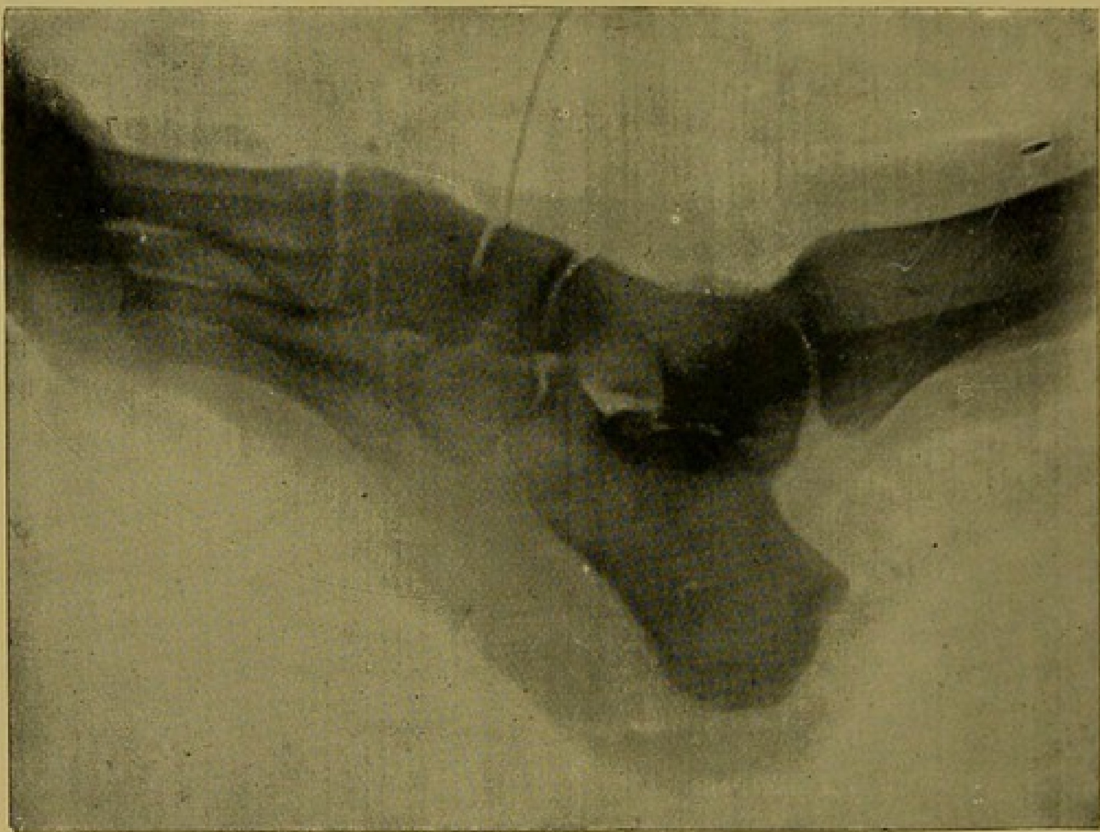


FIG. 70.—SKIAGRAM OF FLAT-FOOT. CASE OF C. T., A YOUNG WOMAN. SHOWS FLATTENING OF OUTER ARCH (skiagram by Dr. Harrison Low).

sometimes occurs. Of course all these evils are not developed suddenly and completely. Flat-feet exist of every degree of severity, and may remain for years, or even for a lifetime, stationary at whatever stage they may have reached. Often the first symptoms noticed are the pain and the easily induced fatigue. Sometimes it is the peculiar gait. Seldom is it the change in the shape of the foot. In children the projection of the inner ankle is apt to excite early attention. It is best seen from behind.

DIAGNOSIS.—In the commencement the pains of flat-foot may be mistaken for neuralgia, especially when the pain is in the heel. But neuralgia of the foot is very rare, and careful inspection of the foot will discover some slight alteration in its shape if it is really a case of incipient flat-foot. Also, it will be found that the pain is relieved by rest and brought on by exercise.

At a later stage the projecting head of the astragalus, with the adjacent scaphoid, is sometimes mistaken for bony enlargement due to struma or to rheumatism.

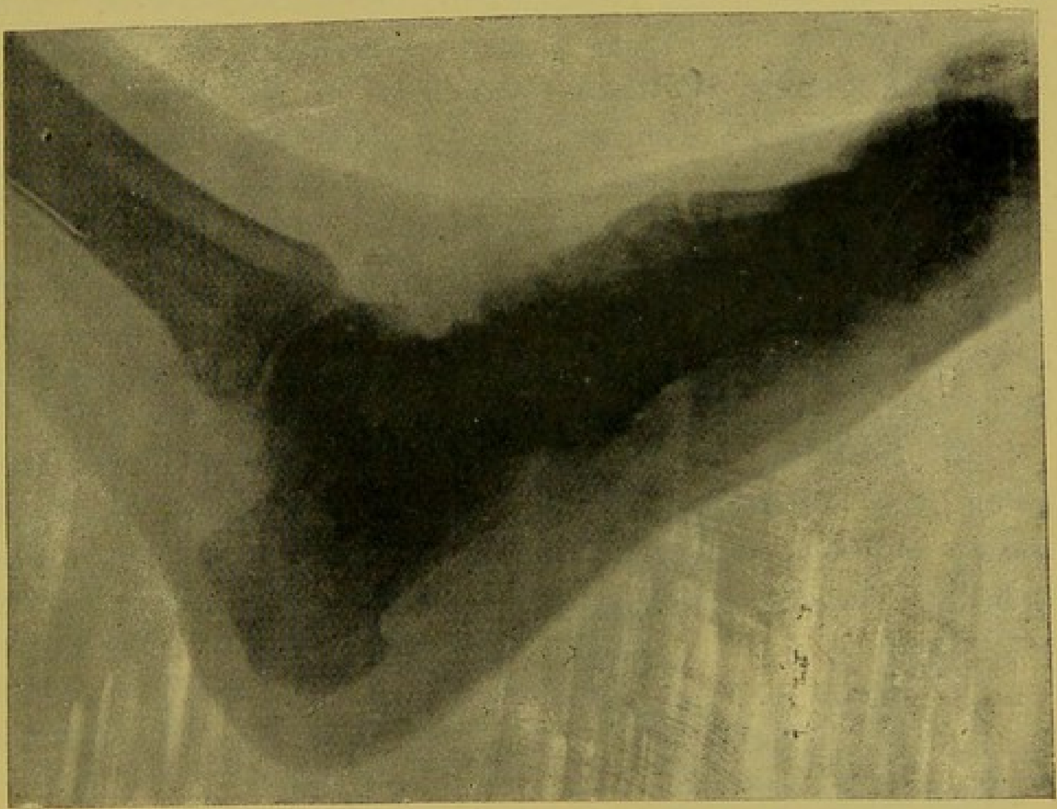


FIG. 71.—OTHER AND WORSE FOOT OF SAME PATIENT (skiagram by Dr. Harrison Low).

Prominence of the head of the astragalus and tuberosity of the scaphoid, appearing first during adolescence, is immeasurably more likely to be due to flat-foot than to strumous disease or to rheumatism. The coexistent sinking of the plantar arch, flattening, with sometimes increased breadth of the foot, and tendency to slight equinus, usually confirm the diagnosis. The swelling is neither hot nor tender, as in tubercular disease, and there is seldom any history of chronic rheumatism in the foot; though rheumatic fever does occasionally precede flat-foot.

ANATOMY.—There is a very general impression that the chief anatomical feature of flat-foot consists in a lengthening of the inferior calcaneo-scaphoid ligament, and that the consequent relaxation permits the arch of the foot to sink in.

Symington writes that in a well-developed foot, in which the muscles had been dissected, but the ligaments were still entire, he divided the ligament and made firm pressure, through the tibia, upon the astragalus, and that this failed to produce any abnormal displacement of the astragalus. Von Meyer measured six normal and five flat feet, and found no lengthening of the ligament in the latter. It is true that a lengthening has been found, by a different system of measurement, in at least one case, but no one pretends that relaxed ligaments *cannot* coexist with flat-foot.

The most striking anatomical features of this malady are (1) the alterations in the shapes and relative positions of the bones and of certain joint surfaces, and (2) not a lengthening, but a shifting of certain ligaments.

The head of the astragalus becomes prominent on the inner aspect of the foot and sinks downwards. The scaphoid moves outwards and upwards from its usual place on the head of the astragalus, and in so doing does not stretch

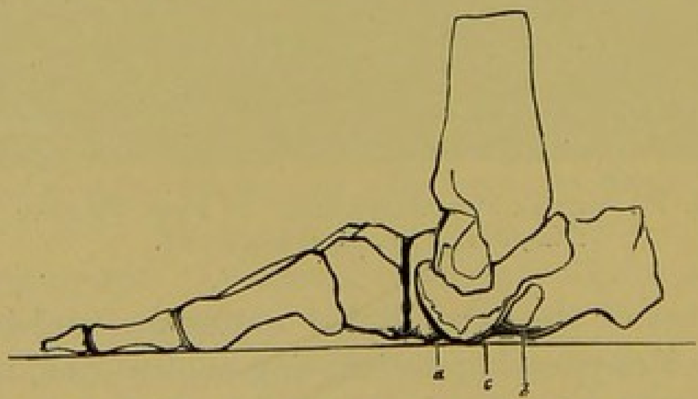


FIG. 72.—VIEW FROM INNER SIDE OF BONES OF FLAT-FOOT (Lorenz). *c*, inferior calcaneo-scaphoid ligament.

the calcaneo-scaphoid ligament, but, as it were, *takes with it the calcaneal insertion of that ligament, which tends to become greatly thickened.* The joint-cartilage on the head of the astragalus alters its position and shape to adapt itself to the new relations between the two bones.

A prominent angle divides the surface of this cartilage into two parts, the upper and outer corresponding to the scaphoid, the lower and inner to the inferior calcaneo-scaphoid ligament. The larger the latter in proportion to the former, the worse the flat-foot. The head of the astragalus is directed abnormally downwards and inwards. While the axis of its trochlear surface normally runs, if extended, between the second and third toe (Symington), in severe flat-foot it may pass internal to the ball of the great toe. The outer part of the astragalus neck is much shortened, and there rises up from it, in many cases, a bony crest, which seems to be analogous to the osteophytic formation seen often on the thinner sides of the wedge-shaped vertebræ in scoliosis. This crest tends to check the progress of the deformity.

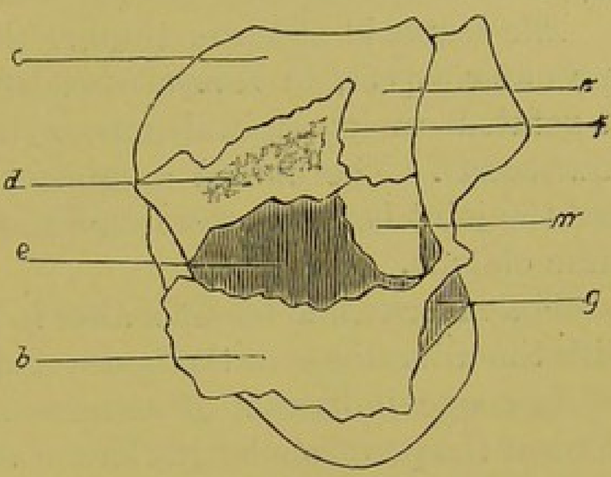


FIG. 73.—ASTRAGALUS FROM A SEVERE CASE OF FLAT-FOOT (Lorenz). UPPER AND INNER ASPECT.

The cartilage is perfect at c, defective at d and at m; b is wholly in front of the ankle-joint.

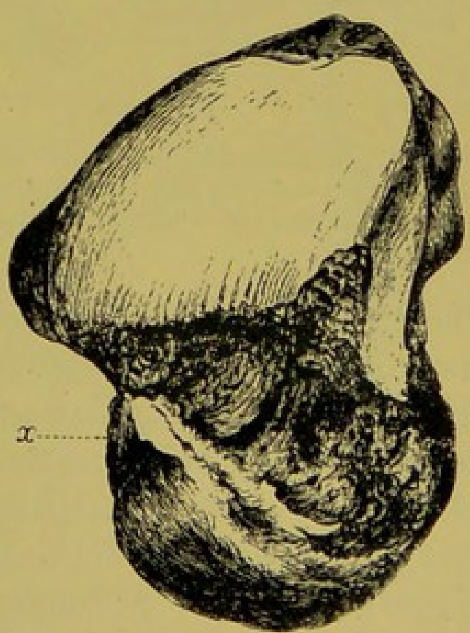


FIG. 74.—ASTRAGALUS IN FLAT-FOOT (Schreiber); shows in a less diagrammatic way the same features as the preceding figure.

The cartilage on the surface articulating with the inferior calcaneo-scaphoid ligament tends to degenerate, and ultimately to disappear, the ligament sooner or later becoming practically periosteum. A last stage of this process ends in ankylosis of the three principal tarsal bones (see figs. 75 and 76, from Chaput).

The scaphoid becomes thinner than normal on its upper and outer aspect, in severe cases strikingly so, and seems to be rotated on its sagittal axis, so as to bring its tuberosity downwards. The cuboid approaches to the outer malleolus, and the joint between the inner and middle cuneiform grows more oblique.

The muscles and tendons alter in length, in correspondence with the alterations in the bones and joints.

In congenital cases of extreme severity the several insertions of the peroneus longus have a very abnormal appearance.

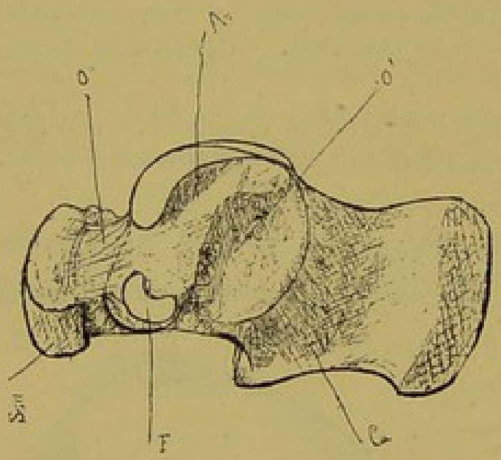


Fig. 75.—Astragalus, Scaphoid, and Os Calcis forming one Bony Mass. (From a case of Flat-foot. After Chaput.[1])

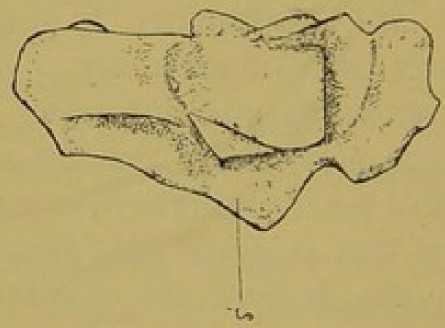


Fig. 76.—View of Chaput's specimen from above.

The illustrious Duchenne, and, after him, many of his countrymen, have held that flat-foot is due to paralysis of this muscle, while Henke blamed the tibialis posticus. That flat-foot does occur of paralytic origin is indisputable ; but those cases whose origin is certainly paralytic are strikingly different in symptoms, in history, in progress, and in the age and appearance of the sufferers from the great majority of cases of flat-foot, whose relationships, it may be repeated, are not with the subjects of infantile paralysis, but with those of scoliosis and genu valgum. That the muscles should waste and degenerate when the deformity of the foot and ankle is severe is natural. During the painful stage they sometimes,

[1] *Le Progrès Médical*, 1886, p. 857.

probably from reflex irritation, tend to give to the ankle and tarsal joints a rigidity which can be removed by anæsthesia, either general or local.

The natural development of the arch of the foot is often attributed to the action of the muscles. I do not know what are the proofs that the joints and bones are pulled into shape by the normal muscles. What muscles arch the Roman nose ?

A person may suffer from a slight degree of flat-foot unknown to himself until the characteristic pains are evoked accidentally; *e.g.* by some traumatism, or by prolonged exertion following insufficient exercise. This was noticed in a gentleman after a 'partially ruptured soleus' had been treated by plaster of Paris, and is sometimes observed in connection with corns, which disturb the gait and over-fatigue certain muscles, especially the peronei.

The os calcis.—This bone is described as being 'rotated' inwards. It is, I think, rather moved outwards in the circumference of a circle whose centre is at or close to the ankle-joint. This is well seen by inspecting a living patient from behind. Only its internal tubercle and its anterior tubercle transmit the body-weight to the ground. The external tubercle is raised out of contact with the ground. Like the astragalus, this bone has its long axis inclined abnormally inwards and downwards. The sustentaculum tali diminishes in size and tends to lose its cartilage and its shape. The astragalo-calcaneal joint gapes somewhat posteriorly. A new facet forms on the outer surface of the os calcis for articulation with the blunted point of the external malleolus; *so that in severe cases the body-weight is transmitted in great part directly through the fibula to the os calcis.* This arrangement and the above-mentioned crest on the upper and front part of the shortened astragalus neck tend to

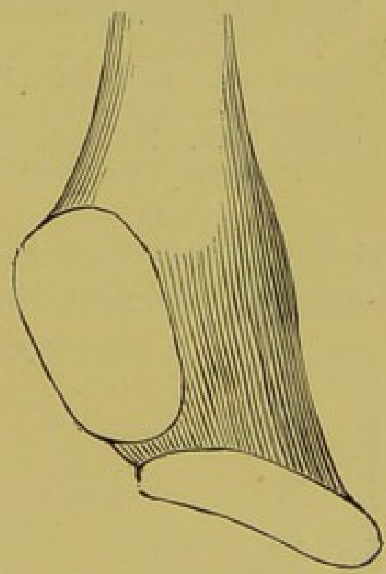


FIG. 77 SHOWS NEW ARTICULAR SURFACE ON TIP OF OUTER MALLEOLUS FOR ARTICULATION WITH OS CALCIS (after Chaput).

put a natural check on the advance of the deformity, and help to enable even the severest cases to walk.

Etiology.—Non-congenital flat-foot almost always attacks young people either at or near the period of adolescence, and especially those engaged in some occupation which requires much standing or walking, or carrying heavy burdens. Hence errand-boys, porters, locksmiths, waiters, servant-maids, and shop-girls form a large proportion of the sufferers. Still, only a minority even of such people acquire flat-foot. This influence of occupation has been grossly exaggerated, and the necessity of some predisposing cause is pretty generally granted. Until lately it has been the custom to give muscular 'weakness,' or 'relaxation,' or 'flabbiness,' as the predisposing cause in question, and the difficulty presented by the fact that large numbers of those who suffer are neither weak, nor relaxed, nor flabby, while many who escape are very weak, &c., has been got over by asserting that the strong-looking. firm-fleshed young folk with flat-foot have really had the affection from childhood or infancy, but have only begun to be troubled with it when they undertook some extra labour. Neither in books nor in clinical work have I seen evidence of this view being anything but a manufactured one, made to fit a theory.

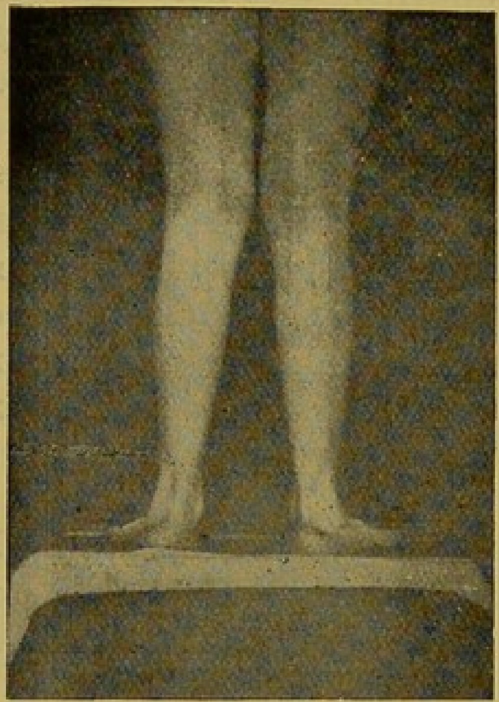


Fig. 78.—Severe Flat-foot with slight Knock-knee (from a photo by Dr. James Allan of a girl aged 14). Posterior View. Note valgus of left ankle and angle formed by heel with leg.

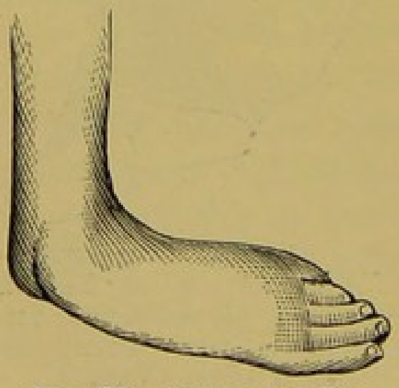


Fig. 79.—Paralytic Pes Valgus (after Wm. Adams).

Flat-foot occurs in persons of the same age as those who suffer from genu valgum and lateral curvature, and I agree with those pathologists who believe that all these varieties of deformity are of rachitic origin. Or, rather, I would put it that their essential cause is an unnatural liability of the bones to grow into defective shapes, either spontaneously or under the influence of statical and dynamical forces which would scarcely, if at all, deform a healthy individual. And it is certain, as may easily be seen, in connection with both genu valgum and scoliosis, that the liability to deformed growth, though strongest near epiphysial and diaphysial cartilages, yet affects interstitial growth and that of the whole extent of the bone.

As a matter of fact, a not inconsiderable number of young children with rickets develop flat-foot as an obvious and indubitable part of that affection. The *rachitic flat-foot* of young children is, I believe, universally regarded as an affection primarily of osseous, and not of muscular or ligamentous origin.

The commonest cause of *traumatic flat-foot* is fracture of the upper bones of the ankle-joint; and the chief anatomical peculiarities (mal-union or non-union of the tibia and oblique union of the fibula), and a consequent subluxation of the whole foot outwards, bringing its inner border to the ground.

Traumatic talipes valgus, or flat-foot, has usually, therefore, its anatomical seat *in* and *above* the ankle-joint, while ordinary flat-foot presents changes principally *in* and *below* the ankle-joint.

Both varieties are liable, especially in middle-aged people, to become complicated with rheumatoid arthritis of the altered joints. It is not always easy to judge which has been primary, the flat-foot or the rheumatism (gonorrhœal or otherwise).

PROGNOSIS.—So far as the *shape* of the foot is concerned no improvement whatever can be expected to occur spontaneously, except in young children. The mechanical conditions, and especially the action of the weight of the body pressing down on the arch of the foot during the acts of walking and standing, tend powerfully in the opposite direction.

Nevertheless, most cases of flat-foot stop short of the extreme degree and remain stationary for years, or for life, at a certain point.

With regard to the pain, that has a striking tendency to ultimately pass away, often without treatment.

With the pain goes most of the disability, and when exercise again becomes painless and possible, strength rapidly returns.

But the style of the gait is permanently more or less spoiled.

As with lateral curvature and with genu valgum, the patient may get along well for years, only to relapse in middle age or advanced life. Such relapses, in cases either of genu valgum or flat-foot, are usually associated with increase of fat and body-weight. The painfulness, disability, and tendency to be quickly fatigued once more drive the patient to seek medical advice.

The prognosis, when modified by treatment, may be fairly stated as follows: There is no complaint more easy to palliate and there are few more troublesome to cure, at least without operation. By the word 'cure' is to be understood a satisfactory removal of the deformity and a restoration of the arch.

Treatment.—Individuals who have no pain or disability, who walk and run powerfully and well, but who have feet with arches less marked than the average, need no treatment at all. They are very numerous, and their condition has probably nothing pathological about it.

On the other hand, cases in which pain is felt, or weakness, or in which the gait is affected, cannot be treated too promptly, as pathological flat-foot is, up to a point varying with each person, progressive, and easier to check than to cure.

Traumatic flat-foot is not very amenable to the treatment we are about to describe, and will be referred to separately afterwards.

The indications in most cases of flat-foot are:

1. To mechanically support the plantar arch both when the patient is at rest and in motion.

2. To train the muscles to assist in supporting the plantar arch when the patient is in motion.

3. To relieve pain.

4. To treat the causes of the affection, when they can be discovered.

5. To resort to active measures to restore an obliterated arch, or to stiffen the astragalo-scaphoid joint, or to cure in-ankle when the case demands it.

Indication 1.—Its fulfilment is attempted by a great variety of appliances.

One of the simplest and the one in most common use is the valgus sole, made of steel covered with leather.

It ought theoretically to be a spring, but the flange rising up on its inner side stiffens it and destroys any spring it would otherwise possess. This is a defect; and it is very doubtful whether compensating good arises, because a case of valgus sufficiently pronounced to require inward pressure will soon evade the action of a mere valgus sole lying, perhaps, loose in an ordinary boot.

As the valgus sole acts essentially as a *stiff* support, it ought, in the case of patients who can afford it, and especially in cases of any severity, to be made to exactly fit a cast of the foot, the cast being taken as the patient sits in a chair with the leg below the knee perpendicular and no weight on the foot.

The question of *fit* is here a very important one, and neglect of it is the chief reason why valgus soles often cause pain and do no good.

Another simple form of support is the *valgus pad*.

The instrument-makers construct this of indiarubber. Intelligent patients can make it for themselves of horsehair. The horsehair pad is more comfortable than the rubber, and quite as effective. Its proper size is usually as thick as the patient's hand, and not quite so large as the palm of his hand. It is best made of a small woollen bag, stuffed neatly and smoothly with horsehair, which can, in towns, be bought at the upholsterer's.

Raising the inner border of the heel and sole of the boot by making it thicker than the outer tends to throw the foot and ankle towards the varus position, and gives relief to many cases, so long as the boot is not old and loose. About one-fourth of an inch is a sufficient addition in most of the cases really suitable for this treatment.

A steel spring let into the waist of the boot, and carried also backwards into the heel and far forward into the sole, is a very good thing; and, in the long run, it is best that this

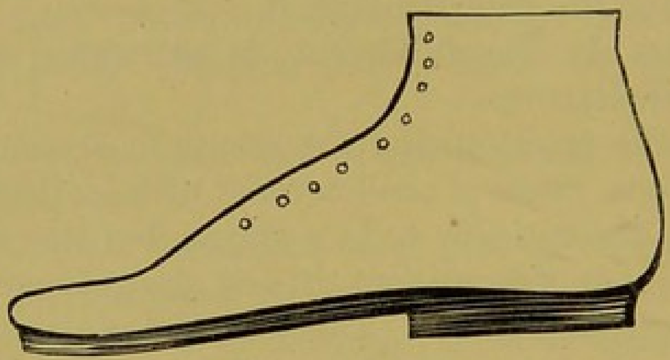


Fig. 80.—Boot with Low and Long Heel and Stiff Waist, suitable for Flat-foot, especially if complicated with Hallux Flexus or Hallux Valgus.

should be left really as a spring, and not stiffened by adding to it an internal flange like that of the common valgus sole.

Meyer recommended a wide heel extending far forward and an inch and a half thick (3 to 4 centimetres).

I usually recommend (1) a rather low heel carried forward three-fourths of an inch under the waist of the boot, (2) a stiff sole, and (3) either a steel spring let into the waist, or else a

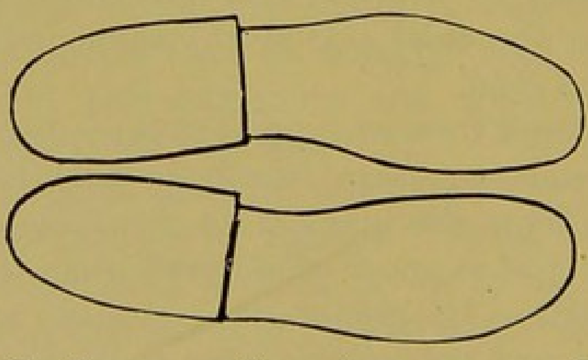


Fig. 81.—Diagram of Soles, &c. of the same Boot.

valgus plate or a horsehair pad inside the boot, between it and the stocking.

Not a few bootmakers are quacks, and prone either to disobey the surgeon's orders, introducing 'improvements' on them, or else to shake the patient's confidence by hinting that they know something better.

It is, unfortunately, sometimes necessary to add something to the above plates and springs to keep them in correct position. The usual addition is a steel upright on the outer side of the leg, but sometimes on the inner, and sometimes even double. It has occurred to various surgeons to use this for the attachment of straps (leather or elastic), which extend down to the inner or to the outer border of the instep (or even completely round it like a stirrup), and suspend it in corrected position. Walsham's apparatus is described in the 'Lancet' for 1885, i. 155; F. K. Green's in the 'Lancet' for 1885, ii. 1184. The latter is not so much intended for flat-foot as for slight cases of valgus ankle.

Indication 2.—The muscles which, when exerted, help to support the plantar arch are those which raise the body on tiptoe, and therefore two simple and excellent exercises for flat-foot are (1) rising up and down on tiptoe, and (2) walking about on tiptoe. In both these exercises the knees should be kept straight, if the plantar arch is to be influenced as effectually as possible. Mr. Ellis, of Gloucester, is the most persistent advocate of this treatment. Influenced by his teaching, I have recommended it to almost every case of my own for fifteen years, and have generally, I believe, seen benefit from the exercises. But it does not restore the arch when lost, and does not, when unassisted, materially, or even at all, improve the shape of an arch merely impaired.

Nor is it right to expect strengthening the muscles to fit them for doing what it is not likely is their proper duty—namely, forming the mainstay of the arch of the foot of a person when standing at ease. I cannot myself believe that Nature ever contemplated such a waste of force. Assuming man to be what he is by the survival of the fittest, persons whose plantar arches require to be kept in shape by ceaseless muscular effort, even when in attitudes of rest, were not the fittest to survive. In attitudes of rest, then, flat-feet should have mechanical support, but for movement the muscles should be strengthened by exercise and by general attention to health and nutrition.

Of course electricity has been recommended. Faradisation of the peroneus longus was much used by those who believed in what, I think, may now be safely termed the 'exploded' theory, which attributed flat-foot to paralysis of that muscle. The constant current is still sometimes used to strengthen the muscles of the leg. Ascending and descending currents are alternated. In but few, if any, cases, in my opinion, are the effects worth the time, trouble, and money thus expended.

Indication 3.—The relief of pain is generally accomplished incidentally by the measures above mentioned. Rest is the most potent agent in this respect, and support to the arch gives it. A few days' rest in bed is often very beneficial. The horizontal position alone, assisted by the action of gravity, tends also actually to restore the plantar arch. Hot fomentations are seldom necessary, and never except temporarily. Ordinary stimulating liniments are sometimes beneficial. And the rubbing itself does some good, especially if extended up the leg. Prof. H. A. Wilson, of Philadelphia, recommends the use of local baths of superheated air, combined with manipulation.[1]

Indication 4.—The prime cause of the affection being almost always either rickets 'of adolescence' or of childhood, and especially the former, the digestion, the menses, the clothing, the hygienic surroundings, the personal habits should be considered, and proper treatment instituted to correct such errors as may be discovered. As a rule little can be done in this direction. Often it is not a present malady, but the effects of one passed away, with which the surgeon has to deal. But this observation applies less to flat-foot (because of its early painfulness) than to other manifestations of rachitis adolescentium.

Indication 5.—Active measures for restoration of an obliterated plantar arch may be classified as follows:

1. Gentle and gradual efforts to restore the arch, maintaining the improvement by such appliances as a Scarpa's shoe, adapted to valgus, or by plaster of Paris, or by poroplastic.

2. The same, with tenotomy.

3. Osteoclasis. This may be either manual or instrumental.

[1] *Annals of Surgery*, February, 1899.

4. Osteotomy.

In children and adolescents gradual efforts, combined with rest, will not only relieve the pain of flat-foot, but will to some extent remove deformity—probably that part which depends on the slipping upwards of the scaphoid over the astragalus head—the subluxation in fact. I can scarcely think that, except in the youngest children, they could materially affect the shape of the astragalus.

Tenotomy of such extensor tendons as appear to most resist the rectification not only favours that, but also, as Paulet and Chauvel have shown, gives the peroneus longus a better chance to retract and brace up the arch of the foot. I have had no experience of tenotomy with gradual treatment by such appliances as Scarpa's shoe; but I have seen good results from tenotomy combined with forcible rectification under ether, and then fixation for two or three months. And I have followed the patients for periods of one or two years.

This forcible rectification, called sometimes '*Brisement forcé*,' practised by Langenbeck and Roser in Germany, Trélat in France, Willett in London, and indeed by many other surgeons, deserves to be tried on cases of medium severity which do not get sufficient relief from measures less expensive of hospital accommodation. Nevertheless, its results are apt to disappoint if the patient is kept in view long subsequently.

Operation.—The patient being anæsthetised and not lying on too high a table for the surgeon, the latter grasps the foot with one hand and the leg with the other, and, partly by a succession of short jerks and partly by main force, presses the foot into a position of varus, with the medio-tarsal joint as much flexed as possible. Or a large 'wrench' such as Thomas's may be used. Still keeping the patient anæsthetised, plaster-of-Paris bandages are then applied over either a woollen stocking or a flannel roller. Six weeks is the minimum time the plaster-case should be left unremoved, and the foot is not to be used at all during that time, unless the patient can walk on the outer side of it.

When the plaster is removed a suitable mechanical support for the arch should be *ready*, and the treatment by exercises and friction should begin at once.

Osteotomy.—Professor Alexander Ogston, of Aberdeen, whose conscientious statements and careful work set an example to orthopædic writers, has the merit of first bringing to bear upon the treatment of flat-foot the new order of things established by Lister in surgery. In the 'Lancet,' 1884, vol. i. p. 152, and in the 'Bristol Medico-Chirurgical Journal' for March 1884, are papers which deserve to be read carefully in every paragraph. He says that want of time and money has hitherto prevented his patients from carrying out a cure by orthopædic machines under his care, and that, 'after employing the ordinary methods long and patiently, there has resulted in the most favourable cases merely a cessation of pain at the instep.' It is no refutation of these statements to point to a mass of cases not followed for a day after they left off treatment, and not recorded with exactness even before they were lost sight of, or to a minute minority of cases who have the time, patience, and money to be treated until an improvement in the shape of the foot is actually secured. Often what is called the 'cure' of a case of flat-foot is simply the relief, and that only temporary, of some of its symptoms.

The primary idea with which Ogston began to operate was to bring about artificial ankylosis of the astragalo-scaphoid joint after restoring that joint to its normal position. He thought that 'ankylosis between the astragalus and scaphoid could do no great harm, for there are so many other points at which the tarsus is movable that probably the rigidity of this one joint could entail no inconvenience.'

In his first attempts to obtain this ankylosis he was content to keep the feet for three months in plaster of Paris. 'Some of them had a fenestra cut in the bandage and frequent injections of carbolic acid lotion made into the neighbourhood of the joint, in the hope of causing rigidity by the prolonged rest and the irritation of the injections.' Permanent improvement was not obtained by these means.

Bidder [1] had shown experimentally that new bone is not

[1] *Langenbeck's Archiv*, vol. xxii., Heft i.

formed when an ivory peg is driven through the articular surface of a bone. Accordingly, Ogston refrained from attempting to produce ankylosis by *simply* pegging the joint surfaces together. He first tried cutting them with a saw, but in one situation only. The ultimate result of this experiment remained doubtful, because the patient was lost sight of.

Next, in two cases 'a small wedge of bone, three-quarters of an inch deep and of a like breadth, was chiselled out of each of the bones, leaving notches at points corresponding with each other, the foot being held in position of most complete rectification while this was being done. In both cases the patients were dismissed in two months seemingly cured; in one of them the cure was permanent a year after the operation, in the second case the result was not satisfactory, as she was still complaining nearly two years after the operation.

But what is now known as *Ogston's operation for flat-foot* consists of (1) the denudation, as far as they can be conveniently reached, of the cartilaginous surfaces of the astragalo-scaphoid joint, (2) the replacement of the foot in proper position, and (3) its immobilisation by uniting the two bones with ivory pegs.

It is needless, I hope, to describe the antiseptic precautions to be used. They are imperative. With regard to anatomy, 'in a normal foot Chopart's joint lies about an inch in front of the internal malleolus, and the most prominent bony point on the inner side of the foot is the scaphoid tuberosity just anterior to it. But in the flat-footed the astragalus head is so greatly displaced from the scaphoid and so prominent that it forms the large projection seen and felt on the inner side of the foot, about an inch in front of the tibia, and the scaphoid is comparatively indistinct, while the line of Chopart's joint is half an inch further from the tibia than usual. By moving the metatarsus this can generally be felt to be the case. Hence an incision to open the joint has to be made further from the ankle than in a normal foot.'[1] (See fig. 67.)

An incision one inch and a quarter long and parallel to

[1] *Bristol Medico-Chirurgical Journ.* ii. 13.

the sole, or slightly curved, with its convexity downwards, is made along the inner side of the foot over the astragalo-scaphoid joint and down to the bones. No important structures are thus divided. This first cut generally opens the joint. The ligamentous capsule is now to be detached from the scaphoid for a distance of half an inch on each side of the wound, its connections with the periosteum and fibrous structures over the scaphoid being maintained as far as possible.

The articular cartilage and a thin layer of subcartilaginous bone are then removed with a chisel, held with its bevelled surface towards the scaphoid and away from the astragalus head.

The joint is now washed out (with carbolic lotion 1 : 20 by Professor Ogston at the date of his paper, 1884), and the arch of the foot restored to its normal shape by the assistant. Two holes are drilled through the scaphoid into the astragalus head, one inch and a quarter deep, half an inch apart, and each pointing towards the central part of the astragalus head. Prepared ivory pegs are gently driven into the holes and cut short. These pegs are made from the finest ivory knitting-needles (No. 13, Wynn's ball-gauge, about the size of a No. 7 or 8 French catheter), cut to three-inch lengths, and sharpened with a file, boiled in 1 : 20 carbolic.

The patient suffers sharp pain for twenty-four hours, and after that the convalescence is painless. The dressings, treatment, &c., are those suitable for osteotomies in general.

Ogston, up to the date of his 1884 paper, had performed this operation seventeen times on ten patients. In all his patients, to the best of his belief, great benefit resulted from the operation, and in most of them bony ankylosis and a painless arch were obtained. In one patient an ivory peg was painlessly extruded five months after operation. As bearing on what probably becomes of the pegs, Ogston gives certain references.[1]

With regard to the question of the effect of the operation on the plantar arch, it appears that in several of the ten

[1] Viz., Riedinger, *Verhandl. d. deutschen Gesell. f. Chir.*, 1881, X. Cong., p. 167; Trendelenburg, *ibid.* 136.

cases its restoration was perfect, but that in the majority it was not so. In all, however, it was much improved. Inquiry at distant periods showed that the results were not transient.

My own experience of Ogston's operation, in which I have sometimes used pegs, sometimes wire, sometimes silk-worm gut, and sometimes trusted entirely to a plaster-of-Paris case over the dressings to retain the proper position, is in accord with Ogston's.

Golding Bird has practised, instead of Ogston's operation, removal of the scaphoid, twice (out of four cases) combining with it excision of the head of the astragalus.[1] Davy also prefers excision of the scaphoid.[2]

In order to restore the plantar arch as well as relieve pain, the former author recommends complete transverse division of the tarsus as well as removal of the scaphoid. H. P. Symonds, of Oxford, simply divided the tarsus with a chain saw, and did not remove any bone.[3] Stokes[4] took a wedge out of the head of the astragalus, finding, however, that he could not do this without implicating Chopart's joint; and then, during the healing of the wound, kept the foot in a position of supination, with a Dupuytren's splint applied as in the treatment of fractured fibula. Vogt has extirpated the whole astragalus.[5] Hare cut the opposed surfaces of the astragalus and scaphoid in such a way (see his diagrams) that the two bones locked together when the arch of the foot was forcibly restored.[6]

All these surgeons, except Ogston, seemed when writing, to have operated on severe cases only. When I myself have osteotomised cases of very advanced flat-foot with great deformity, I have simply, on nearly every occasion, removed a thin wedge from the prominent part of the abnormal convexity (chiefly made up of the astragalus head), and kept the forcibly restored arch in position for at least six weeks with plaster of Paris. No attempt to bear weight on the foot

[1] *The Lancet*, 1889, i. 677. [2] *Ibid.* p. 675. [3] *Ibid.* 1886, i. 15.
[4] *Annals of Surgery*, ii. 283.
[5] Quoted by Kirmisson, *Rev. d'Orthopédie*, 1890, i. 58. Weinlechner, of Vienna, as well as Billroth, has also removed the whole astragalus in cases of valgus. Quoted by Hare. [6] *The Lancet*, 1889, ii. 953.

should be made for another month, unless a new and strong plaster case is applied, with the foot in a varus position. In the meantime, if only one foot has been operated on, the patient may get about a little on crutches.

But there are cases in which neither Ogston's nor Stokes's methods would suffice. I have been obliged to remove from the same limb three wedges—one from the tibia just above the ankle, one from the astragalus head, and one from the head of the first metatarsal bone.

Valgus of the ankle and of the great toe—both of which are found in the worst cases and may be extreme—are not cured, though they may be made less weakening and painful by an operation on or near Chopart's joint.

Trendelenburg appears, even when the deformity is in the tarsus, to operate on the tibia and fibula instead of directly on the centre of the deformity. When the ankle valgus is more marked than the flatness of the plantar arch, the bones should be divided just above the ankle. That is the rule which I lay down for myself at present.

Valgus of the Ankle

This affection, though often associated with flat-foot, especially in severe cases and in rachitic children, is just as distinct from it as it is from knock-knee. Sometimes it represents nothing more or less than a compensatory curve in relation with a form of bow-leg. Sometimes, especially in cases of infantile paralysis, it occurs with pes cavus.

It is commonly described by the patients and their parents as 'weak ankle,' less frequently by the more truly descriptive name of 'in-ankle.'

There is every reason to believe that it originates, except in cases of infantile paralysis, in rickets either of childhood or of adolescence, just as do knock-knees and most cases of acquired flat-foot.

It is most common in young children and in growing girls, and often causes merely passing inconvenience. Before the age of womanhood most of the sufferers cease to be troubled by this complaint, or at least by its pains and disabilities.

General tonic treatment and the ordinary rules of hygiene are indicated. Boots with low heels carried well forward under the instep, and with both soles and heels slightly raised on the inner side, should be worn. Dancing and tiptoe exercises should be practised regularly, and fatigue, especially that due to long standing, avoided.

But the cases which are marked, or which are associated with severe flat-foot, and, still more frequently, those which are *traumatic*, may require osteotomy.

Traumatic Valgus of the Ankle,

usually the result of a former Pott's fracture, frequently requires an osteotomy immediately above the ankle-joint. Less severe cases can be treated more or less effectually with a boot raised on the inner side, or the same supplemented with irons extending up each side of the leg. Exercises as for flat-foot are sometimes beneficial. Hundreds of people are permanently crippled every year by Pott's fracture, and the crippling is chiefly the result of valgus of the ankle, left by imperfect reduction of the fracture. A primary operation with forcible reduction and, if necessary, wiring the inner malleolus is the best mode of dealing with a large proportion of severe Pott's fractures, especially those which are already compound. But the visiting surgeons of many hospitals rarely have their attention called to a Pott's fracture while it is still perfectly recent.

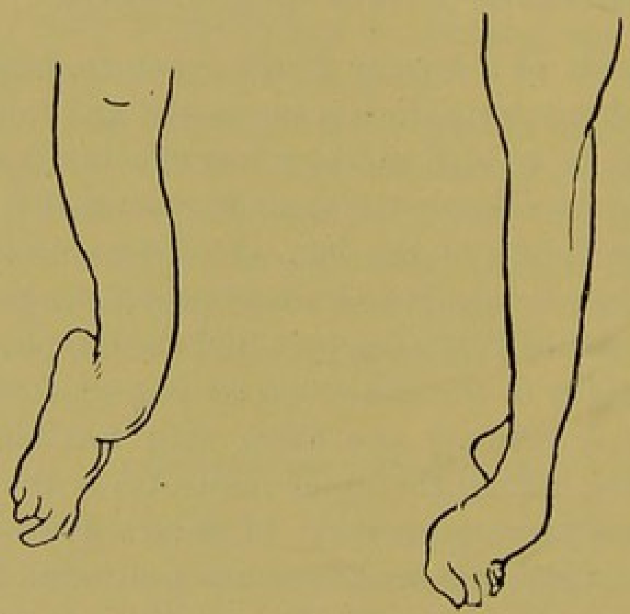
It should be firmly impressed on every house surgeon that the main points to attend to in adjusting a fracture at the ankle-joint are that the lower surface of the heel shall look exactly downwards, and the inner malleolus be in good position.

No patient should be allowed to leave hospital in a condition of valgus after Pott's fracture or Dupuytren's. The surgeon should prefer to break down the fracture afresh, reset it, and operate on it, or fix it in plaster of Paris under anæsthesia.

CONGENITAL DEFORMITIES DUE TO PARTIAL OR TOTAL ABSENCE OF THE TIBIA OR FIBULA, OR TO DEFECTIVE GROWTH OF THOSE BONES, AND CONSEQUENT OBLIQUITY OF THE ANKLE-JOINT.

These affections are sometimes classed with talipes varus and with flat-foot, according to whether they turn the sole of the foot inwards or outwards.

They are rare, but they are exhibited occasionally at the societies, and are common at institutions which give away

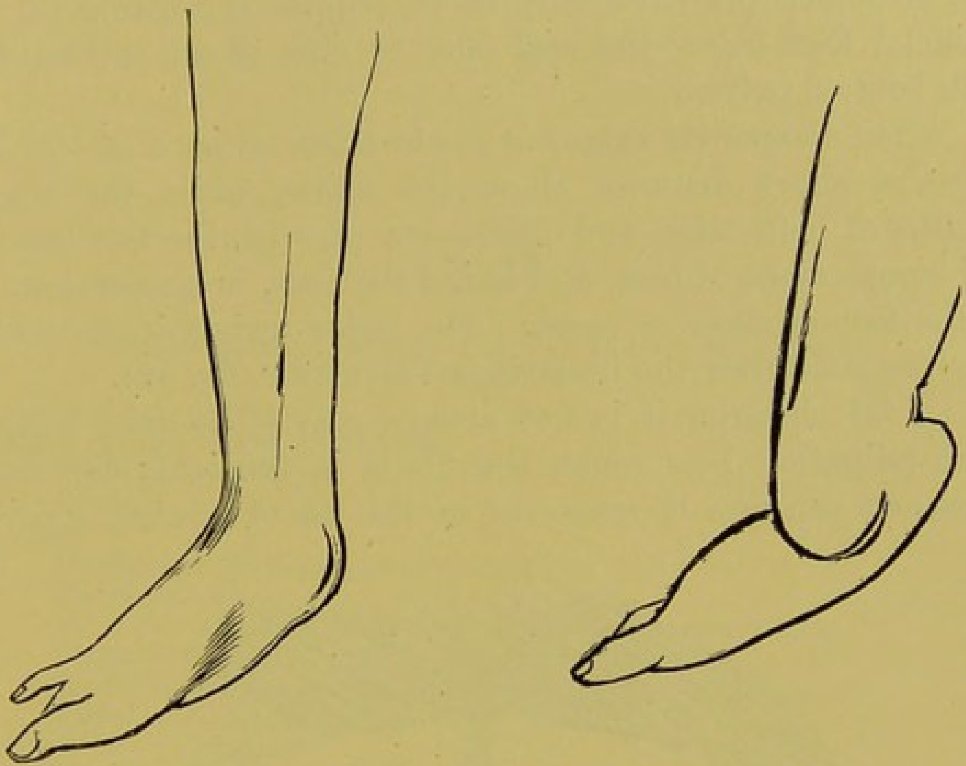


FIGS. 82, 83.—FROM A CHILD WITH CONGENITAL RIGHT TALIPES VALGUS AND LEFT TALIPES EQUINO-VARUS. The hands were also deformed (fingers deficient).

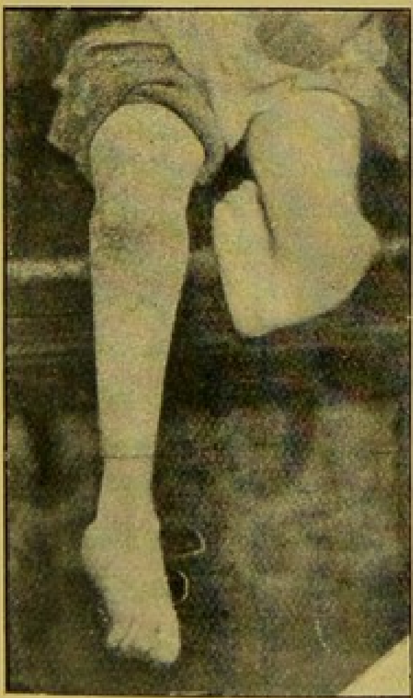
surgical appliances. Of course the same cases turn up again and again for new instruments.

The form usually seen (figs. 84, 85, and 88) is marked by a short limb below the knee; a partial or total deficiency of the fibula; a tibia curved, especially in the lower half, with the convexity inwards and forwards; the foot flat, everted, and easily turned upwards till the dorsum of the inner toes touches the shin; a dimple on the shin at this point of contact, and absence of the outer toes, as well as of the corresponding part of the metatarsus and tarsus.

TREATMENT.—The condition can be remedied by osteotomy; but, unfortunately, the affected leg grows slowly, and



FIGS. 84, 85.—CONGENITAL FLAT-FOOT WITH DEFICIENCY OF FIBULA AND OF TOES. Note the mark on the front of the shin, where the toe is said to have lain at birth.



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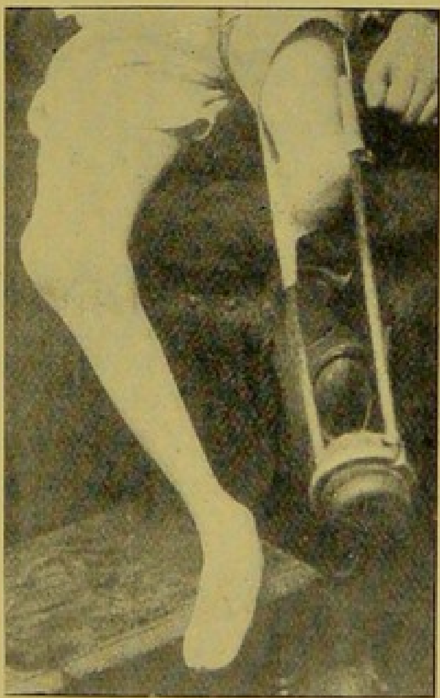


B

FIGS. 86, 87.—MR. E. LUKE FREER'S CASE OF CONGENITAL DEFICIENCY OF LEFT TIBIA AND RIGHT FIBULA. This is an excellent example of congenital deficiency of the tibia.

gets so short proportionally as to require the fitting of an artificial foot below the real one, or else of an awkwardly high boot or patten.

When congenital valgus is due to a lateral bend of the leg bones a short distance above the ankle, while the whole lengths of both tibia and fibula are present, the foot has its full complement of toes, and is not so short, in proportion, as in the former class of cases. The latter variety is named by the Germans after the illustrious Volkmann (fig. 82).

In fat children it is not always easy to be quite certain from palpation how much the fibula is deficient; but such questions can now be answered by the use of Röntgen's rays.

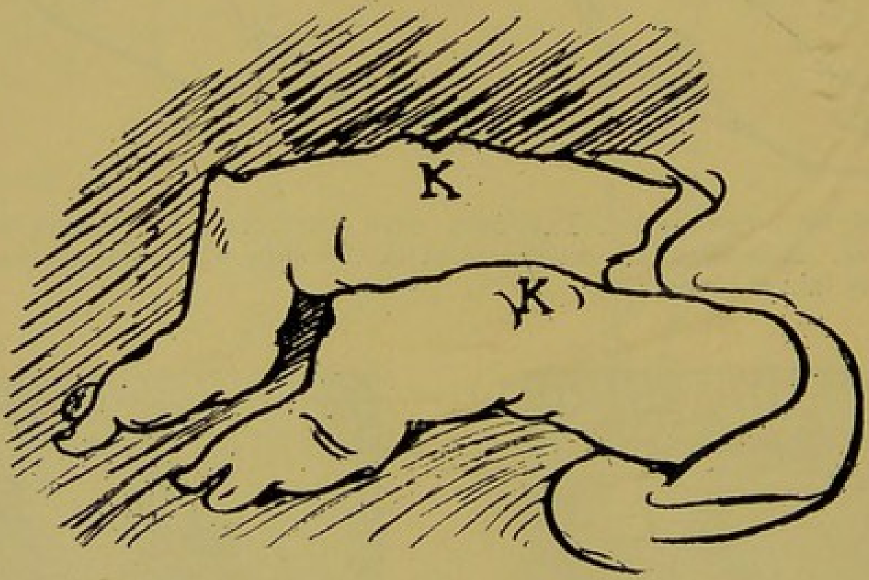


Fig. 88.—From an infant with Congenital Absence of both Fibulæ. Tibiæ bent at right angles in the middle. K, K are the knee-joints. Two outer toes absent, 2nd and 3rd coalescent in left foot. Treated by wedge osteotomy at the angle and tenotomy of tendo Achillis. Straightened with difficulty. A patient of Dr. M. J. B. Anderson's, of Wandsworth.

CHAPTER IX

CONGENITAL TALIPES EQUINO-VARUS AND VARUS

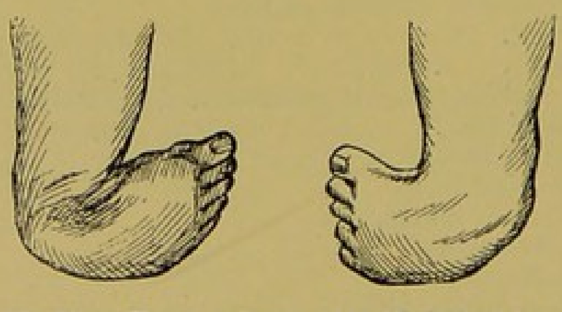
The common variety of congenital club-foot assumes the form of talipes equino-varus. A rough idea of the deformity may be conveyed by saying that in it the heel is more or less raised and the anterior part of the foot twisted inwards, so that the inner border of the foot does not reach the ground, while the sole of the foot, from the instep forwards, tends to look backwards as well as inwards.

But, over and above this, the whole foot, from the tip of the heel to the tips of the toes, has a curve, sometimes strongly, sometimes faintly, marked, of such a nature that, if the varus and equinus could be temporarily removed, there would still remain an unnatural concavity of the inner border and convexity of the outer border of the foot. To avoid circumlocution we shall afterwards refer to this as the 'concavity of the inner border of the foot.'

Moreover, not merely the sole, but the plantar surface of the heel also, looks inwards instead of directly downwards, as in the normal foot. This may be named the 'heel varus.'

The twist of the foot in front of the ankle takes place mainly at and close to the median tarsal (or Chopart's) joint, but it makes no sharp angle there; on the contrary, it spreads gently over the whole anterior segment of the foot. This twist is made up of a flexure of the sole of the foot at the instep, combined with a greater or less degree of supination of the foot.

These sketches of a case of double congenital equino-varus seen from the front illustrate some of the above statements.



Figs. 89, 90. (From Adams, 'On Club-foot,' p. 263.)

But the deformity is not confined to the foot and ankle. There is a rotation inwards of the whole lower extremity; and I believe that the greater part of this rotation usually has its seat in the leg, between the knee and the ankle. It has a superficial resemblance, but is not analogous, to the internal rotation which a normally made person can produce at will. The latter movement takes place at the hip-joint.

As the child walks on the outer border of the foot, or even on the dorsal surface when the supination is severe, a callosity, with a subjacent bursa, forms at the seat of pressure.

The effect of walking is to aggravate the deformity, owing to the pressure of the weight of the body, which, forcing the dorsal and outer part of the foot against the ground, supinates and flexes it more and more. The same force, acting in the same manner, produces another flexion, namely, one of the outer upon the inner part of the sole, so that, in adolescents and adults, a longitudinal furrow is seen along the sole, extending from the interval between the great and second toes, backwards to the obliquely transverse furrow in front of the heel. The latter marks the line of flexure of the sole upon the heel. (Figs. 91 and 92.)

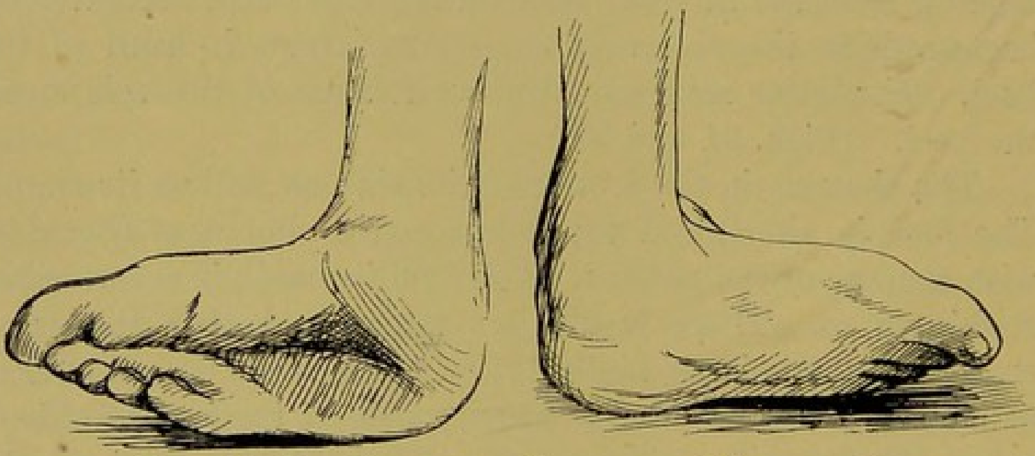
The changes in the foot affect its size as well as its shape. The foot is short, and the comparative shortness increases with the age of the patient. The heel is small, in severe cases strikingly so. There is also an apparent rather than real smallness of the inner malleolus, which is more or less buried, as it were, in the concavity which exists at the inner ankle of a foot affected with equino-varus. The anterior part of the foot has a broad look, unless it has been folded longitudinally by pressure in the way described above.

At birth there is little or no deficiency in the muscles of the leg. But their disuse, owing to the deformed state of the foot, soon tells on their development, so that all old cases of unremoved talipes equino-varus are 'spindle-shanked,' and have the calf short and high. The leg is also generally somewhat shortened, *e.g.* half an inch, in such cases.

Upon taking a club-foot in his hand, the surgeon feels a vastly different state of things, according to the age of the patient. In a newly born infant, the foot in front of the ankle can usually be twisted into an almost normal position with ease, although it immediately springs back into the talipedic form when the straightening force is removed. All the joints are then supple and more or less free. But this encouraging state of things steadily tends to pass away.

Even at twelve months old it is greatly changed; and when the patient once begins to walk on the outer side, or the dorsum of the foot, the change into comparative stiffness is accelerated. The ankle-joint is as much affected as the joints of the tarsus. I have already explained that congenital talipes equino-varus is a deformity of the lower extremity extending upwards at least as high as the knee. In some confirmed cases the ankle-joint becomes eventually absolutely stiff from bony ankylosis.

Anatomy.—The basis of the malformation is in the skeleton itself. It has frequently been shown that, however young the patient, all the soft structures of the foot may be divided, and



Figs. 91, 92.—Congenital Talipes in a Man aged 26. (After Wm. Adams, p. 430.)

even removed, and yet, so long as the ligaments remain, most of the deformity not only persists, but even refuses to yield completely to any force short of one sufficient to rupture the ligaments. When these are ruptured or cut, the foot can be straightened, but the joints gape open; a circumstance readily explained by inspection of the bones, for then these themselves, notably the astragalus, are seen to be of abnormal shape.

But it is of great practical importance to understand and remember that congenital talipes is not purely a bone deformity, as is, *e.g.*, practically speaking, genu valgum or osteitis deformans. It is also a true joint deformity, joint surfaces which normally oppose each other exactly being left only partly in their natural relationship. For instance, the astragalus has its neck turned inwards with an obliquity greater, often much greater, than the slight degree which is normal. This accounts at once for a certain amount of the incurvation of the foot in talipes varus. But what greatly adds to this degree of incurvation is that the scaphoid is, as it were, slipped round towards the inner side of the head of the astragalus, instead of articulating 'fair and square' with its anterior surface.

The os calcis lies in a very oblique, in the worst cases almost vertical, position, with the posterior end tipped upwards. The anterior end, or rather the cuboidal facet upon it, looks more or less inwards. This is partly due to an arching of the whole bone, with the convexity outwards (in conformity with the general form of the talipedic foot).

The astragalus is altered in so notable a manner that congenital talipes equino-varus has been considered (though erroneously) to be primarily due to deformity of this bone. It is perhaps true, as Hüter believed, that the form of the normal astragalus at birth tends to give the foot a slight twist like that of varus. But, at all events, in varus the obliquity of the neck of the astragalus is markedly increased, so as to account for a portion of the deformity of the foot and ankle. Further, the articular surfaces of the astragalus are greatly altered. The trochlear surface is extended so far

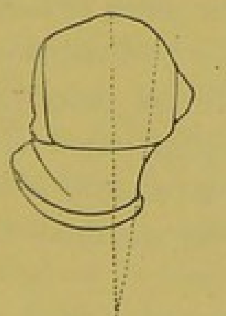


Fig. 93.—Outline of Normal Adult Astragalus. The angle indicates degree of obliquity of neck.

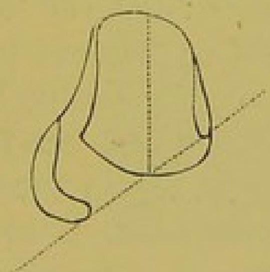


Fig. 94.—Astragalus (Normal). (From fœtus at term.)

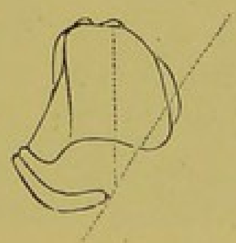


Fig. 95.—Outline of Talipedic Astragalus. (From a newly born infant.)

(These figures are from Parker and Shattuck, p. 16.)

back that it may reach the posterior border of the articular surface which joins the os calcis. Thus the talipedic astragalus terminates posteriorly in a sharp edge, instead of in a blunt end, as does the normal bone. This backward extension of the trochlear surface is obviously due to the abnormal degree to which the ankle-joint is extended. In a corresponding degree, the anterior part of the trochlear surface, being disused, diminishes in extent. Its original and proper limits can still be made out, but the part which never comes into contact with the tibia has lost its polish, and is covered with adherent connective tissue. A transverse line or ridge separates this part from that in use. As the scaphoid is pushed round towards the inner aspect of the head of the astragalus, the articular surface on the latter is extended to correspond, and the part of it in use has an antero-lateral aspect. The outer part, from which the scaphoid is now permanently removed, is often separated from the rest by a perpendicular ridge, and is always (like the anterior part of the trochlea) covered with loose connective tissue. The external articular facet is large, and fits closely to the fibula; but the internal is rudimentary, and, as it were, pushed back towards the posterior extremity of the bone. The neck of the astragalus is lengthened considerably on the outer aspect, and has the appearance of being lengthened throughout, owing to the trochlear surface not extending quite so far forwards as normally.

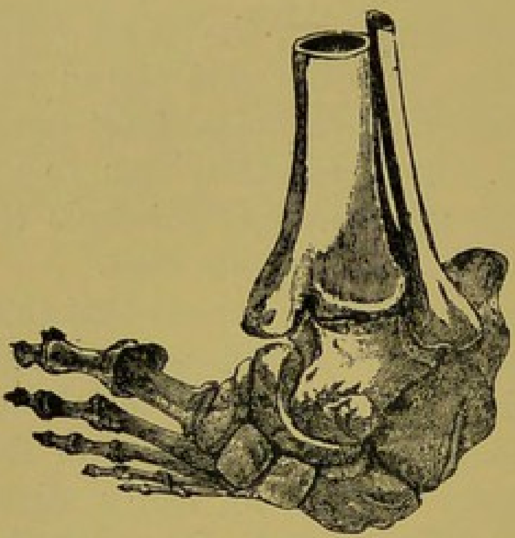


Fig. 96.—Bones from a Case of Congenital Equino-varus in an Adult. (From Dr. W. J. Little's 'Lectures.')

The scaphoid is altered greatly in position, in the manner just mentioned in describing the astragalus (see fig. 98); but its form is little changed. Both the form and position of the cuboid remain almost normal. Nevertheless, they are altered a little in conformity with the general 'turn' of the deformity. Much the same may be said of the remaining bones of the foot.

The bones of the leg have more or less of a spiral twist inwards, and in severe adult cases the internal malleolus is short, and may articulate with the scaphoid.

Adams makes the following important statement : 'Cartilage has been in my dissections constantly found in those portions of the articular surfaces of the astragalus which have either been extended from, or may never have entered into, the composition of the ankle-joint. The articular surface of the inner malleolus appears to be the only exception to this in very severe cases.'

In a genuine case of congenital talipes equino-varus of the ordinary variety, the deformity affects all the bones of the leg and foot, from the knee (and even above it) to the toes, *as if they were one bone*, with modifications due to the fact that *wherever the intervening joints permit normal movement in such directions as would increase the rotation, the varus, and the equinus, those joints yield to the deforming influence*, as well as the bones.

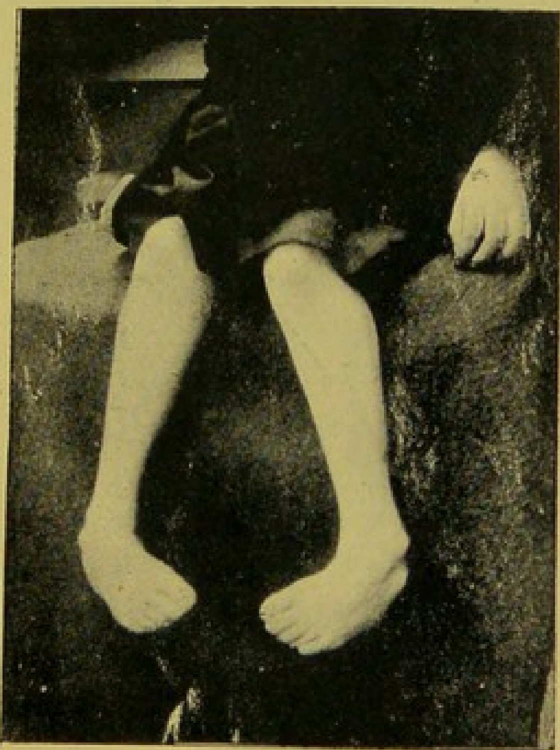


Fig. 97.—Congenital Talipes which has been treated, but not cured, in Infancy—so-called 'Relapsed' Case.

All the soft structures are altered in a manner to correspond with the changes of the bones and joints. This statement holds good equally of ligaments, vessels, nerves, muscles, fasciæ, and even skin.

At birth there appears to be no atrophy of any of these structures. What undoubtedly takes place afterwards is probably due, therefore, to want of normal use. In exceptional cases, such as those complicating spina bifida, congenital fatty degeneration of some of the muscles has been observed.[1]

The ligaments of chief interest are those which resist reduction of the deformity. They are, mainly, the deltoid, the inferior calcaneo-cuboid, the scapho-cuneiform, and the posterior ligament of the ankle-joint.

[1] See Adams, *On Club-foot*, p. 165. Doubtless these cases were paralytic.

The muscles whose tendons are greatly shortened are the tibialis anticus and posticus, the tendo Achillis, and the flexor longus digitorum. The abductor pollicis and the flexor brevis digitorum, with their aponeuroses, are also shortened.

The extensor muscles on the dorsum of the foot lie abnormally towards the inner border of the foot. This is important to remember when removing a wedge from the tarsus. The tibialis posticus tendon lies a little more forward than usual at the inner ankle. Other variations in position are not practically important.

In the adult the anatomical features do not vary essentially from those of the infant. But the growth and nutrition of the bones are defective. They are apt to be 'thin-shelled, light, cancellous, and fatty.' The abnormal pressure resulting from the weight of the body being borne on the outer and dorsal surface of the supinated foot also tends to intensify some characters of the deformity. The os calcis touches the posterior border of the articular surface of the tibia and the fibula, and is sometimes united to them by osseous ankylosis. Its lateral obliquity is very obvious, its tuberosity lying just behind the fibula. There is sometimes a facet on the anterior and under surface of the sustentaculum tali, which articulates with the *under* surface of the cuboid, the latter bone being turned upside down by the supination of the foot. Two-thirds of the anterior articular surface of the os calcis are excluded from the cuboido-calcaneal joint by the lateral displacement of the cuboid. The astragalus is sometimes completely vertical. Its head is ill-developed.

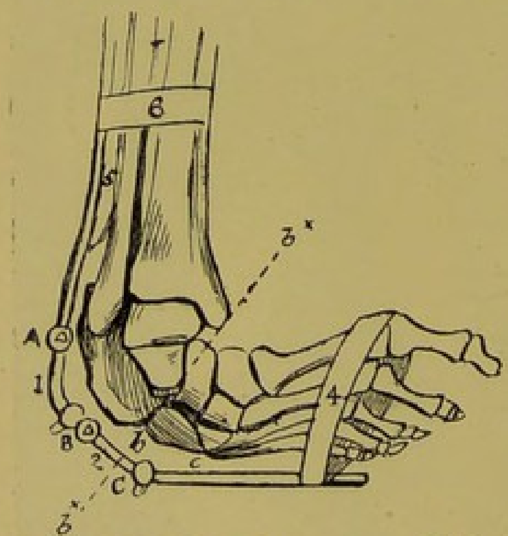


FIG. 98.—This diagram, published by William Adams to explain an apparatus he recommends, illustrates also the shape and relations of the bones in equino-varus in an adult (*Club-foot*, p. 277).

In the act of progression, the uncovered portions of articular surfaces of the astragalus and os calcis, as they look directly downwards, help to transmit the weight of the body to the ground. But it is the dorsal surface of the cuboid which is mainly pressed against the ground in walking.

Ligamentous rigidity is constant and severe. But the ligaments on the abnormal convexities of the displaced joints are elongated. The muscles are ill-developed and the tendons slender. But they recover surprisingly when the deformity is successfully treated. The tibialis anticus tendon is displaced backwards, so that it gets behind rather than in front of the inner malleolus. This displacement is due to the fact that, in severe adult varus, the place of insertion of the tendon lies behind a transverse plane through the leg. This tendon, therefore, might be divided in mistake for the tibialis posticus. Owing to the changed course of the peroneus longus tendon, which takes a short cut to its insertion beneath the os calcis, avoiding the cuboid, it may become tense during the treatment of severe adult varus. In such a case, Adams says he divided it with great advantage.

Even the most skilfully made boots are not always successful in protecting adults with talipes from severe corns, callosities, and ulcerations, and these complications are in danger of special aggravation if obesity comes on with advancing middle age.

Etiology of Congenital Talipes Equino-varus.—No theory of the origin of this affection can be fairly regarded as proved to demonstration, but facts on the whole point to position and abnormal pressure in utero as probable causes. This theory, which dates from Hippocrates, was held by Ambrose Paré, and has been supported by F. Martin, by v. Lücke, by v. Volkmann, and by Parker and Shattuck.

In early fœtal life the lower limbs lie against the abdomen, with both hip- and knee-joints flexed and the feet usually crossed. In the course of development the limbs normally take their share in fœtal movements which are obvious to the mother. There can scarcely be any reasonable doubt but that these movements favour the proper development of the joints, muscles, ligaments, &c., of the fœtus. For such movements to be free there must be a sufficient amount of liquor amnii to give room. It is not, therefore, a far-fetched idea to suppose that deficiency of that fluid may, and does, frequently prevent the feet and lower extremities from, so to speak, unfolding themselves. In this way we get a fairly satisfactory hypothetical explanation of congenital club-foot, and even of other allied deformities. In favour of this hypothesis are both positive and negative reasons. In many cases of club-foot the liquor amnii has been known to be remarkably deficient at birth, and the fœtal movements have been noticed to be limited before birth. It is true that in other cases the liquor amnii has been normal in amount at birth; but it is not certain that it had existed in normal amount from the time of its first appearance.

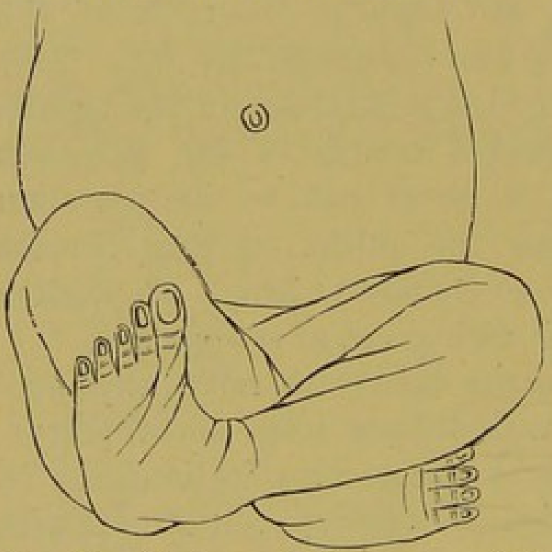


Fig. 99.—(Parker and Shattuck, p. 33.) The habitual position for many weeks after birth of a child with 'not very severe' double talipes equino-varus. P. and S. think a similar position in utero was the cause of the talipes. For a photograph of a similar case, see Appendix.

By way of example the following observation of Lücke's may be given:—A woman had borne one healthy child with plenty of liquor amnii; then, with very little of that fluid, she bore a child with double club-foot. At the third confinement neither she nor the midwife noticed any liquor amnii at all. The child had both double club-foot and double club-hand.

Frequently these cases show, even at birth, atrophied patches of skin, sometimes with subjacent bursæ, at exactly the place or places where pressure would have to be applied in order to produce the deformity.

The most popular theory with those unwilling to accept the explanation sketched above used to be that which attributes to congenital club-foot a nervous origin. This hypothesis was supported by Little with much ingenuity. It found favour also with Duchenne and with the clear-sighted Bouvier. But the arguments against it are of great weight. In ordinary congenital club-foot, at birth, the affected limb or limbs are, as regards their muscles, normally developed. They are warm, and continue warm. They respond to galvanism. In fact, living, they contrast strongly with paralytic limbs ; dead, the muscles are not found degenerated. It is perfectly true that with time and the disuse which necessarily results from the deformity the limb wastes, but it is superfluous to call in a paralytic explanation for that.

As for the hypothesis of primary bone deformity, it is not easily supported. Can it account for the scaphoid being slipped quite round to the inner side of the head of the astragalus ?

There are a few rare cases bearing a resemblance to common congenital varus, and yet having certain muscles in a state of fatty degeneration. The cases in question present marked differences, and must be described as a distinct affection.

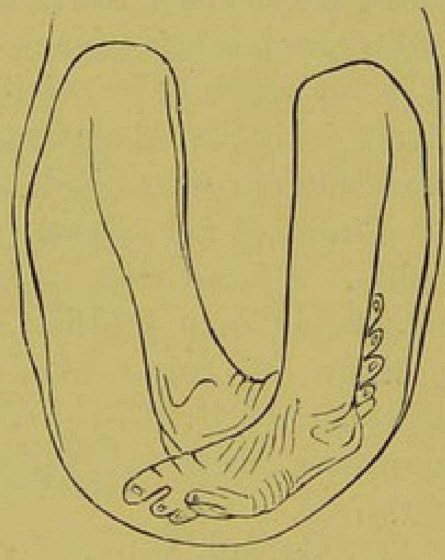


FIG. 100.—(Parker and Shattuck, p. 43.) From a preparation in St. Mary's Museum—a fœtus of four or five months.

Normal infants tend to hold their feet in a *position* of varus ; but this has no more to do with club-foot than the little clenched fists have to do with Dupuytren's contracture. Such feet are easily untwisted, and when quiescent their true *shape* may often be seen to be one of valgus.

Bessel-Hagen, in a very notable work,[1] has studied carefully the etiology of club-foot by examining a large number of fresh specimens. He objects to deductions drawn from examination of specimens in spirit, as they are liable, he says, to be moulded by the counter-pressure of the jar. In these fresh specimens he finds the fœtal foot normally not supinated, but as follows :—In embryos less than 30 millimetres long the foot is fully extended. In those from 30 to 40 mm. a

[1] *Die Pathol. und Therapie des Klumpfusses*, Th. 1 : *Aetiologie und Pathogenie*, Heidelberg, 1889. (See also *Centralblatt f. Chirurgie*, 1890, p. 206, and Hoffa's Treatise.)

slight plantar flexion forms. In those from 90 to 100 mm. long the foot is usually at right angles to the leg and has already assumed its proper form. Henceforward it assumes, now this, and now that position, apparently indifferently. *Supination, as the rule, only takes place in the last month of pregnancy. Further, the supinated foot is always at the same time dorsal-flexed.* Hoffa confirms these statements by observations made on four fresh embryos.

Bessel-Hagen enumerates and classifies ninety-eight different possible ways in which club-foot may arise. How many of these possibilities have been or ever will be actualities is a doubtful matter.

When club-foot is found in what may be termed 'localised monstrosities,' *e.g.* in association with deficiency or coalescence of toes, or with deficiency or absence of the tibia or the fibula, it is obvious that its origin has probably been at a comparatively early period of fœtal life, and it may have been due to something inherent in the germ itself.

Club-foot not infrequently occurs in association with spina bifida. I have seen such a case in which the feet resembled (one being in a position of equino-varus and the other in a position of calcaneo-valgus) the three well-known cases described by F. Martin, Volkmann, and v. Lücke respectively, as proofs positive of the compression theory of the origin of club-foot.

Of course, pressure may act upon children with spina bifida as upon other children, and the spina bifida may somehow tend, perhaps by causing contractures, to place the foot in positions where they are specially exposed to it. But in some cases, at least, club-foot in association with spina bifida is directly of paralytic origin.

Club-foot is also occasionally found in anencephalous and in hydrocephalous fœtuses, and in monsters of various kinds.

In a certain, not very large, proportion of cases heredity may be traced.

Recent authors, by heaping together as varieties of club-foot all kinds of cases in which the sole or heel is found inverted, and then by gravely classifying every conceivable influence which their imagination can suggest as 'causes,' have perhaps tended to confuse rather than to clear the question of the etiology of the ordinary variety of club-foot which is seen every day by orthopædists in ordinary children, as distinguished from whole and partial monstrosities. This etiology still remains unsettled and an affair of more or less well-grounded hypothesis.

Treatment of Congenital Talipes Equino-varus.—In deciding upon a plan of treatment, the first thing to consider is the age of the patient. In infancy and early childhood manual and mechanical treatment is likely to succeed, without the assistance of any operative procedure more severe than the division of tendons, and perhaps also of fasciæ, and even ligaments. In adolescent and adult life, resection of bone is likely to be necessary; and in old age, if there should be indications for interfering at all with a case of club-foot, they

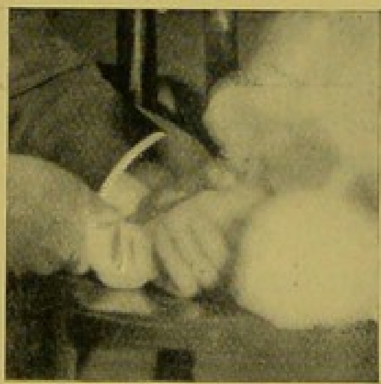


Fig. 101.—To show the Transverse Wrinkles in front of the Ankle made in manipulating Congenital Talipes. This photograph is indistinct because of the restlessness of an infant when its leg is firmly grasped. In the middle of the picture, the manipulator's left hand grasps the leg: the thumb is on the upper part of the shin, and the fingers are seen on the outer and posterior surface of the leg just above the ankle. To the left of the figure is the right hand, with its thumb on the dorsal and fore-finger on the plantar aspect of the toes. Three almost parallel wrinkles are seen on the front and outer surface of the ankles. The nurse or mother should be instructed so to manipulate the foot during the daily passive exercises as to produce these wrinkles.

are more likely to point to a Syme's amputation than to either tenotomy or osteotomy.

Let us consider first the case of a newly born infant. The immediate question is, how soon shall treatment begin? and the answer is, 'at once.' Some surgeons there are who would postpone treatment until the child is commencing to walk, because (1) until that period treatment must be continued, however early it is begun; and (2) in early infancy great difficulty is experienced in keeping dry and clean any instrument applied to the legs. These arguments are, however, insignificant compared with the grand consideration that the actively developing foot makes, during the first year of life, great strides towards the permanent fixation of the osseous, ligamentous, and other structural changes associated with talipes. Some indication of this is given by the comparative ease with which a club-foot at birth can be twisted, or rather untwisted, and pressed into a shape normal, or nearly so. According to Wolff,[1] the foot grows, proportionally, as much when between three months old and six months old as between the ages of one year and two years. Vogt has pointed out another important consideration. A child's parents are more disposed to assist when it is newly born, and the horror produced by the deformity is yet vivid in their minds, than they are when they have had time to grow accustomed to it.[2]

The means used in treating club-foot in *infancy* may be shortly classified as follows:

Manipulations	Independent. Auxiliary.	
Appliances	Removable Fixed	Non-elastic Elastic.
Operations.	Division of	Tendons Fasciæ Muscles Ligaments.

Infancy is not concerned with resection of bone, and rarely with division of skin.

My division of 'manipulations' into 'independent' and 'auxiliary' is a somewhat faulty one. I have in mind the fact that cases are seen so slight in degree that mere manipulations, independent of any operative or instrumental treat-

[1] V. Langenbeck's *Archiv*, Bd. 21, p. 107.

[2] 'Beitrag zur orthopädischer Technik,' *Archiv für Kinderheilkunde*, 1880, p. 225.

ment, can effect a cure. These cases are, however, exceptional. But manipulation is an indispensable auxiliary to all operative and mechanical treatment. The surgeon should teach the nurse or mother how to twist the foot into the best attainable position, and how to exercise the ankle-joint. Some minutes should be devoted to this practice every time the appliance worn is removed and readjusted. If no appliance is being used, the nurse should frequently and for long periods hold the foot in a normal shape, or even, when possible, in a position of valgus.

Of removable appliances, the best known is Scarpa's shoe. This was devised ninety-six years ago by that famous Italian surgeon and anatomist. The instrument in question, as now supplied by the modern maker, differs a good deal in appearance, though not in principle, from the original model. It has a flat sole-plate of iron, and a semicircular plate fixed behind to keep the heel in position. Both are covered with leather and padded. Connected with these is a perpendicular iron bar extending up the outer side of the leg, and intercepted at the ankle by two cog-wheel joints, one of which permits movement in the direction of extension or flexion of the ankle, and the other inversion or eversion of the foot. Both are controlled by a key separate from the appliance. The perpendicular iron is fixed at its upper end by a half-hoop of steel, which, together with a leather strap, encircles the calf, and the patient's heel is pressed down into the heel of the shoe by one or more straps over the instep. Along the outer margin of the sole-plate lies a steel spring. To this is buckled a webbing strap, which surrounds the foot between the instep and the toes. The force of this steel spring is thus employed to pull outwards the anterior part of the foot.

Scarpa's shoe has been modified in various ways by different surgeons, and also by instrument makers. Scarcely any of these modifications have the value claimed for them by their inventors. They have mostly originated in *à priori* considerations, and in the very natural fancy of each surgeon that his own results are better than other people's. A well-known change is that which divides the sole-plate into two pieces, one anterior and the other posterior. This originates in the anatomical consideration that the varus element in the deformity is caused by changes at the median tarsal joint. That, however, is only partially true (see, *e.g.*, the diagram at p. 164). The change, nevertheless, would be an improvement if it were not also a complication. It was, I believe, originally made by Boyer. Davy's instrument is noticeable for its powerful leverage and for its range of action. The plain and hinged metal splints, or troughs, of Little are very simple, and are useful, especially for equinus and for night wear. Reeves's is simple, useful, and very cheap (fig. 104). These appliances are well known at the surgical instrument makers' by the names of their inventors.

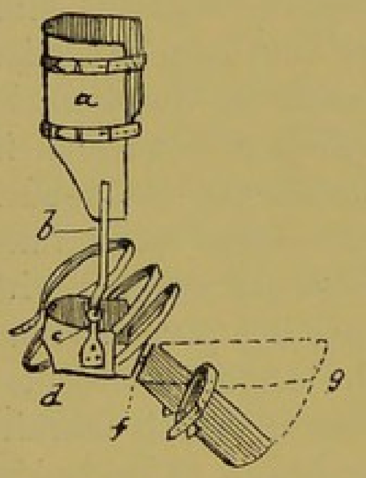


FIG. 102.—SCARPA'S SHOE, WITH TRANSVERSE JOINT IN SOLE-PLATE CORRESPONDING TO THE TRANSVERSE TARSAL JOINT.

c, cog-wheel at ankle; *f*, transverse joint (Adams, *On Club-foot*, p. 136).

An excellent talipes shoe is Henry Baker's. Its movable pads are useful, when the surgeon will give due care and attention to the case, in preventing pressure sores. These exceedingly mischievous complications are by no means uncommon when the treatment of talipes by appliances is placed in the hands of surgical dressers; but they are rarely caused either by surgeons of experience or by parents. Fig. 103 represents the instrument open, and it will be seen to consist of a back splint, connected with a foot-piece by means of a cog-wheel, K, at the heel, and having hinged to it two wings, which extend well below the foot-piece, and have a buckle and strap, H, attached to their lower ends. A, A, are two webbing straps introduced through slots to fix the leg firmly. B is a leather ankle-strap, wide and padded in the centre, to fix the heel immovably in its position ; it is attached to a buckle at the back. D is a plate attached to the external wing, hollowed out and moulded to receive the pad C, or movable fulcrum, which may be placed beneath it to press on the projection at the outer side of the foot. I is a rigid bar for carrying the toe-strap. S is a rectangular pad to be introduced beneath the external wing at M, when it is found necessary to diminish the pressure over the tarsus on the outer side of the foot, even after the pad C has been withdrawn. The leg is firmly held to the back splint by the straps A, A. The heel is kept in place by strap B, and the movable pad C is adjusted. The wings are brought together, and firmly fixed by the further action of the straps A, A, and strap H; and the toe-strap is then tightened, and the cog-wheel, K, screwed up. By simply loosening the toe-strap the pressure is at once relieved, if this should be found necessary, as is frequently the case at night, when the foot becomes hot; and in a day or two, the wings being thrown back, *but the foot*

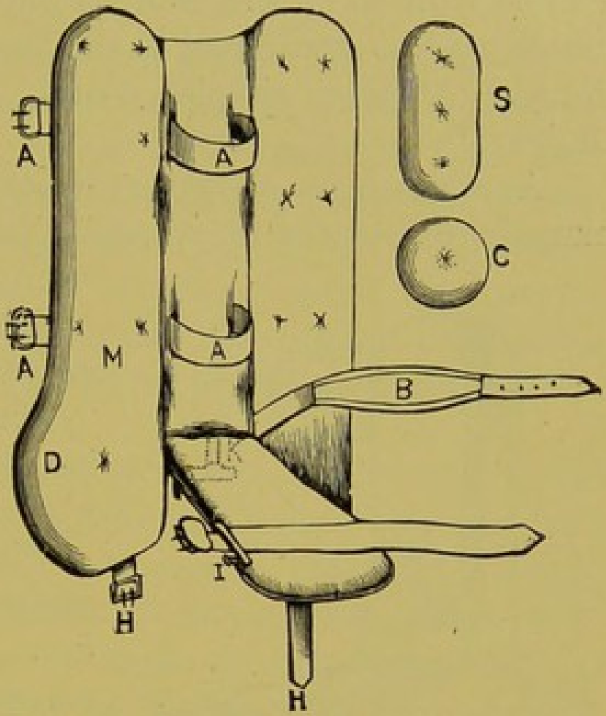


Fig. 103.—Henry Baker's 'Movable Pad' Instrument.

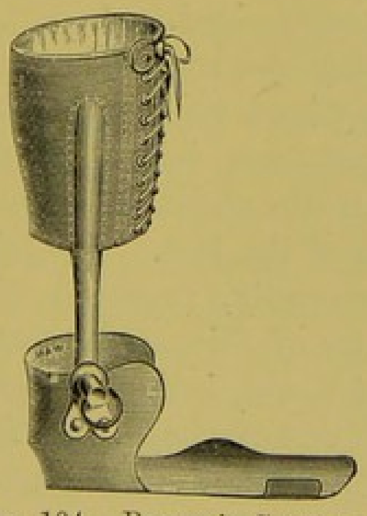


Fig. 104.—Reeves's Splint for Talipes.

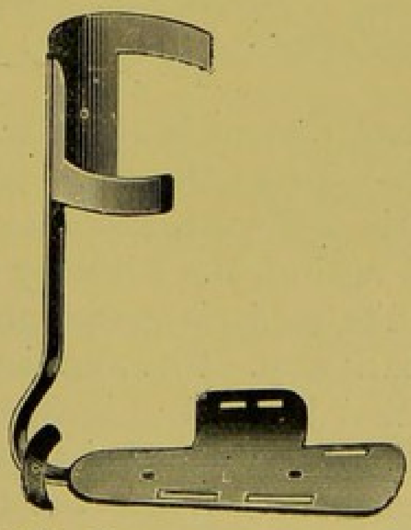


Fig. 105.—Robert Jones's Splint for Talipes.

not being disturbed, the pad C may be slightly shifted or removed, or the rectangular pad S may be introduced at M for a short time until the skin on the outer side of the tarsus is again able to bear pressure. Simple splints of tin, which can be bent to fit the front of the leg, ankle, and instep, are often used to secure rest to the foot for a few days after tenotomy. Another simple, useful, and inexpensive splint is Robert Jones's.

Another class of instruments must not be forgotten, namely, those used to prevent relapse when, the foot having been got into good shape and position, active treatment is at an end.

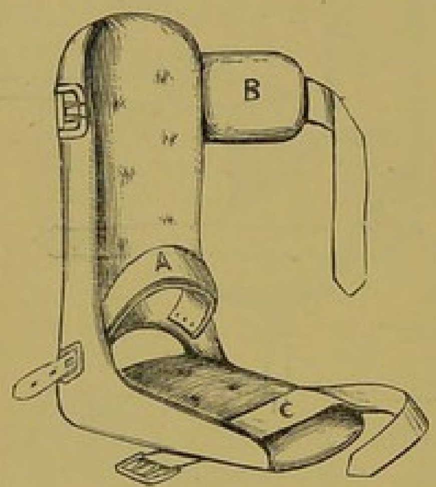


FIG. 106.—SIMPLE SPLINT FOR TALIPES EQUINO-VARUS.

A, ankle-strap; B, shin-piece and strap; C, strap for anterior part of foot. (From H. Baker's *Practical Notes on Treatment of Deformities.* London, 1886.)

These differ greatly, according to whether they are worn by night or by day.

The simplest troughs and rectangular splints do for night use. They should be free from corners and angles likely to tear the bedclothes. They should not press on the heel or ankles. They should not be too hot and heavy for summer wear. Pains should be taken to bandage or strap them on accurately and securely each night.

For day use the almost universal custom is to order an ordinary boot to the foot and side-irons to the leg. These side-irons are jointed at the ankle and knee, and often extend up to the waist, in order to act against the tendency to inversion of the foot. The joint at the ankle is sometimes, but not usually, provided with a back stop. The unsatisfactory feature of this arrangement is that the foot will often twist itself round inside the boot, and even in time twist the boot itself out of shape. In fact a common boot attached to a side-iron cannot control a foot with any active tendency to varus.

For this reason I have had made a kind of sandal with a wooden sole, and direct this to be worn instead of a boot so long as there is any tendency to relapse. The wooden sole is perfectly rigid, its relation to the side-iron is unchangeable, and the foot is laced down to it as securely and correctly as it can be fixed in a Scarpa's shoe.

It would be strange indeed if, in this age of indiarubber, the elastic properties of that material had not been applied to the treatment of club-foot. I will avoid waste of time and space by saying at once that the rather pretentious claims made on behalf of so-called 'artificial muscles' of indiarubber, and for analogous contrivances, are, if not quite baseless, at least ridiculous, in comparison with the other, more convenient and more powerful means we possess of dealing with congenital talipes equino-varus.

If, however, any one is disposed to try elastic traction in the treatment of this deformity, he must indeed be a shiftless person unless he can devise for himself a means of putting into proper action combinations of indiarubber strips and adhesive plaster. They can be made to work effectively in infants which have not learnt to walk. But they involve a great amount of trouble in the necessity for frequent reapplication and readjustment.

Fixed Appliances.—These are made of plaster of Paris, and, more rarely, of one or other of the various materials, such as starched bandage, water-glass, &c., used in the treatment of fractures by immovable apparatus. Although poroplastic, moulded papier-maché and gutta-percha splints are just as removable as a Scarpa's shoe, yet, from the fact that they are moulded while soft to the deformed limb, they have a closer affinity to plaster of Paris than to steel instruments, and will therefore be more conveniently noticed with the former than with the latter.

In applying plaster of Paris to cases of varus I always proceed as follows :—The patient's knee being flexed, an assistant holds the limb firmly and prepares to exercise counter-pressure to the pressure I am about to apply myself. The foot and leg being covered with a bandage of fine flannel, I grasp the toes with my left hand, and press against the balls of the outer toes in such a way as to forcibly evert the foot and to obliterate as far as possible the varus. Of course this manœuvre tends also to stretch the tendo Achillis, or the posterior ligament of the ankle-joint if the tendon have been cut, and to bring down the heel.

I then apply the plaster bandages with my right hand. In order to be able to do this I have to get a nurse to take the bandage-roll from me at the completion of each turn of the bandage. This sets my right hand free to pass round the back of the limb, receive the bandage-roll back from the nurse, and apply another turn of bandage, and so on. But I do not allow the nurse to apply a single inch of bandage. Her duty is quite passive.

I therefore both fix the foot in position and apply the bandage myself. It must be obvious that no ordinary two or three persons could effect these objects with equal skill unless they had each had the same amount of practice as myself. That is, assuming that I have abilities equal to the ordinary. I find it far less trouble to proceed like this than to instruct all assistants or nurses how to manipulate the foot. Simple as is the manipulative process, there are people who seem incapable of learning to do it properly. The application of the plaster bandage is also an important matter. Regularity, smoothness, and homogeneity are not to be given to it by every novice at a first trial.

When sufficient plaster bandage has been applied and the successive layers well rubbed into cohesion with one another, I take both leg and foot into my own hands, and hold them in position until the plaster is firmly set.

There are various other ways of keeping the foot in position during the application of plaster. Some surgeons use strapping first, and then plaster over the strapping.

Although no other appliance, fixed or removable, can equal in power and accuracy the plaster-of-Paris case, yet there are points about the poroplastic felt splint which give to it high value in the treatment of talipes.

In making a poroplastic felt splint proceed as follows. Cut out a piece of paper the shape of fig. 107 until it will fit on the foot and leg as in fig. 108. Use the pattern in cutting the felt splint. Hold the blade of the knife slantwise to the surface of the poroplastic when cutting it. Place a flannel bandage or a sock on the foot and leg. Soak the felt splint in water hotter than you can bear with the hand, but not boiling, until it is soft. Take it out, and dry its surface quickly between the layers of a folded towel. Apply it quickly as in fig. 108. Bandage it into shape firmly, at the same time —with assistance—holding the foot in good position. When the splint is cold and firm, *i.e.* in a few minutes, remove the tight bandage and apply a looser one. Superfluous corners, &c., can be trimmed off the splint.

The poroplastic talipes splint is light and cheap, and it can be removed daily and reapplied by the mother or nurse for manipulating, inspecting, washing, &c.

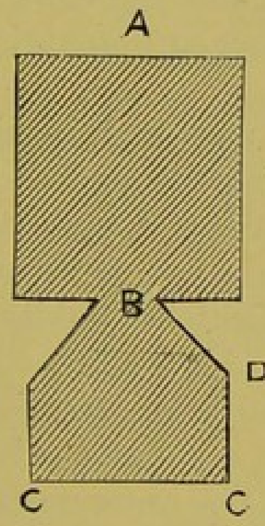


Fig. 107.—Poroplastic Splint for Talipes, when first cut out.

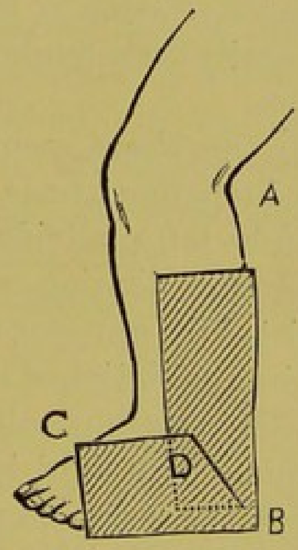


Fig. 108.—Poroplastic Splint for Talipes, softened by Hot Water and applied ready to be Bandaged into Shape.

Operative Treatment of Congenital Talipes Equino-varus.— It has already been stated that there are cases in which even tenotomy is superfluous. These are, however, quite exceptional. Almost always it will be an economy of time and trouble to everybody concerned, and a great preventive of pain and discomfort to the little patient, to operate. It is, therefore, needless to discuss whether this or that degree of congenital talipes *can* be cured without tenotomy.

The tendons to be divided are, as a general rule, the tibialis anticus and posticus and the tendo Achillis, and sometimes the flexor longus digitorum.

The plantar fascia, especially the inner part of it and the inter-muscular division between the abductor pollicis and flexor brevis digitorum, must also be cut; and in doing this the surgeon will not find it either possible or desirable to avoid more or less division of these two muscles themselves. When, after tenotomy and fasciatomy, the foot is still held more or less rigidly in its false position by the ligaments, these must be divided also. They are the anterior part of the internal lateral ligament of the ankle, the internal part of the inferior calcaneo-scaphoid ligament, and occasionally the internal scapho-cuneiform.

It is to be remembered, however, that ligaments offer only a passive resistance to stretching force, and therefore yield more easily than tendons, which have muscular fibres attached to them.

All the above-mentioned structures need not be always divided together at one sitting. Some think the tendo Achillis should be left undivided until the mechanical treatment employed after division of the other structures has, more or less, untwisted the anterior part of the foot, straightened out its inner margin, and flattened its sole and instep. This is what most orthopædic surgeons call removing the varus before treating the equinus. The tight tendo Achillis gives a counter-extension against the force employed to untwist the anterior part of the foot; but quite sufficient counter-extension can usually be obtained from the posterior ligament of the ankle-joint alone.

I believe it is a mistake to make a rule of always attempting to untwist the foot before bringing down the heel. In truth the leverage of a firm foot in bringing down the heel is more necessary than is the counter-resistance of the tendo Achillis in forcing upwards and outwards the foot. Moreover, some of the varus is caused by the tendo Achillis itself.

In congenital club-foot I have for years divided all that required division at one operation. I believe this practice is becoming general.

In dividing the tendo Achillis an anæsthetic is not absolutely necessary. Insert a sharp-pointed tenotome at a distance equal to about twice the breadth of the patient's thumb above the tendon's insertion, and let the point of the knife pierce the skin not far from the posterior surface of the tendon.

Then, when the knife-edge is turned towards the tendon and the actual division commenced, the side of the skin wound pressed upon by the knife will be that towards its back, and the wound will not be enlarged. The knife is passed in on the flat, and not turned edgewise till its blade is fairly beneath the tendon. The surgeon's left forefinger should feel the point of the tenotome beneath the skin on the side of the tendon opposite to the skin wound. The division is effected with a sawing movement.

The assistant grasps the leg and foot with his two hands respectively, relaxes the tendon while the tenotome is being passed beneath it, and makes it tense during the cutting.

Both the skin and the tenotome should be thoroughly cleansed and antisepticised. Why should not an impure tenotome convey infection as easily as a needle will implant vaccine lymph? Erysipelas, suppuration, and even sloughing of the tendon have repeatedly followed tenotomy.

The *tibialis anticus* should be divided below the ankle-joint.

The *tibialis posticus* can be divided either above or below the ankle. The former situation used to be preferred. The exact position of the tendon varies considerably, according as the club-foot is slight or severe, and the variation is greater below than above the ankle. Vogt thinks that reunion of the tendon would be less certain below than above the ankle, because in the former situation there is no tendon sheath.

There is one decided advantage in dividing below the malleolus. There the ligaments may be divided through the same wound.

When operating above the ankle, the skin and tendon sheaths are punctured by a sharp-pointed tenotome, and then a blunt-pointed one passed in to cut the tendon (or rather tendons, for the flexor longus digitorum is usually, intentionally or otherwise, divided at the same time). The blunt point is used in order to endanger as little as possible the posterior tibial artery. The division should be immediately above the malleolus, and the tenotome should be insinuated beneath the tendon or tendons, close to the bone, the edge of the knife being afterwards turned backwards and the tendon being made tense over it by the assistant. In fat children a point midway between the anterior and posterior border of the limb is chosen for the insertion of the tenotome. It is very frequently difficult to feel sure whether the flexor digitorum has been cut or not, and the surgeon may easily deceive himself about the tibialis posticus. If the case is a severe one, rather than leave the matter uncertain the surgeon had better, with antiseptic precautions, divide the tendons openly, through a short longitudinal incision, taking care to disturb their sheaths as little as possible.

If any accident should happen to the posterior tibial artery, pressure had better be applied and the limb well elevated. The plantar fascia, &c., are divided by a sharp-pointed tenotome inserted at the inner margin of the foot, not far from the internal malleolus. Its blade should be carried at least halfway across the sole, or rather the instep, immediately beneath the skin, the foot being relaxed at the time. Then its edge should be turned towards the deeper parts, and, the foot being extended simultaneously, made to cut all the tense bands of fascia and muscle which keep the sole and inner margin of the foot concave. The division must be particularly free and deep towards the inner side.

If the puncture be made close to the malleolus, the tibialis posticus and the ligaments beneath it can, if desired, be divided subcutaneously through the same incision. The division of the tibiales and of the plantar fascia takes more time and is a more delicate series of operations than tenotomy of the tendo Achillis. An anæsthetic should therefore be administered.

In what position should the foot be placed after tenotomy of the tibiales, &c.?

It should immediately, and while the little patient is still under the anæsthetic, be securely fixed in the best attainable position. This has been my usual practice for years, and I have never seen the least harm result from it. What good can result from allowing the plantar fascia to unite feebly for a week or a fortnight, only to tear it afresh immediately afterwards? for surely no one will pretend that gradual screw extension can do anything else but simply tear open a recently united wound in the plantar fascia. With regard to the tibiales also, can any one demonstrate a case of non-union of either of them after tenotomy with immediate rectification of the foot?

Time to the surgeon and (ultimately) pain to the patient will be saved by, immediately after the operation, correcting the varus and fixing the foot in plaster of Paris, in poro-plastic felt, or in some form of Scarpa's shoe, after the manner already described.

The tenotomy punctures should be covered, each with a small thin pad of moist iodoform gauze, fixed with strapping as a rule.

An exception to the above rules occurs when there is any tendency to hæmorrhage, especially when Esmarch's tourniquet has been used. I then place over the iodoform gauze one or more wood-wool pads and bandage them firmly on. If they extend from the calf to the roots of the toes (they should not hide the toes), they will suffice both for *splint* and dressings.

After tenotomy of the tendo Achillis, should correction be immediate or gradual?

A slight but strictly limited amount should be made at once, and secured, but complete correction should only be aimed at by gradual extension, commencing a fortnight after the tenotomy and prolonged over several weeks. The tension may be increased every other day. In many, if not in most, cases the posterior ligamentous fibres of the ankle-joint, and not the newly united tendon, form an insuperable resisting force to immediate extension, and leave the surgeon no choice. This ligament should be forcibly stretched at the operation. Use the wood-wool pads at the first dressing in the way just described.

In correcting both the equinus and the varus the surgeon should aim at *over*-correcting. A tendency to relapse is almost certain. Treatment should therefore be prolonged and thorough. The actual time necessary depends upon the age of the patient, upon individual peculiarity, and upon degree of deformity. Two or three months may suffice to get the foot and ankle into good shape. But the patient should be watched for years afterwards.

In the case of an infant under a year old some appliance, such as the poroplastic splint, or Reeves's, or R. Jones's, should be worn until the power of walking has been acquired. The instrument should be reapplied at least once daily, and each time the foot should be rubbed, and its joints, including the ankle, well exercised by the mother or nurse, who should be carefully instructed by the surgeon.

Whatever the age of the child, as soon as good position combined with the power of walking has been obtained other instruments should be discarded for walking-irons and for simple night-troughs of poroplastic, wood, or metal.

What has been written so far applies almost as well to the period of early childhood as to that of infancy, excepting that the plasticity of the foot steadily decreases as growth advances. Nevertheless, when we reflect that the internal cuneiform does not usually begin to ossify till the third year, and the scaphoid not till the fourth, we *à priori* expect such means as those already described to contend successfully with talipes throughout the whole period of early childhood. And experience shows that under favourable circumstances it can do so. But later the condition of the foot skeleton changes materially, and at puberty the tarsus is almost completely ossified. The resistance it can then make to continuous pressure is shown by the fact that, notwithstanding the rapid increase of the body-weight and the long periods of standing and walking which most young people of the working classes are then exposed to, only a small proportion develop flat-foot. It is true, of course, that their plantar arches are still supported by untenotomised muscles; still, those muscles must frequently, in the class of persons in question, be wearied to the last degree.

Individual differences and the difficulty of recognising them until they are brought to light by experience, as well as the vast importance of the comparative circumstances of patients, would often make it very difficult to decide the best course to pursue with regard to a given adolescent suffering from talipes; but the surgeon will seldom err if he will always, in dealing with children and adolescents, earnestly endeavour to get the best attainable amount of improvement by means of tenotomy and division of fasciæ and ligaments before deciding upon the trial of more heroic measures, such as resection of bone.

In many instances he will find that the patient has already been tenotomised, &c., either altogether in vain, or else with temporary improvement and speedy relapse. The previous operator will perhaps have been some other surgeon, and perhaps himself. It will be necessary to consider whether the tenotomy, &c., and the after-treatment have been thorough; whether, *e.g.*, the tibialis posticus has been divided, and whether ligaments have been attacked at all. The surgeon will seldom be able to satisfy himself on these points, and it will be his duty to operate thoroughly on tibialis and ligaments, not hesitating, in order to ensure success, to make open incisions, of course antiseptically.

The skin itself may be a hindrance to correction. It must not be spared. Indeed, Dr. Phelps, of New York, went so far as to recommend the *free transverse division of the skin of the inner and plantar concavity* of all club-feet which cannot be (1) easily placed by the hand in a normal position, or (2) perfectly relieved by subcutaneous tenotomy with proper after-management.

The advantages of this operation, according to its author, are [1]—

1. It prevents the operator from needlessly cutting tissues not contracted.

2. Convenience for dividing tibialis posticus and ligaments.

3. Easy avoidance of plantar arteries and nerves.

4. Any deformity of bone can, if necessary, be remedied with a chisel after the soft parts have been cut.

5. Restoration of foot to its proper length.

6. 'It makes the surgeon master of the situation.'

In conclusion, he adds that osteotomy should not, as a rule, be performed as a 'primary operation,' and that 'certainly no operator can determine the amount of deformity in the bones until after he has relieved all the contracted soft parts.

These claims will not sustain critical examination; and,

[1] *Trans. Internat. Med. Congress* (Copenhagen, 1884), ii. 132.

indeed, all the arguments and statements of the advocates of Phelps's operation are unconvincing. Because, let it be premised that *in it the skin is cut transversely for some other reason than that it will not yield sufficiently to permit the shape of the foot to be corrected.* If otherwise, then the operation is not Phelps's, and the operation now done wholesale by various surgeons is also not Phelps's, because it is incredible that they have so many skin-bound cases of talipes. Excessively tight skin I have sometimes torn and sometimes cut transversely in talipes cases before I heard of the operation described by Dr. Phelps, and the necessity to either cut or tear it has sometimes occurred to other surgeons.

With the exception of such cases as these, *why should the ordinary and excellent rule of surgery, to prefer a longitudinal to a transverse incision, be departed from in talipes equino-varus?*[1]

At the 1889 meeting of the British Medical Association at Leeds (Section for Diseases of Children) I described the plan of (1) cutting from the redundant skin of the outer and dorsal aspect of the foot a flap with its base at the front of the ankle, and (2) turning this over to the inner and plantar aspect of the foot to fill the gap caused there by division of tense skin. This plan has been independently re-invented by Dr. T. H. Kellock ('Lancet,' 1895) and Mr. Muirhead Little. It is rarely needed.

The newly awakened zeal for open antiseptic incision has led to more than one funeral oration being pronounced over subcutaneous surgery. I believe that when the orators have had a few years' experience of the open method, they will find it will have given them a confident knowledge as to the position of what they want to divide and what they need to avoid, which will make an open incision useless in operating on any but quite exceptional cases of talipes by mere division of fascia, tendons, and ligaments. And what other soft structures need to be cut?

Nevertheless, Phelps's work in this department of surgery may be justly regarded as a bold and not unneeded protest

[1] Bessel-Hagen also advocated this open longitudinal incision at the Berlin International Congress.

against the current views of surgeons of the time. For were they not then mainly divided into two opposed and rather narrow-minded camps? One party taught that talipes was essentially an osseous deformity, nay, almost a purely astragalus deformity! The other wrote as if the most confirmed and frightful club-feet of adults could easily be corrected by old-fashioned and gentle means, similar to those which speedily straighten a recently contracted knee!

The truth must be again repeated that congenital club-foot is *both a bone and a joint deformity.* Phelps's operation and the mode in which he advocated it himself involved a needless division of skin and other innocent soft parts.[1]

With regard to the accusation of shortening the outer border of the foot, constantly levelled against anterior tarsotomy, if the foot is to be straightened, either its outer margin must be shortened or its inner lengthened. And what operation is there which can leave the soft parts of the inner and plantar aspect of the foot not absolutely deprived of all functional power, and which can at the same time lengthen the inner border of the foot? Moreover, excision of the astragalus shortens a little more an already somewhat shortened leg.

If all other means fail to give a satisfactory result, nothing remains but to consider the question of *osteotomy for congenital talipes equino-varus*, or else to resort to *instrumental osteoclasis.*

There are two chief forms of *osteotomy* for talipes varus. One is typified by excision of the astragalus, the other by removal of a wedge from the tarsus with its base at or near the cuboid.

But the number of different procedures is far more numerous. The following classification of operations on the bones for the cure of club-foot is due to Lorenz:[2]

[1] At the Berlin International Congress in 1890, Dr. Phelps came somewhat, in the practice he advocated, if not in the theories he proclaimed, into accord with the general tendency of modern orthopædic surgery, covering his retreat by firing a good deal of blank cartridge about 'degrading the orthopædic surgeon,' 'empiricism,' 'quackery' 'tinkering,' 'fooling,' &c. The free transverse incision had dwindled into 'If the skin is short, an open incision one-fourth the distance across the foot can be made.'

[2] 'Ueber die operative Orthopädie des Klumpfusses,' *Wiener Klinik*, 1884, p. 125.

A. *Osteotomies*

1. Linear division, with the chisel, of the scaphoid from the sole (Hahn).

2. Linear osteotomy of the tibia above the ankle-joint (Hahn).

B. *Enucleations*

a. Of a single bone

3. Of the cuboid (Little, Solly).

4. Of the astragalus (Lund, Erskine, Mason), with three modifications.

5. Of the astragalus, with excision of the point of the external malleolus (Erskine, Mason, Ried).

6. Erasion of the spongy substance of the astragalus, leaving its articular surfaces (Verebely).

7. Enucleation of the astragalus and excision of a perpendicular wedge (with its base external) from the whole thickness of the anterior process of the os calcis (Hahn).

b. Enucleation of several bones

8. Of the astragalus and cuboid (Albert, Hahn).

9. Of the astragalus, cuboid, and scaphoid (West).

10. Of the scaphoid and cuboid (Bennet).

C. *Resections*

11. Of the head of the astragalus (Lücke, Albert).

12. Of a wedge from the outer half of the neck of the astragalus (Hüter).

13. Of two wedges, at right angles to each other, one from the median tarsal, the other from the astragalo-calcaneal joint, both having their bases external (Rydygier).

14. Of a wedge from the tarsus regarded as a whole, and not from any special bone or joint belonging to it (O. Weber, Davies Colley, R. Davy).

To the above list of fourteen operations others might now be added; *e.g.* Verneuil has removed not only the astragalus, scaphoid, and cuboid, from the same foot, but also the anterior part of the os calcis. But Lorenz's scheme appears to me more logical than useful, and I recommend the student to arrange all the tarsotomies, tarsectomies, &c., in his mind as follows:

(1) Removal of the astragalus.

(2) Removal of bone from near the calcaneo-cuboid joint.

These two may be regarded as types of what have been called 'posterior' and 'anterior' 'tarsectomies' respectively. They claim priority also from an historical point of view.

With simple removal of the astragalus should be associated—

(1A) Removal of the astragalus, with excision of the point of the external malleolus.

(1B) Erasion of the spongy substance of the astragalus, leaving its articular surfaces.

With removal of the cuboid should be associated—

(2A) Excision of a wedge from the tarsus regarded as a whole, and not from any special bone or joint belonging to it, the base of the wedge being at or near the cuboid.

(2B) Removal of the scaphoid with the cuboid.

Entitled to form a third primary group are—

(3) Those operations conducted on the principle first practised by the late J. F. West, of Birmingham, who, commencing with the astragalus, removed one tarsal bone after the other, until he found he could get the foot into shape without sacrificing any more. He removed the astragalus, cuboid, and scaphoid. Verneuil, as already remarked, went on to

(3A) The removal of the same three bones, plus the anterior part of the os calcis.

Yet a fourth primary group consists of those whose acknowledged principle is to combine anterior with posterior tarsectomy. Its type is—

(4) Removal of the astragalus and the cuboid.

Allied to this, though in important respects a very distinct operation, is Rydygier's, viz.:

(4A) Resection of two wedges at right angles to each other, one from the median tarsal (Chopart's joint), the other from the astragalo-calcaneal joint, both having their bases external.

Groups 3 and 4 resemble each other a good deal in fact, but they differ in principle and intent.

With regard to linear division of the scaphoid, it is an operation which has attracted no attention, and it is difficult to see how it can even compare favourably with mere division of the calcaneo-scaphoid and other ligaments.

I have once tried linear osteotomy of the neck of the astragalus myself, but without any advantage. Nor can I see what I should have gained by following Lücke and Albert, and excising the head of the astragalus. Lorenz observes truly that the inner margin of the foot is already short enough.

Hüter's operation of removing a wedge from the outer half of the neck of the astragalus was founded on an imperfect theory of the anatomical nature of congenital club-foot. It is not, I believe, now practised or advocated by any one.

Osteotomy of the tibia and fibula is chiefly indicated in certain cases of traumatic talipes. But in congenital cases fair results may be got by combining it with anterior tarsectomy. It is not necessary to remove a wedge from the leg bone.

In commencing a comparison of the four groups into which I have divided the really effective tarsectomies for club-foot, let us at once realise that all these operations are remarkably safe, at all events when performed on children and adolescents. After 160 recorded operations collected by Lorenz there were four deaths. But two of these were, respectively, after diphtheria of the throat and after ulcerative endocarditis. The remaining two were cases of pyæmia and septicæmia respectively. The septicæmic case occurred in the practice of a surgeon noted for the contempt in which he then held antiseptic surgery. The pyæmic case was one of the earliest (1877).

But suppuration has been frequent, while necrosis of fragments and even erysipelas have occurred quite often enough to prove that tarsectomy is not an operation to be carelessly executed. It is also possible enough that there have been unrecorded fatal cases in the practice of surgeons of limited experience of the operation. The great rules of surgery must be applied with special rigour to operations about the foot, for there are few regions where the septic poisons can act more mischievously in adult and advanced life, or attack more effectively at any age.

Very good results may be attained by the wedge operation, *provided only that the soft structures in the concavity at the inner side of the foot, including the ligaments and tendons, and even the skin if necessary, be divided as freely as each case may demand.*

At first sight it is not quite clear how removal of the astragalus can undo the varus of the anterior part of the foot, except that it must, of course, tend to loosen the median tarsal joint, the centre of what may be termed 'the varus movement.' And, indeed, it is clear that 'posterior tarsectomy,' as excision of the astragalus has been called, must sometimes be ineffective, or else surgeons like West and Verneuil would not, after commencing with excision of the astragalus, have gone on to remove, successively, the cuboid, scaphoid, and even half the calcaneum before they could get the foot into good position. At the same time, I must say that I can scarcely bring myself to believe that in these heroic cases the ligaments, or perhaps even the tibial tendons, had been dealt with thoroughly.

Nevertheless, in estimating the value of resection of the astragalus we must not ignore the powerful testimony which has been brought in its favour. Take, for example, what Rupprecht writes in the 'Centralblatt für Chirurgie' (August 5, 1882). He had done anterior tarsectomy by the wedge operation nine times, and in the majority of cases had noticed a long-persistent tendency to relapse. He removed the astragalus eighteen times (all in the two years before writing), and in none of these had he any tendency to recurrence. On the contrary, the longer the time after operation, the more favourable was the result. The same tendency to improve has more recently been noted by Terrier in the case in which Verneuil removed astragalus, scaphoid, cuboid, and half the calcaneum. The last-mentioned 'thorough' mode of tarsectomy may be appropriately and conveniently named 'West's,' after the excellent and lamented Birmingham surgeon who introduced it.

In advocating Lund's operation (excision of the astragalus), Rupprecht argues that—

(1) What especially prevents a person with club-foot from treading upon the sole is neither the adduction nor the plantar flexion, but the supination of the foot. And he adds to this the statement that the cause of the last is the shape of the body of the astragalus.

(2) The wedge operation (No. 2A above) adds to a frequently already somewhat stiffened ankle-joint a synostosis in the place of Chopart's joint. And it also shortens the foot, both immediately and also by interfering with its growth.

After the removal of the astragalus there ensues either a movable joint between the tibia and the calcaneum, or else a useful mobility between the scaphoid and the anterior border of the tibia.

Now, to the above considerations various objections arise at once; *e.g.*, the shape of the astragalus is certainly not the cause of the supination. The two things are rather effects of the same cause (see Etiology). But it must, on the other hand, be acknowledged that one cannot be completely removed without interfering with the other. Again, does the loss of mobility in Chopart's joint after the wedge operation really do more harm than the injury done to the ankle by excision of the astragalus?

After all, it is not by anatomical and *à priori* considerations, but by experiment, that the comparative advantages of Lund's and the wedge operations must be decided. I can in this connection testify to the good orthopædic results of excision of the astragalus for strumous disease. Even when the external malleolus is removed at the same time in strumous cases, the injury to the gait and to the appearance of the foot is astonishingly small.

Operative Technique—Anterior Tarsectomy (removal of a wedge).—Esmarch's bandage must be applied. The skin incision should extend longitudinally along the outer margin of the tarsus, having its centre over or behind the most prominent part of the convexity caused by the varus. This usually corresponds to the calcaneo-cuboid joint. It had better be a little too long than too short. It should arch a little, with the convexity downwards. The extensor tendons are not in the way, and the peroneus tertius, with the soft structures on the dorsum of the wedge about to be removed, can be held up with a retractor.

The dorsal and outer surface of the bone to be removed should be thoroughly free from the superjacent soft parts, and the wedge removed in two or three separate slices with a chisel and a pair of 'necrosis forceps.' Up to the seventh year, or even later, a mallet or hammer is superfluous.

In this way a space is made, around which the chisel can work easily and freely to enlarge it in any direction, until a wedge has been removed having its apex on the inner side of the foot. I have found no difficulty in operating in this way, though pains must be taken to avoid leaving any semi-detached fragments of bone, which might necrose.

Many surgeons prefer a narrow-bladed saw to the chisel, and thrust in a very broad director, first above, and then below, to protect the soft tissues. With the saw the wedge is removed *en masse*. It must, however, sometimes happen that when the wedge has been thus removed it is found desirable to remove still more bone, and then I imagine the chisel would be more convenient than the saw.

For almost every kind of osteotomy I prefer the chisel to the saw, on general grounds. But the surgeon should be practised in its use, and should not make his first experiments with it on living human beings.

It will sometimes happen that, when the wedge has been removed, the foot can be brought into good position, but can only be kept there by the exercise of considerable force. I would deprecate, in such cases, the hasty sacrifice of more bone. Attention should be turned from the convexity to the concavity of the foot, and all tense soft structures on the latter aspect freely divided, through an open longitudinal skin incision, if need be.

The operative measures being completed, antiseptic dressings should be applied with great exactitude, firmness, and snugness, and the limb kept elevated for hours afterwards to prevent recurrent hæmorrhage, which would necessitate speedy change of dressing and consequent disturbance.

Partial rectification should be immediate. Wood-wool pads will themselves serve for splints during the first few days.

When the sutures are removed a comparatively light dressing will be needed, and then is the time to put the foot, with anæsthesia, into plaster of Paris and into correct position.

Excision of the astragalus is made easier in a talipedic than in a normally shaped foot by the bone's prominence anteriorly and externally.

An incision should be made curving round the margin of the external malleolus from near the tendo Achillis, and reaching downwards and forwards over the neck and prominent head of the astragalus. The former tendon and the tendons of the peronei longus and brevis may be divided, and afterwards the ligaments passing from the fibula to the astragalus should be cut away from the latter bone. After the careful division of a few more ligamentous fibres the assistant must wrench or turn out the foot, exposing the upper or trochlear surface of the astragalus, and enabling the surgeon to reach and cut away the deltoid ligament at its astragaloid attachment. The interosseous calcaneo-astragaloid ligament is not easy to get at, but it can be cut with a strong scalpel, while the astragalus, seized by the neck with a pair of strong forceps, is at the same time twisted and wrenched.

The peronei tendons should be sutured with catgut; the tendo Achillis may be left divided.

After this operation immediate adjustment of the wound and fixation of the foot in good position with plaster of Paris is the best plan.

In removing the astragalus, a spud, or chisel curved on the flat near the sharp end, will be found useful.

Old and neglected cases of club-foot in adults are occasionally seen in which a combination of anterior and posterior tarsectomy, tenotomy of the tendo Achillis, free division of ligaments, &c., on the concave aspect of the deformity, and the exercise of considerable force as well, would be fully justified, and in which nothing less could be expected to produce a respectable and permanently good result. Some surgeons recommend for these cases a Syme's amputation, on insufficient grounds I think.

When 'immediate reduction' of the deformity is effected after mere tenotomy, &c., of an ordinary case of congenital club-foot, some force is usually necessary, and the surgeon supplies it with his hands. But greater force may be required under certain circumstances :

(1) When the case is of long standing and, especially, if it is also of great severity.

(2) When the surgeon's own muscular strength is below the average, and his experience small.

(3) When he objects to tarsectomy and to operations which freely divide the soft parts.

Under such conditions the surgeon can, in the *first* place, have the leg above the ankle fixed against the edge of the table by a strong assistant, who should bring his weight as well as his strength to bear by keeping his arms straight and perpendicular, standing on a stool for the purpose if he is not tall enough otherwise. Then the surgeon himself has *both* his hands and his whole weight free to act upon the foot.

Still, there are a few adult cases too resistent even for this method, and the feet of small children do not always give room for a proper grasp.

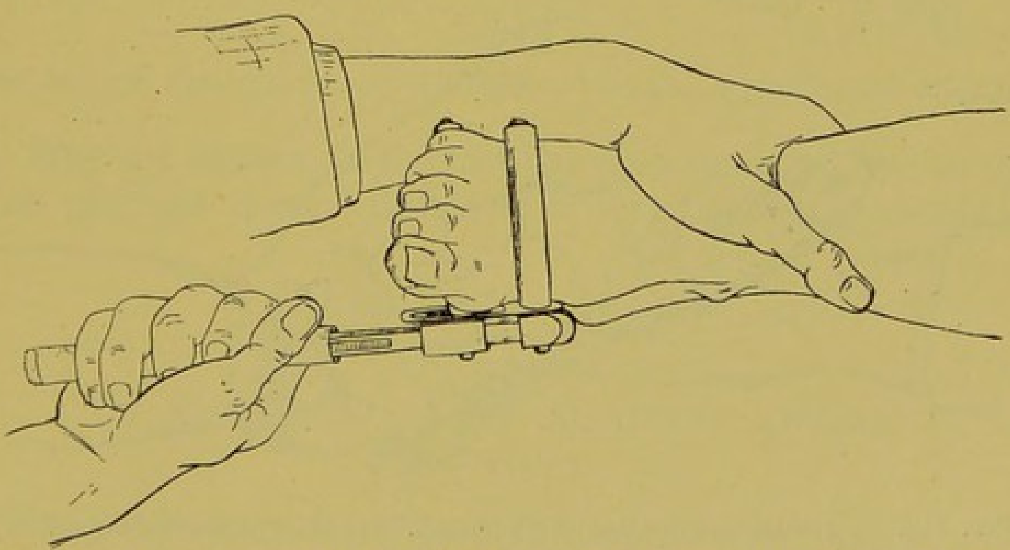


Fig. 109.—To illustrate the use of Thomas's Wrench. (After Robert Jones.)

For these cases various instruments have been devised.

Almost the whole tribe of osteoclasts can be adapted to club-feet, at least in principle.

Among special instruments (1) Thomas's club-foot wrench, (2) Morton's, (3) Redard's, and (4) Bradford's are perhaps the best known.

Bradford's consists of a long bar, to which are attached a hook to press upon the head of the astragalus, a small plate to fix the anterior part of the foot, and a handle. The long bar is placed along the inner border of the deformed foot, after tenotomy and manipulation have straightened it out as much as possible. The hook is slipped along the bar, fixed by a screw, and then the grasp of the hook made firmer by means of another screw. The small plate, with the small bar belonging to it, is now slipped along the main bar and the anterior part of the foot fixed. Then the handle is placed on the bar. An assistant fixes the leg, while the surgeon brings the lever into action.

Redard described his apparatus, which is also worked with a lever, at the French Congress of Surgery in 1889.

Thomas's[1] consists of an adjustable wrench with two straight and parallel arms at right angles to the handle or lever bar.

Morton's[2] was the original mechanical appliance described specially for '*brisement forcé*' of club-foot. It consisted of

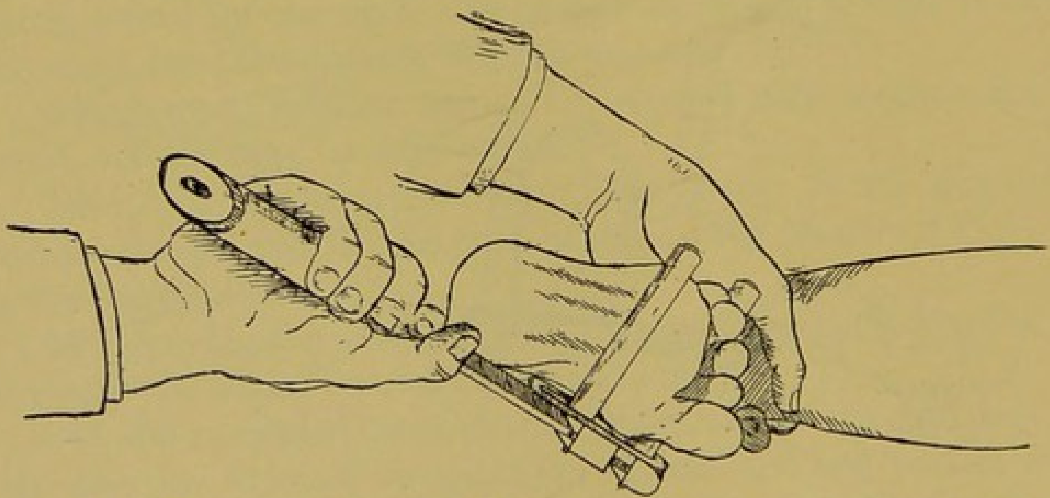


FIG. 110.—To illustrate the use of Thomas's Wrench. (After Robert Jones.)

a board and straps. A modification is described by Bradford and Lovett in which screws are substituted for the straps.

Recently, Mr. William Thomas, of Birmingham, has con-

[1] H. O. Thomas, *On Fractures and Dislocations*, London, 1890, p. 27; Bradford, *Rev. d'Orthopédie*.

[2] *Boston Medical and Surgical Journ.*, 1881, p. 241; and Bradford and Lovett, p. 484

trived a wrench, in shape rather like an Allingham's pile-crusher, but of course much larger. It seems to be an effective instrument.[1]

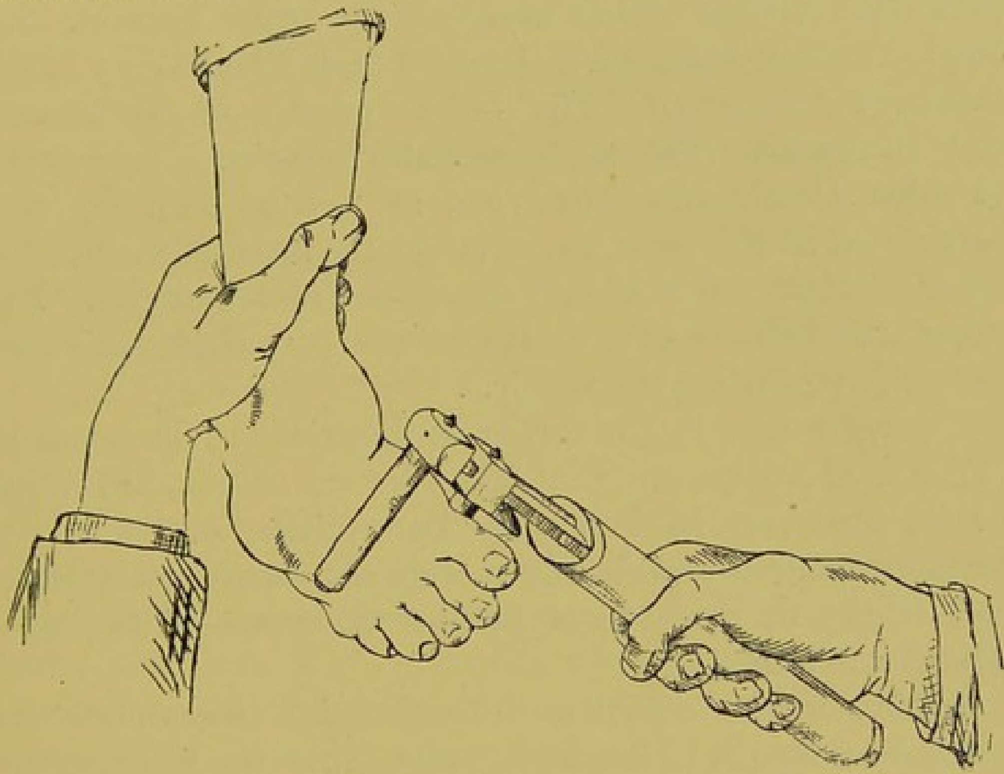


Fig. 111.—To illustrate the use of Thomas's Wrench. (After Robert Jones.)

After the position of the foot has been corrected by one of these machines it must be placed in some fixation apparatus.

ON THE REUNION OF TENDONS AFTER TENOTOMY

Many experimental studies of this subject were made in this country by John Hunter, Mayo, Paget, Savory, and William Adams, and on the Continent by von Ammon, Pirogoff, Gerstaecker, Thierfelder, and Boner. Adams also had and used many opportunities of examining the tendons of persons who died at various periods after tenotomy. The first effects of tenotomy are separation of the cut ends and the effusion of more or less blood between and around them. This

[1] British Orthopædic Society, current session (1899).

effused blood does not appear to fulfil any useful purpose, and, if it is excessive, delays union. Increased vascularity of the sheath ensues, and probably helps the process of repair. The reparative material which occupies the space between the retracted tendon segments was named first, I believe, by Paget 'nucleated blastema.' The red corpuscles of the effused blood disappear. The white probably remain. Dembowski and other Continental observers, as well as Ballance and Sherrington in this country, came to the conclusion that the nucleated blastema is at first composed of leucocytes. But Korner and Beltzow gave to the tendon corpuscles the credit of actually producing the repair.

The references to the earlier authorities can be found at p. 17, &c., of Adams on 'Club-foot,' second edition, 1873, and to later observers in Tubby on 'Deformities,' p. 318 *et seq.* The more modern experimenters were able to carry the microscopic study of the subject further by means of improved methods of staining, &c.

Tubby, whose excellent experimental researches are reported at length in his book, states that the leucocytes in the reparative material serve only as pabulum for the plasma cells derived from the connective-tissue spaces of the tendon and from the vessels of the tendon sheath.

He does not believe either that tendon is capable of perfect regeneration, or that primary union of tendon is possible. In these respects he confirms the views of Adams, who does not seem to regard the new material between the cut tendon ends as being itself true tendon.

Regarding the subject from a practical view, I am inclined to think that experimental studies of tendon repair support the views of Syme and Gross, who seem to have been the pioneers in the practice of immediate (as opposed to gradual) reduction of deformity after tenotomy.

CHAPTER X

HYSTERIA IN RELATION TO ORTHOPÆDICS

Spinal curvatures, as well as paralyses and contractures of the limbs, are sometimes hysterical in their nature. Although such affections may persist far on into middle life, they almost always originate during adolescence. In the great majority of cases they are symptomatic of some disorder of the genital organs, a disorder not usually amounting to severe, coarse organic disease.

It is true that serious diseases of the genital organs are often accompanied by hysteria, but this combination occurs in different classes of patients from those who usually come to the orthopædic surgeon. For example, a married woman or an immoral single woman with chronic endo-cervicitis may be hysterical enough, but if she has a contracted or painful knee it is more likely to be gonorrhœal, pyæmic, or rheumatic than hysterical. On the contrary, if a respectable girl in her teens is hysterical and has a contracted knee, and if tubercle can be eliminated from the diagnosis, hysteria is very likely to be the main factor in her case.

What the anatomical changes in the genital organs of such a girl may be is not known; but I believe some nearly always exist. Judging by analogy from the other sex, dilatation of the pelvic veins analogous to varicocele would possibly be one of the changes. Whatever the changes are, it is certain that they are sometimes caused by masturbation. Some patients have signs of this affliction, or vice, plainly written in their manner, and even in their faces. In one or two instances I have been informed of its existence in young hysterical women of appearance so comparatively frank and bright that I should not have suspected it.

The various manifestations of hysteria often seem to be excited by depressing emotions of different kinds and origins.

An hysterical joint or limb is in the first place marked by the absence of symptoms generally or always associated with the disease simulated. For example, take a knee hysterically contracted. The circumference of the knee is *not* increased; that of the thigh is *not* decreased. The knee is *not* warmer than the other, unless it has been warmed by coverings. There are *no* genuine night-startings coming on in sleep. The subjective signs elicited by pressure and movements are *not* altogether independent of what occupies the patient's attention.

A difficulty sometimes arises when the patient has got or has had recently some *bonâ-fide* organic disease or injury of the knee, on which hysteria has been grafted. Experience, and reservation of the judgment until careful consideration has been given to *all* the symptoms, individually and collectively, should enable a right decision to be reached. When there is swelling in such hysterical *ci-devant* organic cases, it is often less limited than when hysteria is absent; *e.g.*, instead of being confined to the knee it may extend down to the ankle and foot.

A doubtful diagnosis may sometimes be cleared up by examination under anæsthesia.

The *prognosis* is good with proper treatment, or rather management, of the patient; but without sensible management an hysterical contracted joint or curved spine may last a sufficient number of years to spoil all the patient's prospects and the best years of her life.

Hysterical Spine

There are *two principal kinds*. *No.* 1 *simulates angular* curvature, *No.* 2, *lateral.* Angular curvature and caries are imitated in the numerous cases in which several spinous processes, usually dorsal, especially lower dorsal and dorso-lumbar, are, or seem to be, more prominent than the rest. The patient is usually a young woman between seventeen and thirty years of age, and often rather thin. She complains of pain in the spine itself, either in the situation of the prominent vertebræ or in the sacral or lumbo-sacral region. The older she is, the more likely is the lowest part of the spine to be the seat of the pain; and it is, especially in single women, not easy to distinguish genuine hysterical cases from those in which the pain is not exaggerated at all, but merely reflex and symptomatic of intra-pelvic disease. In younger women who complain of pain in the *dorsal* region the diagnosis is less difficult. There is usually superficial tenderness, sometimes greatly exaggerated; and the pain as well as the tenderness is in the spine itself, where the vertebræ are prominent, and sometimes also over other spinous processes.

In caries this tenderness is rarely superficial—indeed is often not easy to elicit at all by any force which a gentle surgeon would use; but its presence can be detected by the care the patient takes not to hurt herself by movements. And the pain extends along the course of the inter-costal or lumbar nerves to the pit of the stomach, or the sides and front of the abdomen. Moreover, the merely hysterical spine is not rigid like the carious spine. Of course, when the patient is tuberculous elsewhere or has a lumbar or psoas abscess, it is easy to get on the right scent. With regard to rigidity, the surgeon should place the patient so that he sees her in profile, and, watching the outline of the spine very attentively, make her alternately and slowly bend forward and straighten herself or rather bend backward.

Hysterical simulation of lateral curvature usually, at least, commences before twenty years of age. The lateral inclination of the spine is marked and the signs of genuine rotation are absent, and this from the very commencement. On the other hand, at the beginning of a case of true lateral curvature of the spine the signs of rotation can be discovered more easily than those of lateral flexion of the spine. And actually, in genuine lateral curvature the peculiarities generally first noticed by the patient's friends are signs of rotation rather than of flexion. For example, they are the projection of one shoulder-blade, or of one hip, or of one nipple, or of the rib-cartilages near the sternum of one side.

An almost universal error, fostered greatly by practitioners in 'Swedish movement cures' and other teachers of special, more or less pretentious, gymnastics, is that there is a stage of well-marked lateral inclination of the spine, without rotation, which is the first stage of true lateral curvature of the spine. No such stage exists. A lateral inclination of the spine without rotation is either hysterical, or reflex, or spasmodic, or a piece of malingering. It has no tendency to go on to true lateral curvature, whether treated or not treated, excepting only when it is secondary to some contracting cicatricial lesion, such as an empyema. Empyemic lateral curvatures, of course, form a class by themselves.

Hysterical, malingering, and reflex lateral curvatures of the spine furnish some of the cases whose photographs, 'before and after treatment,' are given in proof of alleged cures of genuine scoliosis. Others of these photographs represent merely the different appearances presented, according to the degree of exertion or skill with which the patient, or the medical man guiding her, attempts to hide the deformity, temporarily, by position.

No such photographs as I have seen have received that corroboration which would be necessary to make them trustworthy for scientific purposes.

Treatment.—In the first place, pains should be taken to discover, if possible, some local trouble of a physical nature, or some habit of life, or some mental or moral cause of distress, and to remove it. The effort will often be unsuccessful, but it should never be omitted. Tact and discretion are required. The young medical man who accused the patient of eating a horse because he discovered a saddle under the bed is a caricature, it is true, but not an absolutely false one, and he may be cited as a warning.

It has been indicated that sexual trouble is beyond doubt at the bottom of many of these hysterical cases. The actual nature need not necessarily be anything so coarse as masturbation. It is sometimes sentimental. People can, even at a very early age indeed, or at an age far from early, imagine themselves hopelessly blighted in love by the indifference of the object. They may even, strange to say, be depressed by merely general want of confidence in their own capacity to excite admiration and sympathy, at least to the degree desired —a state of mind, it need not be said, comparatively rare among young men.

There are hysterical young women suffering from simulated diseases whose trouble would vanish if, by a prescription, one could make them good-looking and attractive. And something can be done in that direction by inducing them to rise early and not sit up late, to live an outdoor life, and not to look upon so large a share of happiness as their due in life, but to try to take things more patiently, just as they come. Such habits and such a frame of mind are directly conducive to good looks, and by delicately pointing this out a powerful motive can be set to work. Solitude is a bad influence, and cheerful—not too sympathetic, and yet not unkind—companionship, night and day, if possible, a most beneficial one. With regard to diet, it should be always plain, unstimulating, digestible, and regular. Where anorexia exists to a severe degree, half-measures do not suffice, and the patient may have to be isolated from her friends, and, in fact, subjected to the Weir-Mitchell treatment.

Hysterical spinal curvatures sometimes disappear quickly under influences unseen and even unsuspected. Any strong motive seems capable of removing them.

Gymnastics and outdoor games judiciously used, *i.e.* not absolutely forced upon the patient, and not used to excess, are beneficial. 'Special' gymnastics, by persons who pretend to regulate the development of the different muscles, &c., are an imposture, and mainly differ from other gymnastics taught by intelligent instructors in being more expensive. Gymnastic teachers are apt—unconsciously, perhaps, and misled by reading books about 'movement-cures'—to glide into quackery. All who pretend to trouble their heads much about the action of the muscles, and to modify the exercises with reference to the position and direction of the curvature, are to be avoided.

A simple change from town to country, with removal from friends to a house or institution where early hours and regular habits are strictly adhered to, suffices to cure some cases, without any other treatment whatever, especially if the curvature simulated be angular.

With regard to medicine, good sometimes follows the use of tinct. valerianæ co. in ʒj doses; but I have never known a case cured by it. I think bromides, and still more morphia and opium, are to be avoided. Nothing radical can be expected from iron or other tonics, but, like purgatives, they may be used if special indications seem to call for them.

One of the best exercises for the hysterical, when they can be induced to take it, is swimming, especially in the sea. A useful and, if possible, interesting occupation is valuable, but it should not be exhausting; and there are cases of hysteria so bad that their treatment should be commenced with rest in bed, but not at home or among friends.

CHAPTER XI

WRY-NECK AND SPASMODIC WRY-NECK

Wry-neck

There is a certain ambiguity about this as about many other terms in the nomenclature of disease. A name is given to a roughly defined group of symptoms, or perhaps to one well-marked symptom. Time and observation differentiate several distinct, perhaps vitally distinct and contrasted, pathological conditions at the bottom of different cases respectively. If a minority of cases are found to depend on a disease far more serious than the original symptom which has attracted attention, there will be a tendency to cease to name such cases after the mere symptom, and to associate them rather with other cases of the primary disease. Hence there are few surgeons who now would follow the old-fashioned practice of speaking of a case of cervical caries as a form of wry-neck.

Again, when from its comparative commonness, its intrinsic interest, and the regularity of its symptomatology, one particular pathological condition seems to demand a distinct name all to itself, it is apt to arrogate to itself exclusively the name which in times of vague pathology it shared with other conditions, different essentially, though similar superficially. For this reason contraction of the sterno-mastoid is coming more and more to be regarded as the only affection having a thorough claim to be called 'wry-neck;' and even cicatricial contractions of the skin after abscesses and burns, whatever may be the position in which they place the head, are no longer granted the name in question.

Therefore this chapter will be devoted to the consideration of

Wry-neck due to Contraction of the Sterno-cleido-mastoid.—The deformities resembling this affection will be referred to when treating of its diagnosis.

Etiology.—Wry-neck is thought to be usually congenital, but it frequently comes on later in life, especially about the time when childhood is passing into adolescence; and it often escapes the parents' observation until it has existed for some years. A practice followed by Golding-Bird, viz., that of looking in the family photographic album at portraits some years old, may indicate if not demonstrate this.

When congenital, it has sometimes existed in utero, and may be observed immediately after birth; but, more frequently, it is rather what is believed to be the immediate cause which is noticed at or soon after birth, while the wry-neck itself begins to develop not less than a fortnight afterwards. The immediate cause referred to is traumatic hæmatoma of the sterno-mastoid, produced at the time of birth. It was first noted by Stromeyer, who also remarked that wry-neck was comparatively frequent after breech presentations. The trunk and limbs then coming first, during the short time the child, as it were, hangs by the head in the maternal passages, there is a natural liability to sprain of the sterno-mastoid, rupture of some of its fibres, extravasation, and subsequent absorption with cicatricial contraction. The swelling itself may be observed, and sometimes ecchymosis appears as the extravasated blood comes towards the surface.

Petersen controverts Stromeyer's theory that wry-neck is caused by contraction of the cicatrix with which a torn sterno-mastoid heals. He points out that the usual effect of rupture of muscle is not shortening, but lengthening. He is doubtless right, and the scanty exceptions to this rule which have been brought forward in opposition to it really only tend to prove it. But when he says that the infant's sterno-mastoid which has been ruptured in the act of birth was previously contracted, and that the contracture caused the rupture, and not *vice versâ*, I think he assumes too much.

It is possibly not the ruptured muscle fibres, but the torn vessels among them, or at least inside the muscle sheath, which produce the eventual contracture, and the process may be analogous to the production of shrivelled ear by hæmatoma auris.

This theory affords a hypothetical and plausible explanation of why some cases of rupture of the sterno-mastoid at birth are followed by wry-neck, and others not: in the former extravasation may have been slight or localised, in the latter considerable and diffuse. It is also consistent with the state of fibroid degeneration in which the *whole* muscle is sometimes found.

Fabry found that, of 14 cases of torticollis in Trendelenburg's practice, 12 followed difficult birth. Zehnder noticed the same 11 times out of 22 at Berlin, and Hensch 24 times out of 35—as a rule breech and foot presentations, rarely forceps delivery (Hoffa, p. 190). Of thirty cases of congenital hæmatoma of the sterno-mastoid observed by Clutton, Edgar Willett, and D'Arcy Power, 'eleven eventually had wry-neck.' In two of these it is described as having been very slight, and in four only is it said to have been necessary to divide the tendon.[1]

It is said that syphilitic infiltration of the muscle and after-contraction, with or without suppuration, may bring on torticollis in childhood. And, during adolescence, glandular

[1] D'Arcy Power, *Med.-Chir. Trans.* vol. 76, 1893, p. 147. For Clutton's paper, see *St. Thomas's Hospital Reports* for 1888.

abscess has been known to be followed by contraction of the neighbouring sterno-mastoid (Koenig). But these causes are quite exceptional.

Permanent contraction of the sterno-mastoid is also said to be sometimes of purely rheumatic origin, and has even

FIG. 112.—WRY-NECK. CONTRACTION OF RIGHT STERNO-MASTOID. Note how the face and neck are, as it were, moved laterally to the patient's left, until they lie almost altogether over the left half of the trunk. Note the scoliosis or asymmetry of the face and head.

been occasionally attributed to a continued bad habit of holding the head awry. But it is doubtful whether any satisfactory proof could be offered of either of these statements; although rheumatism of the cervical vertebræ and their joints will undoubtedly produce cases of distorted neck. That is, however, a different thing from rheumatism of the sterno-mastoid or its sheath.

The primary injury to the sterno-mastoid at birth is sometimes, but not commonly, caused by the use of midwifery forceps.

Fischer, of Hanover, relates an instance in which torticollis, pes equinus, and contracture of the pronators of the right fore-arm co-existed. In this, and also, perhaps, in the cases where strabismus and wry-neck are congenital in the same patient, it is possible that the cause may lie in the central nervous system. It is also possible that such cases as Fischer's may be the result of intra-uterine pressure.

But surely those who ascribe ordinary examples of congenital wry-neck either to paralysis or to pressure ignore the pathological anatomy of the sterno-mastoid. Compare the fatty gastrocnemius of a case of infantile paralytic talipes with the fibroid changes so often found in the sterno-mastoid of wry-neck.

Wry-neck, when acquired after birth, sometimes appears after an attack of one of the continued fevers. It may then be possibly due to a chronic specific myositis or to a contracture of nervous origin.

Pathology.—Autopsies have been few. But Skrzeczka found extravasation into the sterno-mastoid and its sheath in three infants with congenital swelling of that muscle. Bouvier found, in one case of wry-neck, the sterno-mastoid shorter, thicker, and its muscle fibres partly in a state of fibroid degeneration. At the same time, although the case was congenital and the patient some years old, with a marked degree of apparent scoliosis, he found scarcely any change in the shapes of the cervical vertebræ.

In open antiseptic section of the muscle, as Volkmann has pointed out, cicatrices are sometimes seen in it, but not always.

Dr. J. Vollert, who had the privilege of examining the specimens from the illustrious v. Volkmann's three last cases (which were typical), thus describes what he noticed at the operations by open section: 'The exposed muscle showed very clearly a circumscribed segment of fibroid degeneration in its substance. It had a peculiar bluish white, shining, and reflecting appearance ('Sehnenfleck'), at least in two cases; in the third the tendinous shimmer was not so plainly visible, but only a whitish streak in the muscle, and a lighter shade of colour in a short extent of it. The division made a crisp noise, like that of a tenotomy of the tendo Achillis.'[1]

As Volkmann himself stated, the above-described condition of things is frequently not seen, at least in 'autopsies *in vivo*;' and it is possible that then the wry-neck may have had a different origin. It must, however, be remembered that in a mere operation the part of the muscle affected might escape exposure, and it is remarkable how large a proportion of the few *post-mortem* examinations recorded have shown the fibroid degeneration.

Sometimes the muscle is converted into the semblance of a short, narrow, thin, and forked tendinous band. The contracted muscle may be barely half the length of its fellow. Guyon, describing a specimen taken from a man of fifty-three, in whom wry-neck had been first noticed at four years of age, writes that, besides being very short, narrow, and thin, it appeared, at first sight, to consist entirely of the sternal portion, to which the clavicular was added as a mere slight appendage.

With regard to the vertebræ, in the autopsy made by Bouvier, a particularly keen observer of slight irregularities in vertebræ, only the body of the axis was a little thin on the right (the affected) side. The subject was a young girl, twenty-three years of age, wry-necked from infancy to such a degree that one sterno-mastoid was only half the length of the other. But Witzel found in his case wedge-shaped vertical bodies. And Fischer says that they sometimes have wedge-shaped bodies, thinned towards the concavity of the wry-neck. Even in the living subject the asymmetry and obliquity of the facial bones of the cranium, and especially of the lower jaw, may be perceived at a glance.

The right sterno-mastoid is affected at least twice as often as the left, and the sternal head is almost always more tense than the clavicular, and it may be affected alone. The cases recorded of contraction of the clavicular without that of the sternal head are comparatively few. Of the cases of conge-

[1] *Centralblatt für Chirurg.*, No. 38, 1890.

nital hæmatoma given by D'Arcy Power, he states the side affected in 14. It is significant that 9 were on the right, 4 on the left, and 2 double.

The neighbouring cervical fascia, especially the muscle sheath, is also shortened, and bands of it may spring into prominence during myotomy. The cervical triangles are necessarily reduced in size on the affected side and enlarged on the other.

The scoliotic curve of the cervical and upper dorsal spine has a compensatory curve in the middle and lower dorsal, and another in the lumbar region. Nicoladoni, however, argues that the dorsal curve is the primary, and caused by the weight of the head being brought so much over to the sound side! This seems rather like going out of the way for a reason.[1] When scoliosis is present, it is accompanied by the usual changes in the thorax and pelvis.

But the most remarkable co-sign of wry-neck is the *asymmetry and curvation of the face and skull.* By far the most thorough study of this has been made by Witzel of Bonn.[2] Indeed, his is the only thorough *post-mortem* examination of all the collateral changes in torticollis that has been put on record. It is therefore worth while to give an abstract of it.

The subject was a woman, forty-four years old, with a congenital sterno-mastoid contracture affecting the *left* side.

Soft parts of the neck.—The right anterior triangle is larger, the left smaller than normal. On the right are seen, in order from without inwards, several cervical transverse processes, covered with muscle, the carotid artery and the jugular vein, all nearly on the same transverse plane. On the left, the carotid artery lies behind even the larynx. A line through the middle of the hyoid bone, the larynx and trachea, passes downwards and to the right, behind the right sterno-clavicular articulation.

While the right sterno-mastoid is a broad and long band of muscle, sweeping obliquely and sinuously round the neck, close to the cervical spine, the left is a short, narrow, and round fibrous band, bifurcating nearly in its middle, its outer

[1] Wiener *Med. Jahrb.* 1886, p. 263.
[2] *Deutsche Zeitschrift f. Chirurgie*, 1883, p. 534.

part almost perpendicular, and the whole of it far removed from the vertebræ.

The common carotids of the two sides show no perceptible difference in calibre, nor do the two vertebrals.

The spinal column and thorax and pelvis show the appearances usual in ordinary scoliosis. The cervical and the lumbar spine curve with convexity to the right, the dorsal with convexity to the left. The natural kyphosis of the upper part of the spine is increased. So is also the lumbar lordosis. The pelvis is lowered to the right, and at the same time rotated in the same direction. The thorax is 'pushed *in toto*' upwards and towards the left, so that the left sterno-clavicular articulation lies perpendicularly below the corresponding mastoid process. The sternum lies in a line inclined upwards and to the right.

The cervical spine.—The vertebral bodies are higher on the convex than on the concave (left) side, the transverse processes still more asymmetrical. These changes are most marked in the upper half of the neck. The joint surfaces are smooth, and the ligaments only altered in adaptation to the bone changes.

The odontoid process of the axis, besides being inclined to the left, is so rotated (apparently, at least) that its anterior articular surface looks towards the right.

The two lateral masses of the atlas are very unsymmetrical. The articular surface for the odontoid process is widened and displaced to the right.

The skull.—For descriptive purposes, Witzel imagines two planes, each bisecting the other at right angles, and both at right angles to the base of the skull. One passes transversely through the two anterior condyloid foramina. The other passes antero-posteriorly midway between the two condyles, cutting the foramen magnum into two lateral halves. The external tuberosity of the occipital bone lies to the left of this (see phototype, fig. 113). On the upper surface of the cranium the sagittal suture runs forward, diverging increasingly to the left of this plane. In front, the middle of the glabella and the point of the anterior nasal spine lie 1·5 cm. to the left, the posterior end of the median suture of the hard palate

1 cm., the anterior end of the right paro petrosa 1 cm. away, and that of the left 3 cm. distant (see illustration, fig. 113).

The fronto-facial plane (that which runs through the infra-orbital margins) converges to the left, with the trans-condyloid plane. In short, *when regarded from below, the*

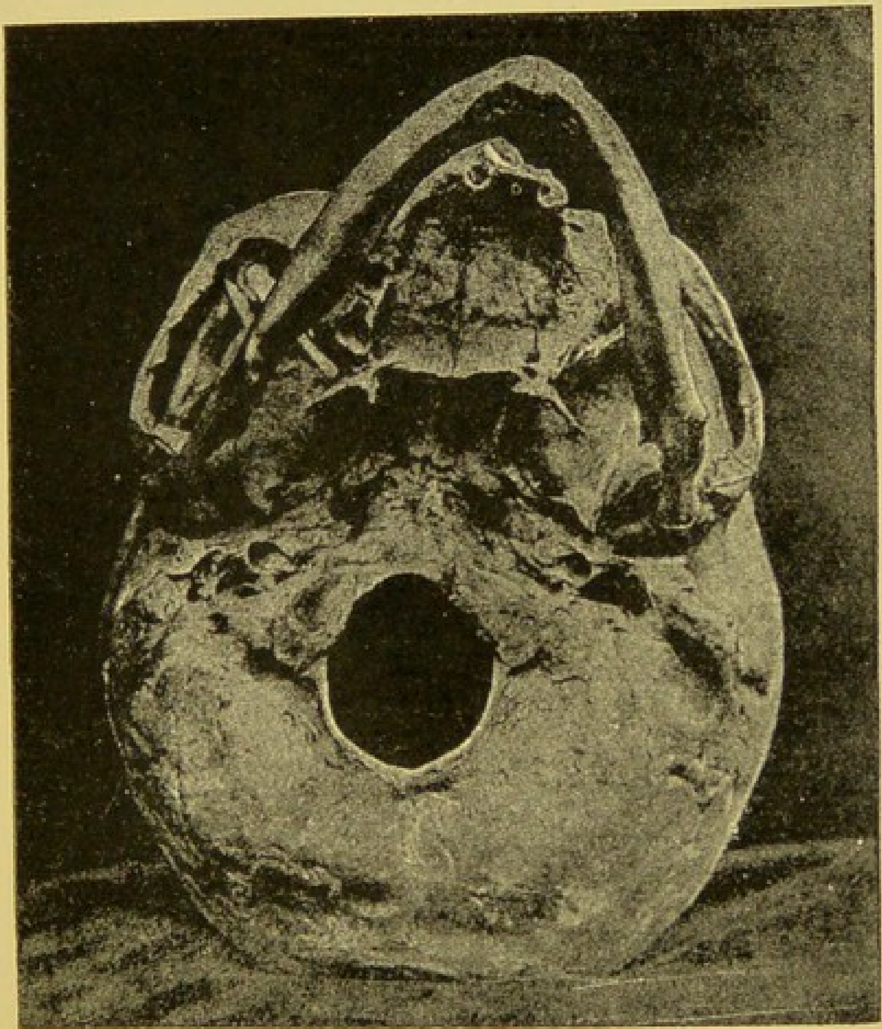


Fig. 113.—Under Surface of the Base of the Skull in Wry-neck. (After Witzel.)

middle line of the skull curves with the concavity towards the left, especially in the facial region.

With regard to the horizontal plane, the facial part of the skull is drawn downwards.

Measurements gave very significant results: *e.g.*, the distance between the middle of the mastoid process and the posterior condyloid foramen was, on the right, 2·8 cm., on the left, 3·8 cm. *The base of the cranium is therefore much narrower on the right than on the left side.*

The appearance of the inside of the skull corresponds to that of the outer. The right cerebral fossæ are longer and narrower than the left, and the crista galli lies 1 cm. to the left of the sagittal plane between the two condyles.

The highest part of the convexity of the skull runs from the right anteriorly to the left posteriorly. The oblique

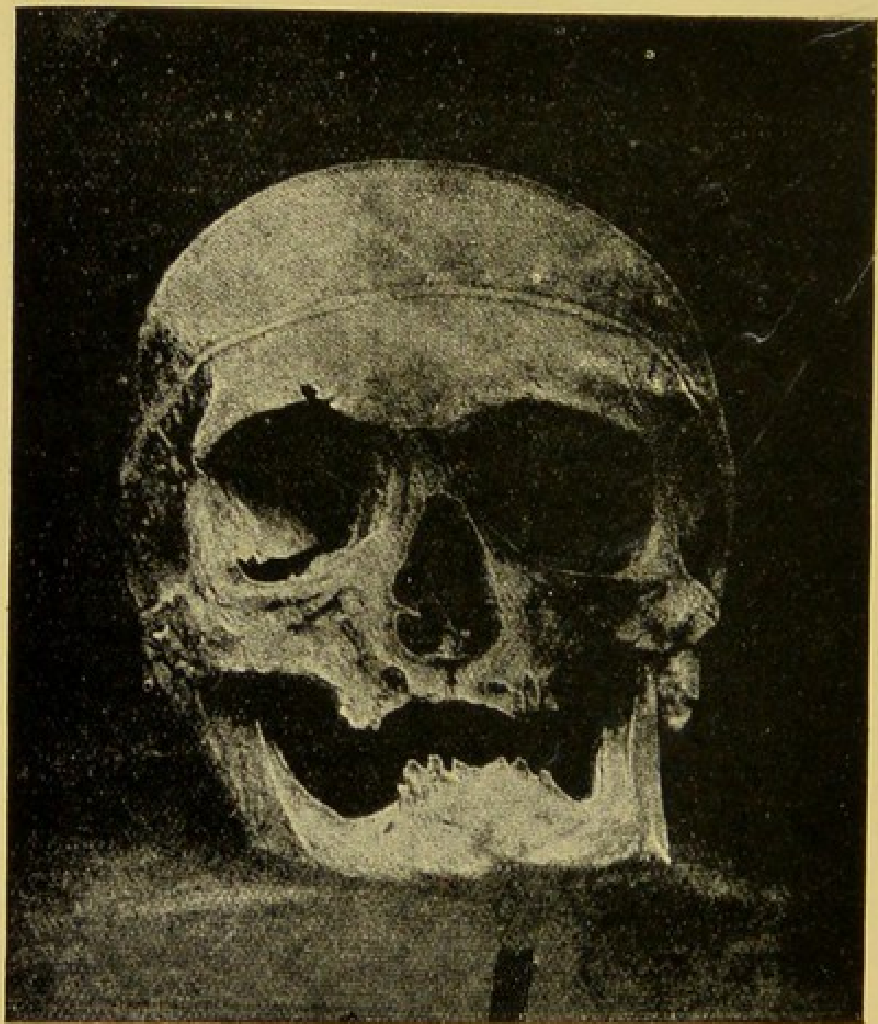


Fig. 114.—Facial Bones in Wry-neck. (Witzel.)

diameter between the right frontal eminence and the left parietal is longer than the other one. The right frontal region and the left occipito-parietal are more arched than the corresponding parts.

Skull of the face.—As fixed positions of comparison for this, Witzel takes (1) a line passing between the two supra-orbital foramina, (2) a sagittal plane bisecting that line. This plane falls not between the two central incisors, but, in the upper jaw, through the right canine, and in the lower through the right first molar, and 2 cm. to the right of the 'spina mentalis anterior.'

The lines through, respectively, the supra-orbital foramina, the infra-orbital, and the mental converge towards the left. But the right side of the face, though longer, is narrower, and the right orbit, though higher, is narrower than the left. The other osseous details of the face correspond. The right canine fossa is shallower than the left, and the angle of the facial surface with the temporal of the zygomo-malar arch is flatter on the right than on the left. As an example of measurements, the right fronto-zygomatic suture in the outer margin of the orbit is 7·5 cm. from the anterior nasal spine, the left 6·6 cm. *The upper part of the skull of the face is, in relation to the cranium, displaced backwards and to the left, and the left half shorter and wider, the right longer and narrower.*

The lower jaw is altered in the following manner. The right half is longer, thinner, and straighter than the left, its angle more open (about 120°), and its ramus descending with an inclination inwards of 40° from the perpendicular; whilst the mandibular angle on the left side is scarcely more than 90°, and the left ramus is about perpendicular. The left body arches somewhat outwards. At a superficial glance one might suppose to exist a left-sided atrophy, but there is really only a difference of shape.

As Witzel remarks, we may attribute these changes to a force which, with the condyles as fixed points, moves the symphysis of the jaw downwards to the left and a little backwards.

The changes in the pelvis resemble somewhat those seen in rachitic scoliosis, but there appears to have been nothing likely to interfere with labour. For details, see Witzel, *op. cit.* p. 556.

The *causation of the facial scoliosis and asymmetry* is still a question in dispute. Stromeyer blamed a real or imaginary defective respiration on the affected side, consequent on embarrassment of the neck muscles of inspiration, due to approximation of their points of attachment. Dieffenbach attributed the cranial deformity to traction exerted by the shortened sterno-mastoid. Bouvier thought that the inclination of the neck interfered with the circulation through the corresponding carotid. Guérin's view may be stated as follows. The head and cervical vertebræ being carried towards the shoulder of the sound side and the chin turned towards that side, the skin and subjacent soft parts are on the side of the short sterno-mastoid stretched, and on the sound side relaxed, and so the face comes to be dragged into asymmetry. Witzel says that the very groundwork of this theory is unreal. Both Gudden and Witzel found that the ligation of one carotid in young animals produced atrophy of the same side of the skull, and that the middle line curved with its concavity to the side operated on ; in other words, the skull became scoliotic. However, there are no just grounds for regarding the asymmetry as due to atrophy at all. Witzel's *post-mortem* observations show this, and they are supported by measurements which any one can make for himself on living cases. These prove that what one side of the face and head loses in length it gains in breadth, and *vice versa.* As Witzel himself puts it, what we have really found is a scoliosis of the face and skull, not a one-sided atrophy. Hence explanations like those of Little,[1] Busch,[2] and Golding-Bird,[3] based on the opposite idea, have the ground cut away from beneath their feet.

The hypothesis which Witzel advances is that the face and head are laterally curved by the tension of the soft parts (muscles, fasciæ, &c.). The lower jaw is deformed by the pull of those structures which extend between it and the sternum. The soft parts which pass from the lower to the upper jaw transmit the deforming influence to the latter ; and so on. On the convex side of the neck, the muscles drag on the parts of the skull into which they are inserted.

Nicoladoni[4] thought the asymmetry of the head, as well as the scoliosis of the dorsal spine, is due in a great measure to unequal pressure, in the former case acting on one side of the basi-sphenoidal and basi-occipital region of the skull.

[1] Holmes's *System*, iii. 701 (1870).
[2] V. Ziemssen's *Handbuch der allgem. Therapie*, Bd. II. 2, p. 100, 1882.
[3] Atrophy secondary to infantile paralysis.
[4] *Med. Jahrbuch* (Wien), 1886, p. 263.

The defects of character, occasionally amounting almost to insanity, but more commonly to a less serious condition, such as a silent or morose disposition, have been attributed to the changes in the form of the skull, but the connection is doubtful. The same may be said of the defective eyesight sometimes connoted.

Symptoms.—The head is bent over towards the side of the contracted muscle, and the shoulder is often more or less raised to meet it, so that in extreme cases it may almost touch the ear. At the same time the chin is thrust forwards and the face turned away towards the opposite side. On the sound side the neck looks long and its skin smooth, on the other it looks short with its skin in folds.

From behind, the rotation and lateral inclination of the head are plainly visible, and also a lateral curvation of the spine. Of the latter, the cervical curve has its concavity to the affected side, while there are two secondary curves: one upper dorsal, towards the opposite; and one dorso-lumbar, towards the same side.

The movements of the neck are limited by the contracted muscle, and the face cannot be properly turned towards the affected side, or the head bent away from it. Attempts to effect these movements passively bring the contracted muscle into strong relief, and especially the part of it most contracted. The face is asymmetrical, and careful scrutiny will show that it is scoliotic, with the concavity towards the affected side. Particulars of this deformity have just been given under 'Pathology.' The head is similarly deformed.

In about half the cases both the sternal and the clavicular parts of the sterno-mastoid are shortened, but not to an equal degree. In the other cases only one part is shortened, and then the sternal is affected four times as often as the clavicular (Bouvier).

In quite exceptional cases the platysma myoides, the splenius, the levator anguli scapulæ, and the clavicular part of the trapezius are, one or other of them, contracted as well as the sterno-mastoid.

Diagnosis.—Various affections may simulate the wry-neck which is due to contraction of the sterno-mastoid. First there are transient conditions, such as the 'stiff-neck' caught by sitting in a draught (doubtless a form of muscular rheumatism), and such as also acute cervical abscess. Pain, tenderness, fever, &c., mark the latter clearly enough; and in the former there is the soreness on movement, as well as the history of quite sudden and recent onset.

But the most important diagnosis by far, and one sometimes difficult, is that between true wry-neck and cervical caries. I have therefore tabulated the chief differences:—

Mobility limited in range, but perfectly free within the limits.	As a rule, little or no *free* mobility at all; on the contrary, stiffness.
No spinal deformity, except *lateral* curvation. But the rotation which accompanies this may in the upper part of the cervical spine cause a postero-lateral prominence, which might be mistaken for the results of subluxation or inflammatory thickening.	Frequently a prominence can be felt (if not seen), posteriorly, of the carious vertebræ. It may be difficult to feel anything abnormal if the atlas or axis be the bones affected, but then the stiffness, and perhaps tenderness, of the atlo-axoid and atlo-occipital joints will be marked.
The position of the head and neck shows the characteristic inclination to one side, combined with a twist to the other.	It is rare for the position of true wry-neck to be accurately simulated. There is much more frequently a mere bowing forward of the head, bringing the chin towards the sternum.
No pain caused by pressing the head firmly or jarring it moderately, consequently the patient usually looks fearless, and perhaps bright and merry.	Pain *is* caused by jarring the head or firm pressure on it. Consequently the patient is cautious and timid, both in moving it himself and permitting it to be interfered with by others. He may support his chin in his hand.

He picks up an article from the floor with as much activity as a healthy child.	He lowers himself cautiously, with a view to avoid jarring the spine or throwing his head forward.
No abscesses or sinuses, except that in rare cases they may be accidentally present.	Frequently sinuses or other signs of suppuration, past or present.

This contrast should almost always suffice to distinguish the two affections ; but the diagnosis is sometimes very difficult, and even Bouvier confesses himself to have once mistaken an old case of atlo-axoid disease for sterno-mastoid wry-neck. I have written nothing about the state of the sterno-mastoid in the above diagnostic table, because even in cases of caries it may be the subject of *reflex* contraction.

Wry-neck is sometimes simulated by malingerers. There is, of course, absence of the developmental changes seen in true wry-neck. Nor is the deformity itself always accurately mimicked. The two sterno-mastoids do not contrast in appearance, as in the true disease. The effect of faradisation, applied first to one and then to the other, and also to the back of the neck, should be noted. The patient should be watched when he is not aware of being observed. The malingerer is usually older than the ordinary subjects of wry-neck, and has a motive, such as the desire to evade some duty or to get into hospital.

Treatment.—*Prophylaxis.*—When, after birth, a child is found to be suffering from an injured sterno-mastoid, the muscle should be frequently and gently rubbed by the nurse with oiled fingers, and every day its head should be, for a few minutes, slowly and gently bent away from the shoulder of the side affected, while the face is turned towards the same side. In these manipulations the nurse should be regularly instructed and superintended by the surgeon, who should on his visits practise the movements himself.

When a wry-neck has actually developed, the sooner the sterno-mastoid is divided, the better. Exceptions to this rule are rare ; they occasionally present themselves in the case of very fat infants with short necks.

Instrumental treatment without myotomy is always a very tedious and expensive affair; and it has often seemed to me, when watching it in the practice of other surgeons, to be not so effective as it has been represented. It sometimes happens that the poor child falls into the hands of some instrument-maker, who assures the parents that the use of an (of course costly) appliance, under his superintendence, or perhaps under no superintendence at all, will cure their child. It is unnecessary to point out the cupidity, conceit, and ignorance at the bottom of such conduct.

It is desirable to not merely cure a wry-neck, but also to cure it *quickly*, so as to stop without delay, as far as it is possible, the continuous development of asymmetry of the face, head, and even shoulders, which secondary deformity is scarcely less disfiguring than the wry-neck itself.

The Operation.—(1) *Subcutaneous division.*—Dupuytren, who first divided the sterno-mastoid subcutaneously (1822), did so by passing the knife beneath it and cutting towards the skin; and that is the safer plan, as, if the knife should slip, it had better cut through the skin than into the vessels underlying the muscle.

Except in the case of a child distending its jugulars by screaming, crying, and struggling, any other anæsthetic than nitrous oxide or $\frac{1}{2}$ gr. of cocaine is superfluous. The patient lies down, with the head, neck, and shoulders raised on pillows. An assistant holds his head, and the surgeon stands at the side affected. Entering the tenotome at the inner edge of the sternal end of the muscle, he at the same time presses the end of one finger of his left hand to the outer side of the same sternal head, and, as it were, beneath it. With this finger-end he feels the point of the knife (of course through the skin), when he has insinuated the blade, on its flat, beneath and close to the deep surface of the muscle. He now turns the edge towards the muscle; and, as the assistant makes extension, a little gentle sawing and pressing divide it. The snap at the moment of section is marked.

The clavicular origin has now to be inspected, and, if tense, divided in a similar manner through a separate puncture.

Care must be taken to avoid the anterior external jugular. And, more especially in the practice of a general hospital, the skin and the tenotome should be thoroughly cleansed, and the latter at least antisepticised. It is quite a mistake to suppose that blood-poisoning does not sometimes follow tenotomy, and the excuses then given for the misfortune by some orthopædists are ridiculous. I enjoin the reader, therefore, to be as careful with his tenotomes as with his amputating knives.

So far, however, the procedure as described may be regarded as free from danger. But when both heads of the muscle have been divided, if, as sometimes happens, other bands spring into reach and prevent reduction of the deformity, we are told to go on cutting them subcutaneously. I have not felt disposed to do any such thing. On the contrary, following Volkmann, I make an open wound and see what I am doing, working antiseptically.

(1) *Open division of the sterno-mastoid, &c.*—The skin, fascia, &c., should be incised perpendicularly for about 2 inches, and the edges retracted. The prominent and comparatively superficial muscular and fibrous bands may be divided without ceremony; but as the deeper parts are approached, while an assistant keeps the wound perfectly clean and dry with thorough sponging, the operator should rather scratch with the point of his knife, or nibble, as it were, with the point of a pair of scissors, until he has divided every tense fibre he comes across. If he went too far, it would be possible that he might puncture one of the large vessels; that, however, would be very unlikely with ordinary care; and it is inconceivable that he could *accidentally nibble* a large hole in the jugular.

If I punctured one of the jugulars, I should apply and fix carefully a compress of iodoform gauze, soaked in sublimate solution (1 : 2,000), and there would be little cause for fear.

After open division all bleeding should be checked, the wound thoroughly cleansed, and the skin sutured accurately. The dressings should be carefully adjusted and fixed with strapping, as well as with bandages.

From the first the head, neck, and shoulders should be fixed by some means or other, night and day.

When Dupuytren had done the first subcutaneous section of the sterno-mastoid, he fixed the patient's hand to her foot of the same side, as in the lithotomy position. I was not aware of Dupuytren's method, which is certainly simple enough, though perhaps rather irksome, when I first contrived the mode of extension which I am about to describe and recommend.

Extension and counter-extension are made by weights attached by strapping to the head and upper arm respectively.

From a wooden yoke or stirrup above the head passes down on each side a piece of strapping, which covers the corresponding side of the head, the parotid and mastoid regions,

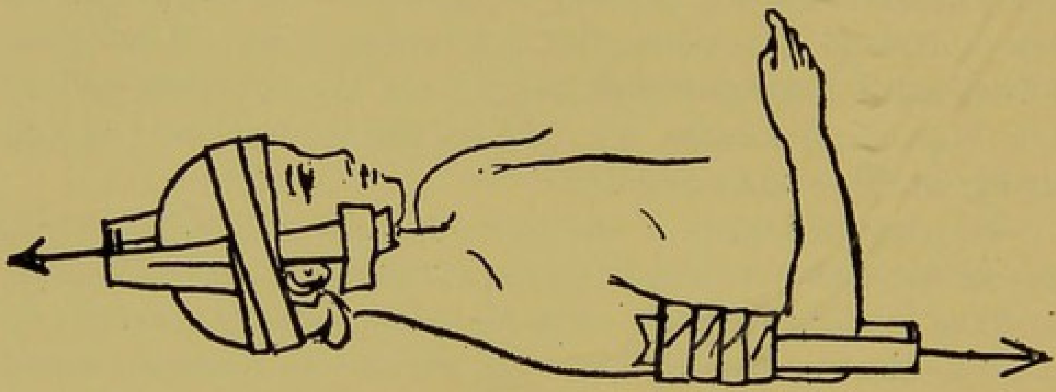


FIG. 115.—EXTENSION BY WEIGHT AND COUNTER-WEIGHT TO HEAD AND ARM RESPECTIVELY AFTER DIVISION OF STERNO-MASTOID.

and the neck to just below the level of the jaw, but does not reach its fellow of the opposite side beneath the chin. A hole is cut in it just large enough to let the ear through. A narrower circular band of strapping encircles the head immediately above the ear and eyebrows. Strapping of the best quality must be used. (Fig. 115.)

The weight extension is applied to the upper arm exactly in the same manner as that in which it is affixed to the leg for the treatment of hip disease. The elbow is not fixed. The patient is left free to use it, and generally holds it spontaneously in the flexed position, as in the illustration.

Commencing with 4 lb. each, both the two weights should be gradually increased, until in a week they equal 7 lb. each, or more, if an increase of weight can be borne and appears to have any beneficial effect. Of course regard must be had to the size and strength of the patient. It is worth while to keep up this weight extension for a month. A fortnight after operation manipulations may begin, the weight being temporarily removed for the purpose.

When the weight extension is given up at the end of the month, the manipulations must be regularly continued for some months more. When at last they are dispensed with, the patient should be occasionally seen, and at the least sign of relapse manipulation should be recommenced.

If one has to do with a neglected child, which cannot get proper manipulative treatment from its friends or medical man, instrumental extension must be applied, and continued for a long time, or the danger of relapse will be great.

The cheapest appliance for wry-neck is a combined collar, shoulder-piece, and head-piece of poroplastic felt.

Powerful but expensive instruments of steel, with screw joints and keys, can be obtained at the surgical-instrument makers'.

All appliances should be inspected once a week, and readjusted or repaired if necessary. If an instrument fail, a great deal of ground may be lost in two or three weeks.

Of portable apparatus for wry-neck there are many varieties. They all agree in being divisible into a movable part and a fixed, or comparatively fixed, one. The latter may be attached (1) to one shoulder or to both, or (2) may rest on the hips, as in many examples. The movable part may consist of (1) a circle round the head, or (2) of straps beneath the chin, with others round the head, and even round the neck, or (3) of pads at the end of levers.

The movement may be given by (1) elastic traction, (2) simple traction, (3) pressure. Elastic traction is usually applied by means of an accumulator acting in such a way as to reinforce the uncontracted sterno-mastoid, as, *e.g.*, in Sayre's apparatus. Simple traction is applied by leather-strap circlets and collars, such as those used with a jury-mast; and, indeed, it requires a jury-mast or some analogous contrivance, as a stay or support above and to the side of the head. Pressure is applied either to a circlet round the head, or to pads pressing beside the chin on one side, and on the post-aural region on the other, or to moulded plates, caps, or shields which grasp the posterior part of the head completely.

Needless to say that steel, leather, poroplastic felt, and plaster of Paris, not to mention wood, are all used as materials.

The india-rubber accumulator, extending between a circlet round the head and a loop in the axilla, is the simplest and cheapest contrivance. Jury-masts with plaster of Paris or poroplastic cuirasses, and chin and head straps, rank next in these respects. Steel levers worked by keys can be adjusted most accurately, and serve best to keep the pads or circlets on which they work in place, but have no continuous elastic action. They can be fixed to corsets of any material, steel or leather, or plaster of Paris or felt. I myself prefer poroplastic felt, as, on the whole, the most economical and the most convenient material for the basis of wry-neck appliances.

SPASMODIC WRY-NECK

This distressing malady attacks adults more commonly than children. In young people its history may point to a cerebral origin, and to the spasms of the neck being allied in nature to the athetoid movements which, in the subjects of cerebral paralysis of childhood, are more commonly noticed in the hand. Indeed, arm, hand, and neck may be affected in the same subject.

It is also quite possible that spasmodic wry-neck in adults may have a cerebral, or at least an intra-cranial, origin. There is sometimes a clear history of injury to the head. For example, F. Page, of Newcastle, describes a case in which the first result of the injury was diplegia, lasting a fortnight. The second effect was tonic contraction, and this passed into spasmodic wry-neck.[1]

Etiology.—Exposure to cold and wet seems occasionally to

[1] *Brit. Med. Jour.* 1888, vol. i. p. 245.

be the exciting cause. In individual cases, the first attack has followed and been attributed, not unreasonably, to inflammation of the middle ear, neuralgia of the fifth nerve, depressing emotions, and exposure to malarial influences. To suppose that it has resulted from 'habit-spasms' seems to me to require much credulity. A person develops spasmodic wry-neck with deviation to the left. It is remembered that he has been for years in the habit of copying from something which he places towards the left, and towards which he frequently turns. It is as natural for the habit to be blamed for the disease as for the sight of a mouse during pregnancy to be blamed for a hairy mole on the infant. 'Neurotic heredity' is said to have been traced. At all events, two members have been attacked in the same family, and the disease under consideration has attacked individuals with several relations suffering from other neuroses.

To sum up, I think traumatism, middle-ear disease, exposure to cold and wet and to malarious influences, the more likely to have been true causes than the others suggested in the last paragraph.

Pathology.—This has not been elucidated by *post-mortem* examination. But the seat of disease can scarcely be other than central, *i.e.* either in the brain or in the medulla ('oblongata' or cervical), or in their immediate coverings. In the case of children, when the arm and eye movements are also affected, hæmorrhage is not unlikely to have been the starting-point, and after middle-ear disease, localised meningitis, or irritation or inflammation of the cortex. The absence of present symptoms of such conditions does not prove much, as the spasm may be a sequel of a past condition. Epileptiform convulsions, if present, would be significant.

But only in the small minority of cases can the anatomical seat and nature of the affection be even guessed at with any confidence.

Symptoms.—The objective symptom most apparent is the occurrence of a rhythmical spasm, which, at frequent intervals, jerks the head to one side, and simultaneously turns the face somewhat to the other. This of itself is distressing enough to the patient, and sometimes exceedingly incapacitating. But there may coexist also great pain, especially in the back of the head and the side of the neck, and the difficulty of getting rest and sleep may further undermine the health. Sometimes the head is jerked directly backwards. Gowers suggests the name of 'retrocollic spasm' for this form. Whether the disease ever goes away spontaneously, or not, I cannot say. In the recorded cases it has almost always lasted for some, and often for many, years, and that usually in spite of treatment. But it does sometimes pass off after, and possibly in consequence of, general treatment, including rest, warmth, careful diet, and drugs.

Arsenic is worth trying. See, *e.g.*, a case of Dr. Buzzard's,[1] of 'twitching of the head to the right,' in a girl of twenty. Another, mentioned by the same author, at the same time, was apparently cured by a circular blister around the arm.

The spasms cease during sleep, and in a given case are apt to vary greatly in intensity at different times and under various influences, such as emotion or nervousness. In some instances they have been known to disappear for years and then return.

Tonic and clonic spasm may coexist.

The *diagnosis* is almost entirely between the true complaint and hysteria, and is sometimes very difficult. Hysteria should always be suspected in young women with spasmodic wry-neck, and its symptoms searched for. But if the latter are found, and even if the affection is alleviated by valerian, &c., the wry-neck is not necessarily hysterical. Gowers says that hysterical torticollis tends to spread downwards, and to produce writhing movements of the trunk.

Treatment.—Commence with rest in bed, warmth, regulation of the bowels, arsenic internally, and the use of some simple contrivance against which the patient can steady his head a little, but which does not attempt to fix the neck. For a very short time only is it justifiable to try strong anodynes, and then only at night. Counter-irritants, especially to the nape of the neck, may be freely used and often repeated. If the case is a recent one, such treatment should be used patiently for months; and other drugs may be tried,

[1] *Brit. Med. Jour.* 1881, vol. ii. p. 937.

such as quinine, salicylate, phenacetin, and compound tincture of valerian, or valerianate of zinc. If opium is to be given in any form, and the case be a recent one, try Dover's powder at night. The opium or cocaine habit is worse than the disease. Electricity seems to have failed utterly.[1]

If general treatment is unsuccessful, *operation* should be resorted to.

As the sterno-mastoid is practically always, and the trapezius very often, affected, the part the surgeon attacks is the spinal accessory nerve. This may be *stretched*, *divided*, or a *piece cut out of it*; and it may be approached either at the anterior border of the sterno-mastoid muscle or at the posterior border, and followed beneath or through the fibres of the muscle. I think the almost universal condemnation of the results of stretching is probably due to the stretching not having been thoroughly done. The effect has been so trivial in one or two recorded cases that it is doubtful whether the nerve was really stretched at all. The object which almost all surgeons now have in exposing this nerve is excision.

Ballance made an incision 3 inches long from over the transverse process of the atlas down the anterior border of the sterno-mastoid—a somewhat similar incision to Annandale's.[2] On raising the anterior border of the muscle and pulling it back, the nerve is put on the stretch, and the finger should detect it coming from under the posterior belly of the digastricus and passing downwards and backwards.

Campbell de Morgan, who was the first to perform neurectomy of the spinal accessory, made his incision along the posterior border of the sterno-mastoid, and followed the nerve up through the muscle.[3] Ballance, at the end of his paper, suggested an attempt to reach the sub-occipital nerve in intractable cases. Keen and Noble Smith have described cases in which they operated on the posterior branches of some of the upper cervical nerves. The pamphlet in which Noble Smith describes his case contains a valuable collection of extracts from almost, if not quite, all the recorded cases of

[1] Refer to Russell Reynolds, *Lancet*, 1870, vol. ii. p. 532.
[2] *Lancet*, 1879, vol. i. p. 555.
[3] *Brit. and For. Med. Clin. Review*, 1866, vol. ii. p. 218 (Ref. from Neale's *Digest*); *Lancet*, 1867, vol. ii. p. 128.

operative treatment of torticollis in the language, including Southam's[1] and Page's[2] cases of nerve-stretching. The histories of Southam's and Page's cases are very suggestive. One was probably a case of infantile cerebral paralysis, in which the spasmodic torticollis did not supervene for ten years. Another is the case, which I have already quoted, in which the primary trouble was traumatic diplegia.

The inconveniences resulting from sterno-mastoid and upper trapezial paralysis are smaller than might be expected. Otherwise I should be disposed to recommend, in preference to resection, simple division of the spinal accessory with dislocation of the two ends, which could easily be effected by dissecting one free for an inch and fixing it with a suture. Reunion could be effected at any future time, if thought judicious.

Operation on Posterior Cervical Nerves.[3]—Incision 3 inches long, from middle line behind, horizontally, to ½ inch below lobule of ear. Trepezius divided transversely. Great occipital nerve to be traced through complexus (by dividing the muscle transversely). It leads to the post division, second cervical. Divide this. Divide sub-occipital nerve in sub-occipital triangle, close to vertebra. Lastly, divide third cervical. Do not wound vertebral or occipital artery.

Spasmodic Affections of other Muscles

Clonic spasms are liable to affect almost all the muscles of the head, face, and extremities, as well as those already referred to. Those variations which have attracted special attention are spasms of the *platysma myoides*, and of the *orbicularis oculi* and other muscles supplied by the facial nerve.

Their pathology is probably, and the treatment certainly, similar (in principle) to those of spasmodic torticollis. I have not heard of the facial nerve being resected for facial spasm, but it has often been stretched. All the usual array of 'nervine tonics' and 'anti-spasmodics' are generally tried first. Most patients rather bear these ills, when they are so

[1] *Lancet*, 1881, vol. ii. p. 369.
[2] *Brit. Med. Journ.* 1888, vol. i. p. 245.
[3] As practised by Keen. *Annals of Surgery*, vol. xiii. p.

unfortunate as to have them, than fly to others that they know not of. Errors of digestion should be carefully sought out and corrected.

A full notice of this class of affection scarcely belongs to orthopædic surgery. This also applies to *writer's cramp*, *violinist's cramp*, &c., sufferers from which usually go to electricians and masseurs, I am sorry to say often with little benefit. Each of these cases requires a very careful study of the individual, his habits, his constitution, and his general health, as well as local treatment, sometimes by electricity, sometimes by massage, sometimes by appliances, and sometimes by a combination.

CHAPTER XII

DEFORMITIES OF THE HANDS AND FINGERS

Some are *congenital* and some *acquired*.

Webbed Fingers and other Forms of Syndactyly

These are probably true instances of arrested development, and not of cohesion in utero of fingers once separated. The thumb is the first digit to appear, and it has very rarely been found at birth united with the index finger.

When two or more fingers are united from end to end they constitute an instance of *total* syndactylism, as distinguished from *partial*, which is the more common form.

The bond of union may be (1) skin only; (2) thick and fleshy; or (3) it may be osseous. In the last case it is frequently only partial, and the distal phalanges may be fixed together while the proximal remain separate.

Sometimes polydactylism coexists. Both it and syndactylism are often hereditary.

Treatment demands the recollection of the strong tendency in these cases to cicatricial reunion after division. Various operations have been devised with a view to preventing this.

None of those usually described make a proper use of skin-flaps, or grafts, transplanted from distant parts of the body. Their judicious employment renders the management of even the most severe cases easy, and can often be made in slighter cases to usefully supplement one or other of the following operations.

A considerable number of distinct operations have been practised, but half of them have probably only an historical interest, and will, I think, be never more employed in surgery, unless it be in deference to some patient's or parent's ignorant prejudice against the knife. Such are the operations known as Krimer's, Severin's, Maisonneuve's, Lister's, Vogel's, and Rudtorfer's. Many other surgeons seem to have devised scarcely dissimilar methods. None are particularly ingenious, and, as I have said, all are practically obsolete. *Krimer* cut gradually through the web with a leaden wire tightened down to a bracelet; *Severin*, after perforating its apex (or part nearest the knuckles), surrounded it with a thread soaked in caustic potash or in croton oil, and so divided it by destructive ulceration; *Maisonneuve* used a screw-clamp; *Lister*, an elastic ligature fixed to a bracelet; *Vogel*, a constricting elastic ligature passed through a hole in the apex; and *Rudtorfer* perforated the apex with a lead wire, and after it had 'healed in,' as does an earring, divided the commissure.

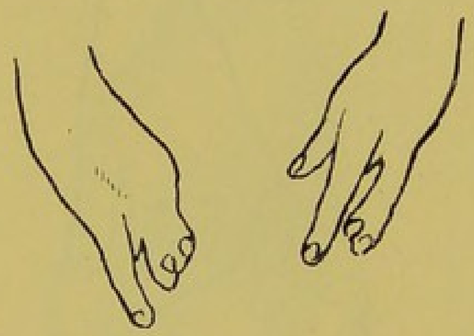


FIG. 116.—CONGENITAL SYNDACTYLISM WITH DEFICIENT FINGERS AND PARTIAL CLEFT OF LEFT HAND. From a case at the Surgical Aid Society. Legs and feet of same case illustrated in Chap. XIII.

All these plans constantly failed, or at least only partially succeeded, because they left raw surfaces which, even if they were prevented from cohering again, yet healed with so much cicatricial contraction as to partly reunite the fingers.

And even the plans next to be described are only entirely free from the same defect when the web is unusually wide and thin, and therefore the skin plentiful. *To secure an approximately perfect result some skin-grafting or transplantation must be added.*

Norton's Operation.—Two triangular flaps are cut at the apex of the web. After the web itself is cut through the flaps are united between the finger-roots. 'The flaps should be thick enough to avoid risk of sloughing, and somewhat narrow to prevent bulging.' 'Any tissue between the knuckles

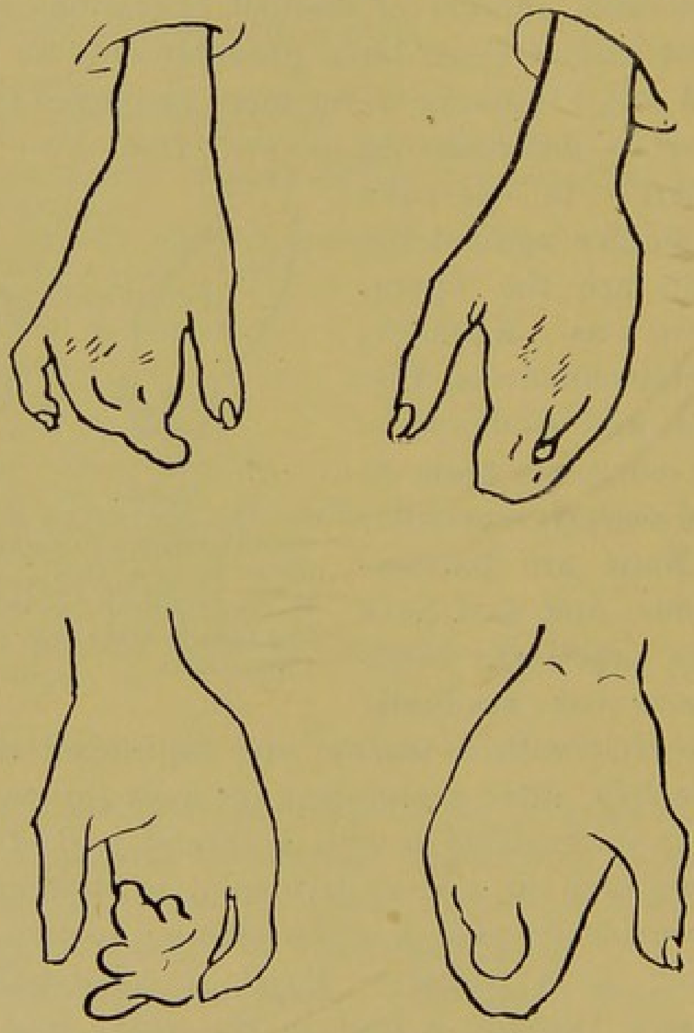


FIG. 117.—EXTENSIVE CONGENITAL SYNDACTYLY (DORSAL AND PALMAR VIEWS).

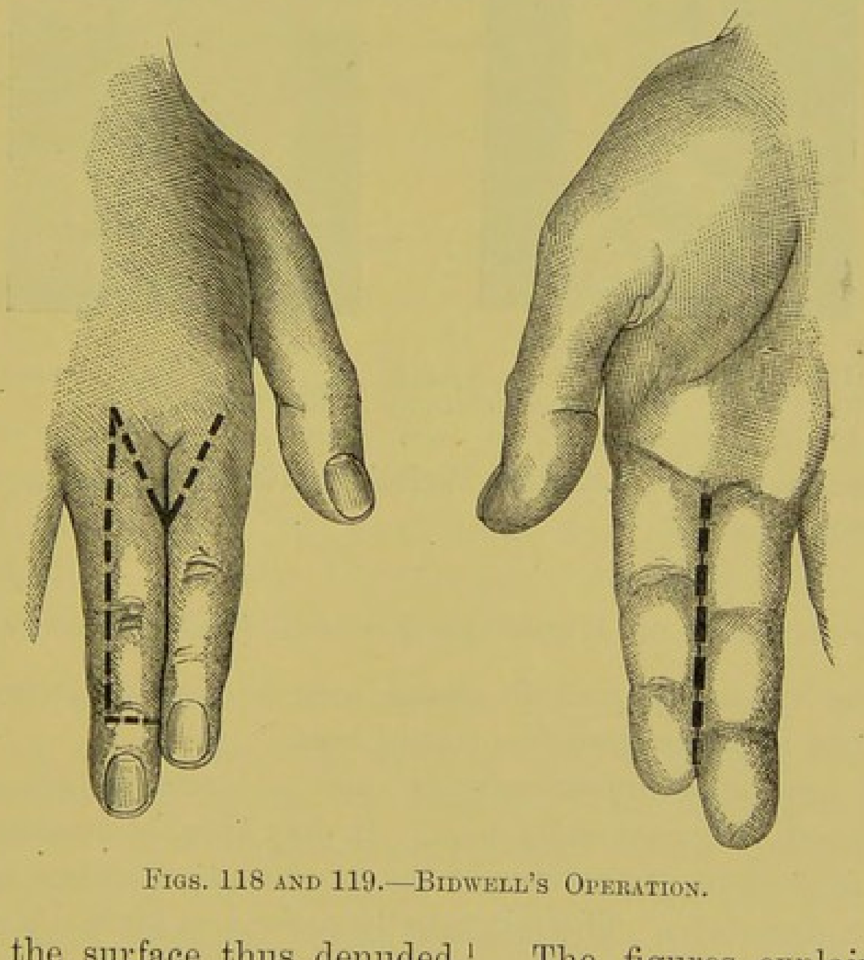
that prevents their coming together should be cut away.' This is a modification of the operation of *Zeller*, who used only one flap instead of two.

Barwell and others have employed flaps with the base attached (as in the Italian method of rhinoplasty); *Pauli* used a flap cut from the back of the hand, and twisted round into place.

Didot's Operation.—The skin on the palmar side of the web is cut away from one finger, and used to cover the raw surface of the other finger; while the skin on the dorsal side of the web is cut away from the latter finger, and used to cover the raw surface of the first-mentioned finger.

Langenbeck used all the skin of the web to cover one finger only.

Bidwell describes a case treated by a dorsal flap from the web and one finger, and the use of Thiersch's grafts to



FIGS. 118 AND 119.—BIDWELL'S OPERATION.

cover the surface thus denuded.[1] The figures explain his method of operating.

I, myself, begin, like Zeller, by reflecting one triangular flap, or, like Norton, by reflecting two triangular flaps, at the apex of the web, *i.e.* between the roots of the fingers. Next I cut through the whole length of the web midway between the two fingers. The third step is to cover the apex of the cleft with the Zeller's flap (or Norton's flaps). The fourth is

[1] See *Lancet*, June 29, 1895.

to cover any raw surface on the *sides* of the fingers with thick Thiersch's grafts. By this mode of operating two points are gained (1) the scar is scarcely visible from the dorsal aspect; (2) it is not felt on the palmar surface.

The raw surfaces left should be covered with *thick*

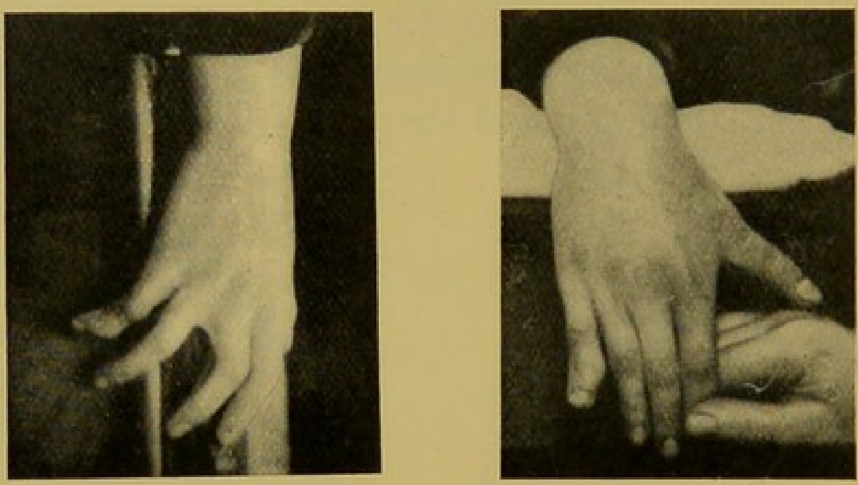


FIG. 120.—SYNDACTYLY AFTER OPERATION IN THE MANNER RECOMMENDED. Note lateral deformity of little finger.

Thiersch's grafts—*i.e.* with Wolfe's grafts or a near approach to them.

HYPERTROPHY OF HAND AND FINGERS (MEGALODACTYLISM)

The hypertrophy of the hand seen in cases of acromegaly need not be more than mentioned here.

A congenital hypertrophy of one or more fingers, or of the thumb, is occasionally seen. It may then be accompanied by enlargement of portions of the hand and arm, even as high as the shoulders. Though usually noticed at birth, its degree is apt to increase faster than the child grows, and so to become more noticeable. It usually affects all the tissues of the finger, but not in exact symmetrical proportion. Therefore the digit is imperfect in function, and may even interfere with the other fingers. Hypertrophied fingers are seldom quite straight. The choice of treatment lies only between doing nothing and amputating.

The opposite condition—viz. that of arrested growth—is occasionally seen. Fingers may be short or absent. Absence is associated with deficiency in the bones of the hand and fore-arm. (See figs. 131 and 136. See also 'Cleft Hand,' below.)

Supernumerary Fingers (Polydactylism)

Practically speaking, everything which is written in the chapter on 'Polydactylism in the Toes' applies to the fingers, the great toe corresponding to the thumb.

The difference is in the indications for *treatment*. A supernumerary finger being more visible, and therefore more disfiguring, than a superfluous toe, it more frequently requires amputation. When toes, or parts of toes, are not only supernumerary but fused or webbed, the use of X-rays may sometimes be useful to determine which digits or which phalanges to remove.

Cleft Hand

This is a rare deformity in man, though more common in some of the lower animals (G. St. Hilaire). When it occurs, either syndactylism or ectrodactylism is likely to coexist.

The following cases have been described :[1] (1) Right hand cleft to carpus, middle finger absent, index finger and thumb united (v. Walther) ; (2) Cleft hand and absence of thumb (Fumagalle, and also Murray and Giraldès) ; (3) Clefts between third and fourth metacarpals.

Congenital Dislocation of the Finger

A boy aged about eight was operated on by me at the West London Hospital last autumn whose right forefinger had a partial but well-marked dislocation forwards of the first phalanx on the head of the metatarsal. This had scarcely attracted his parents' attention, being disguised by the deformity for which he was brought, viz. a condition of valgus at the first inter-phalangeal joint, shown in the illustration. (See fig. 121.)

The finger was so rotated on its own long axis at the sub-luxated joint that it partly faced the adjacent thumb. But for practical purposes it was nearly as good as a normal finger. In a case of Malgaigne's the last phalanx of the dislocated finger was bent backwards.

My patient was otherwise well formed. But patients with

[1] Vogt.

congenital dislocation of the finger have often other coexisting defects.

Fig. 121.—Congenital Subluxation of Base of First Phalanx of Index Finger, with Lateral Deviation of the Finger. This was straightened by osteotomy of the first phalanx; a certain degree of rotation was at the same time partially corrected.

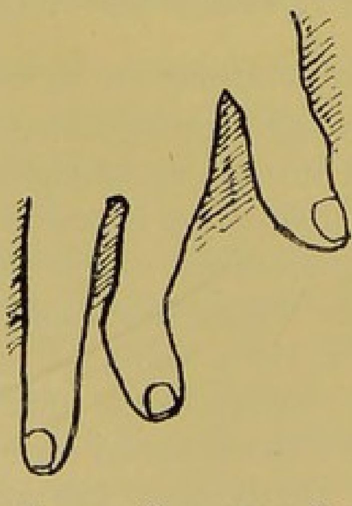


Fig. 122.—From another Case of Congenital Valgus of the Forefinger.

Contractures of the Fingers

They often occur *congenitally*, especially in the form of inability to completely straighten the little finger of one or both hands. Such are scarcely true contractures at all. They are, rather, instances of limited range of mobility. My own right little finger is itself an example of a slight degree of this affection. It can be passively straightened almost completely, but actively not within 25° of the normal. A minor degree of this peculiarity is exceedingly common. I have never been conscious of the slightest inconvenience or disability arising from it. No treatment is either necessary or desirable.

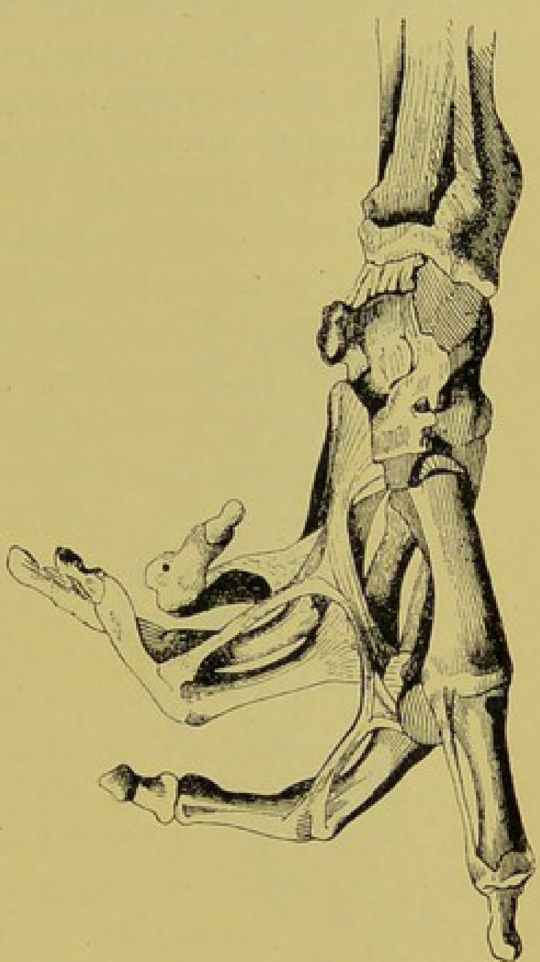


FIG. 123.—CONTRACTED PALMAR FASCIA.[1]

DUPUYTREN'S CONTRACTURE

The strong part of the palmar fascia spreads out from its narrow base at the anterior annular ligament to the roots of the four fingers, dividing in the middle of the palm into a separate piece for each digit, and each of the four divisions subdividing into a segment for each side of the corresponding fingers. This arrangement is that of the thick longitudinal fibres only. They are connected by thin, chiefly transverse, sheets. And the ball of the thumb, as well as the muscles of the little finger, are also covered with thin parts of the fascia, a fair proportion of stronger longitudinal fibres passing to the thumb. The digital portions enclose the flexor tendons, are inserted into the sides of the first phalanx, into the glenoid ligament, and, by means of a thinner expansion, onwards as far as the terminal pulp of the finger. Everywhere bands pass from the palmar fascia to the skin and bind the two together.

[1] The three drawings of the palmar fascia in Dupuytren's Contracture are from Hoffa, after Goyrand.

Certainly as a result of injuries of various kinds, and probably, in some cases at least, as a consequence of predisposition by gout, parts of the palmar fascia are liable to thicken, contract, and limit the extensibility of the fingers. It is especially the thicker parts and longitudinal bands of the fascia which suffer; hence the terminal joints of the fingers almost always escape, and the thumb is seldom affected. The ring-finger is usually first attacked, then in quick succession the little and middle fingers. Flexion is not obstructed, only extension beyond a certain range, the extent of which narrows as the disease progresses. Cases of all degrees of severity occur, from those in which there is a

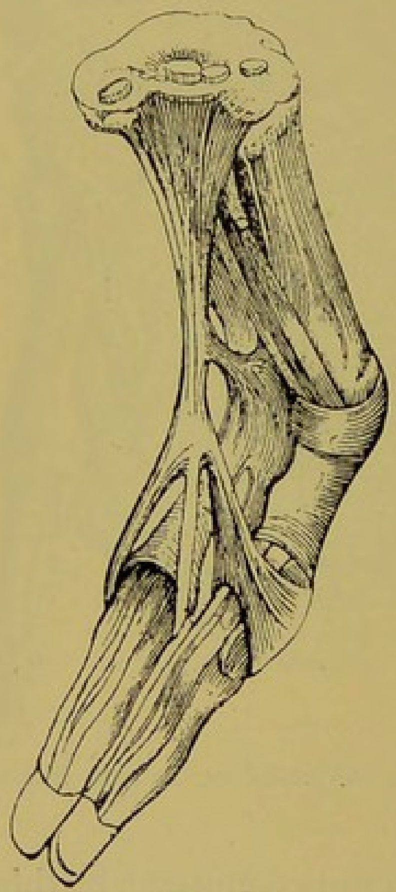


Fig. 124.

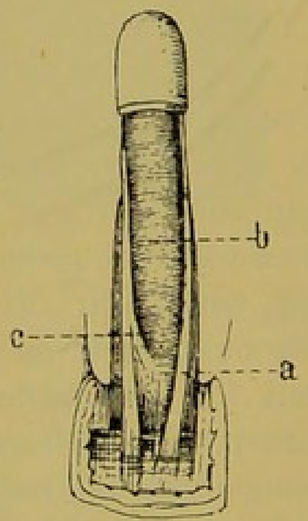


Fig. 125.

Showing the Contracted Fascial Bands at the Side as well as on the Palmar Aspect of the Fingers in Dupuytren's Contracture. (From Hoffa, after Goyrand.)

scarcely perceptible contraction of one finger to those in which the points of two or three fingers cannot be separated from the palm of the hand. The kind of influence which excites the contraction is usually one to which the term 'injury' scarcely applies. Gardeners suffer, apparently from continually grasping the spade handle, and sailors from pulling ropes. But cases do occur in which the contraction commences immediately after a cut (without being cicatricial) or a strain. In the course of years the joint surfaces, capsules, and ligaments adjust themselves to the abnormal condition, and form an obstacle to complete cure.

Pathology.—The nature of the affection seems to be a chronic inflammation. An increase of nuclei has been observed (Kocher and Langhaus), especially in the sheaths of the arteries and in the subendothelial layers of the capillaries.

Diagnosis.—Dupuytren's contracture may be distinguished from all others by the following combination of characters: (1) A thickening close beneath the skin, attached to it in part, but not involving it; (2) a consequent puckering, folding, and occasionally even knotting of the skin; (3) the freedom of the terminal phalanx; (4) the contraction of the first and second joints of one finger.

In early stages the first and second signs may be scarcely perceptible, and the fourth slight. It must then be remembered that the inner fingers are almost always those to be first affected, especially the ring-finger, and the palmar surface should be carefully palpated with the fingers stretched to the utmost. The attachment of the contracted structure to certain points of the skin will probably then identify it.

The complaint never recedes spontaneously. Accidental cures have been recorded in which the contracted fascia has been violently ruptured.

Treatment.—It has been claimed that cases not too severe can be cured by massage. Remembering how frequently the good effects of other measures used in association with it, especially passive movement, are attributed to massage, and remembering also that too much friction so often appears to be the exciting cause of the disease itself, I confess myself sceptical. Further, I have never seen any true contracture benefited by pure massage, however perseveringly employed. Joints stiffened by effusion, whether synovial or interstitial, are the proper subjects of treatment by rubbing.

The correct mild treatment for very slight cases of Dupuytren's contracture is the use of well-padded palmar splints at night. They should be made of some slightly elastic and light material, such as aluminium or xylonite. The metal should be thick enough not to bend like a piece of lead. The splint may be flat—*i.e.* it need not be moulded—but it should be cut to accurately fit the palm of the hand and the length and breadth of each affected finger. Each finger and the

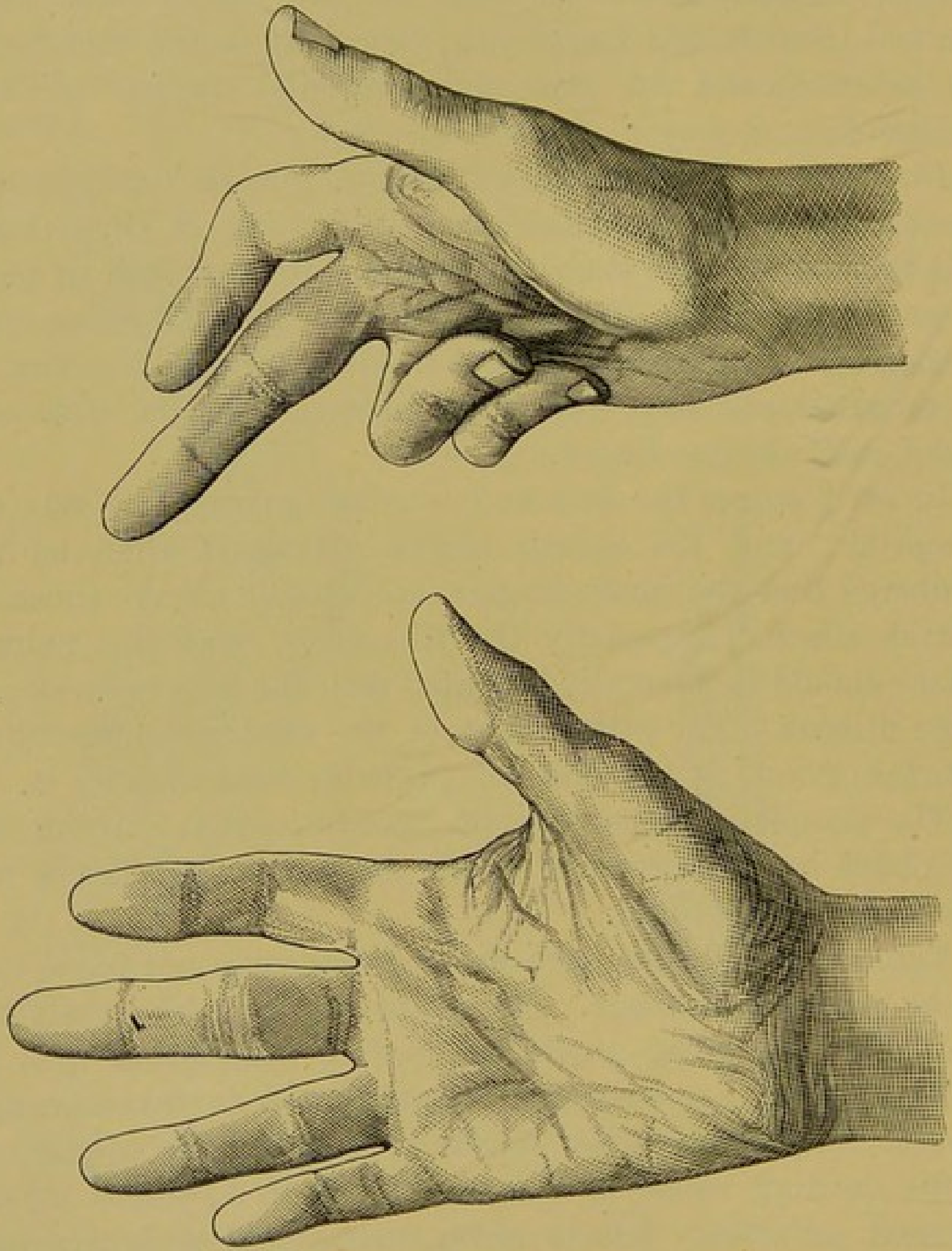


FIG. 126.—DUPUYTREN'S CONTRACTURE (after J. F. C. Macready).

body of the hand should be bound down to the splint by broad straps of soft leather. In the morning the hands should be well washed, brushed, and dry rubbed, and they may be left free during the day. During any occupation which necessitates grasping, the hand should be protected by a glove, padded, or at least thickened on the palmar surface. At night, before applying the splint, the contracted fingers should be stretched by placing their tips on the table, the patient at the same time standing up and pressing intermittently on the dorsal or convex surface of the curved fingers with the fingers of the other hand.

In very early cases warm boracic fomentations should be used perseveringly, especially if the patient be young.

The great majority of cases require *operation*. There are four principal methods, all cutting, and to these may be added that of forcible rupture.

Adams' Operation.—A small, straight, sharp-pointed knife or tenotome is used. The affected finger is stretched, and the contracted fascia cut or nicked transversely in numerous places through multiple punctures made in the overlying skin. As soon as by this means the contracture has been sufficiently overcome, and after dressing the wound, a dorsal splint is applied, by means of which gradually increasing extension is employed. After a few days the splint is regularly removed to permit active and passive movements. The length of treatment in this, as in other operative methods, varies with the case.

Multiple Transverse Division through an Open Longitudinal Cut.—This, which is the method I generally use myself, is carried out as follows: Esmarch's tourniquet is applied after perpendicular elevation of the limb for several minutes. The outstretched arm and supinated hand are held down on a table placed beside the operating-table, with the fingers outstretched if possible. A longitudinal incision is made through the skin, and into the contracted fascia. If the finger is much contracted, this incision can only be completed by degrees, as the division of the bands gradually permits the finger to be unfolded.

The extent and limit of the thickened fascia are now easily seen, and it should be divided transversely and completely in many places, both in the palm and in the finger, until all resistance from the fascia has been removed, and nothing but nutritive shortening of the structures around and acting on the finger-joints remains. This should be left to be overcome by after-treatment. Here and there the skin itself may have to be freed by a touch of the knife.

The skin incision is now closed by a row of sutures (silkworm gut), inserted as near to the edge of the wound as possible.

Dressings are applied, and the fingers should, at this stage, not be straightened any more than is possible without using very much pressure or causing painful tension. A wood-wool pad over the iodoform gauze, which should be placed next the wound, serves, in fact, for both splints and dressing. But an L-shaped elbow splint should be applied, not to straighten the finger, but merely to fix the wrist and elbow, and, by projecting as far as the finger-tips, to prevent the hand from being used.

This is very nearly the same thing as an Adams' operation done through an open incision with strict antiseptic precautions, and I believe it was first practised by Goyrand in pre-antiseptic days (1834), and was revived by James Hardie, of Manchester.[1] It has the advantage of absolute precision, and I think that those who practise subcutaneous fasciotomy will operate with more accuracy and confidence if they have done the open operation several times first. I certainly have found this the case with myself in operations, not only in the palm, but in every region of the body.

If the above directions are strictly followed, merely a linear cicatrix will remain, such as contrasts favourably with what has been reported as the ultimate state of things after the following operation :—

Excision of the contracted Fascia.—This operation has been practised and strongly recommended by Gersuny,[2] Reeves, Kocher, and others. Through a longitudinal incision the fascia is first separated from the skin, divided transversely, and then dissected up from its deep connections. It is claimed that it is not more dangerous than other proceedings (none of them ought to be dangerous to life), and that it is a radical cure. Whether owing to defect in the operation itself, or in the mode of carrying it out, I cannot say, but there is strong evidence to

[1] *Med. Chron.* Oct. 1884. [2] *Wien. Med. Woch.* August 9, 1884.

show that it is, in a serious proportion of cases, followed by a considerable danger of cicatricial contraction. Consult on this point Macready's paper in the 'British Medical Journal,' 1890, vol. i. p. 411. One patient at least complained of an unpleasant sensation when the scars were touched. The total removal of the contracted fascia necessarily takes away its capacity for protecting the underlying nerves.

If contracted palmar fascia were a new growth, its excision would, of course, be plainly indicated; but it is, at the worst, apparently an effect of a chronic process of inflammatory, or at least irritative, origin, and its inconveniences have been known to be removed by mere accidental rupture; and, further, there is the risk that in complete excision another form of contraction, namely cicatricial, may be substituted for the original one.

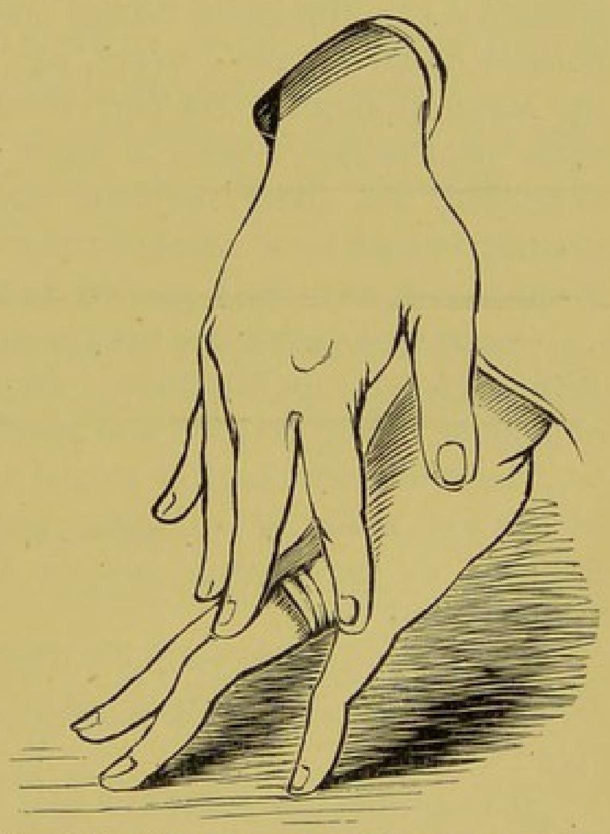


Fig. 127.—Mode in which Patient can Passively Exercise his own Fingers to Preserve the Gain after Straightening by Operation.

Whatever operation is performed, the patient should afterwards be kept under occasional observation for a long time, and encouraged to combat any tendency to relapse by active and passive extension exercises, and, if necessary, by wearing a simple splint at night.

Cicatricial Contractures of the Hand and Fingers

are very common and very important, especially after burns, lacerations, cuts, and gunshot wounds. Their diagnosis can present no difficulty; though a very careful examination may be needed to determine how much each structure, viz. tendon, muscle, nerve, fascia, or skin, is affected. Then wide scope is afforded for ingenuity in devising, and for skill and experience in executing, plastic operations to remedy matters.

Pedunculated flap transplantations from the trunk, or even from the thigh, to the hand should be freely used. Nerves should be carefully freed from cicatrices and united, if divided. If a segment of nerve is deficient, its place should be supplied either by an autoplastic bridge operation, or by implanting a portion of an animal's nerve, as has been done successfully by Mayo Robson. Tendons should be dealt with on the same principles. When a large segment of one tendon is destroyed, its distal segment may sometimes be advantageously united to a neighbouring tendon of similar action. Even nerves have been grafted in this manner.

Contracted structures may sometimes be simply divided without injury to function. In other cases they require oblique or zigzag division and reunion.

The after-treatment of almost all these operations consists of several weeks of complete rest on well-padded splints, followed by persevering passive and active exercise of an 'educational' kind.

The surgeon, the young surgeon especially, should think long and seriously before sacrificing the smallest portion of a hand or finger.

It is needless to point out that when the hand and fingers are traumatically contracted, it may be the fore arm, or even the upper arm, or, in extremely rare cases, even the brachial plexus, which is the seat of injury, and that cerebral disease and cerebral traumatism are common causes of contractures of the extremities.

Rupture of Finger-tendons

Either extensors or flexors may suffer. There may be an open wound, or the injury may be subcutaneous. The loss of power and the history of injury usually make the diagnosis plain enough for practical purposes, although the precise seat and extent of the injury may only be revealed by operation. It should be remembered that great injury is sometimes done by slight but sudden force.

Early operation through a longitudinal incision is indicated. After a few months, or even weeks, it gets very difficult to distinguish where the torn and now contracted and adherent tendon fragments belong to, and equally difficult to so place them that they will not form fresh and laming adhesions.

If the patient will not submit to operation, or for any reason should be thought unfit for it, he should be warned not to expect a good result from treatment by splints.

The term '*drop-finger*' is sometimes applied to the effect of rupture of the extensor tendon near the last phalanx.

Paralytic Contractures of the Hand and Fingers

These are noticed in the chapters on 'Infantile Paralysis,' 'Cerebral Paralysis of Children,' and in the last section (on Cicatricial Contractures).

Inflammatory Deformities and Disabilities

Deep suppurations, and even inflammations which do not go on to the formation of pus, are apt to leave the hand or fingers with a greatly limited range of movement, or even perfectly stiff. Sometimes the immediate reason is simple and obvious. For example, it may be the destruction of a tendon. Usually it is inflammatory adhesion and thickening of various structures, and sometimes the joint cartilages are eroded.

Even the most severe cases will generally, provided that the tendons be intact, yield to persevering use of passive exercises. But the surgeon should occasionally have an anæsthetic administered, and forcibly move the stiffened joint to a degree that the patient could not endure without. Nitrous oxide usually suffices. The after-pain is often surprisingly small. Now and then it is worth while to give ether. Immediately after the operation thick masses of cotton-wool should be packed around the hand, and a firm bandage applied. These may be removed next day and the passive exercises renewed. After a time active exercises will become possible and useful. When the patient uses either passive or active movements, he should begin by bathing his hand in hot water, or hot water and salt. The bowels,

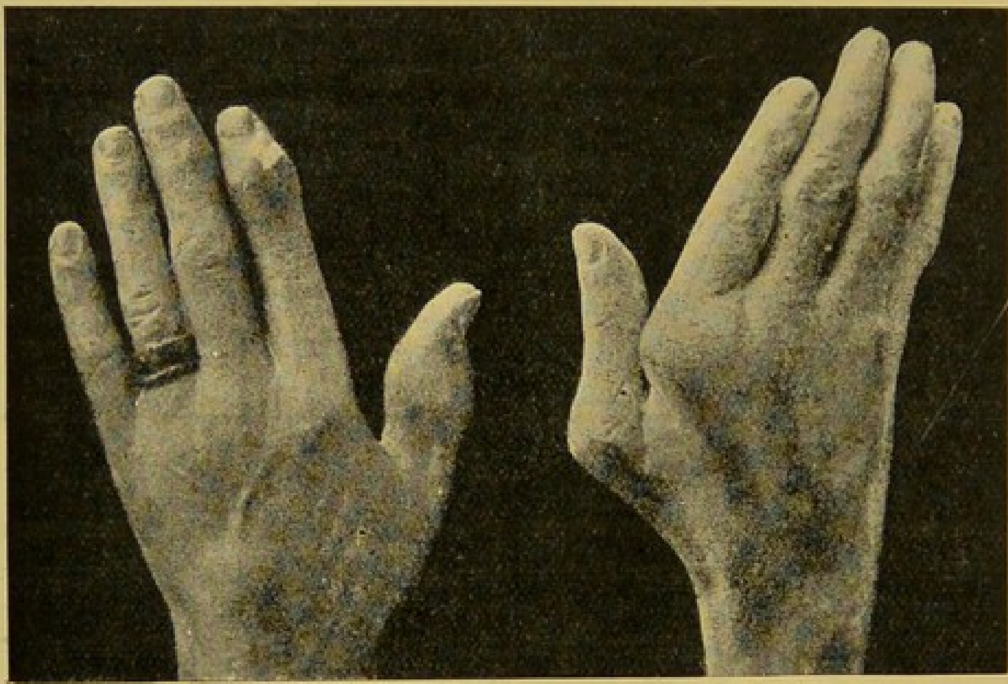


FIG. 128.—GOUT. FIG. 129.—RHEUMATISM.

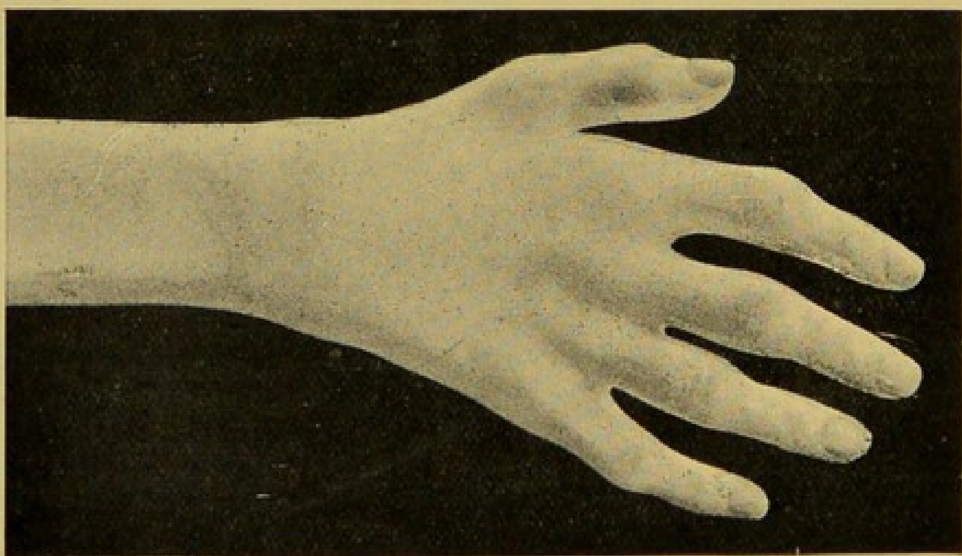


FIG. 130.—RHEUMATOID ARTHRITIS.

These illustrations contrast well the gouty swellings due to lithic acid deposits, the lateral deflection of the digits towards the ulnar side in rheumatism, and the wasted soft parts and thickened joints of the crippled hand and wrist of chronic rheumatoid arthritis. (From Dr. A. S. Wohlmann's 'Clinical Significance of the Human Hand,' 'Bristol Med. Clin. Journ.,' June 1896. By kind permission of the editors.)

digestion, and diet should be seen to, especially in middle-aged persons.

Tenotomy should be avoided in the vast majority of these cases. When it is judged essential, it is better to divide the tendon in the arm than in the hand or in the fingers, as operations for lengthening and splicing tendons are more feasible and successful in the arm than in the fingers. There is less room in the digital parts of the sheaths, and less vitality in the digital parts of the tendons.

Plastic proceedings are sometimes required to repair the ravages of suppuration, as well as those of pure traumatisms.

Rheumatic deformities of the hand and fingers are, when severe, not very amenable to orthopædic treatment. I have seen an instance in which it has been tried for lateral deviations. Tenotomy had apparently been applied. Function was greatly injured, and appearance not improved. Such a deformity is of a very compound nature, and would require quite a series of operations, including a number of osteotomies in each hand, to even approximately correct it.

Contraction of Finger-tendons in Glass-blowers ('Main en Crochet')

Poncet of Lyons described this deformity. It is characterised by a permanent flexion of the fingers, especially of the little and ring-fingers, upon the hand. The second phalanx is almost at a right angle to the first. The contracture is not in the skin or in the fascia, but in the flexor tendons, especially those of the flexor sublimis. The inter-phalangeal articulations are more or less deformed, with a tendency to subluxation. The fingers are inclined towards the ulnar side.

Most glass-blowers are said to suffer, in France at least (M. Etienne Rollet, a pupil of Poncet's). These workmen employ a tube, which they hold in the hand all the working day and frequently rotate rapidly between the closed hands.

Clonic Spasms of the Hands and Fingers

are usually indicative of some old cerebral trouble. They can sometimes be advantageously controlled by apparatus without

FIG. 131.—VARUS OF THE WRIST AND DEFICIENCY OF DIGITS IN AN ANENCEPHALOUS FŒTUS IN THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS, LONDON.

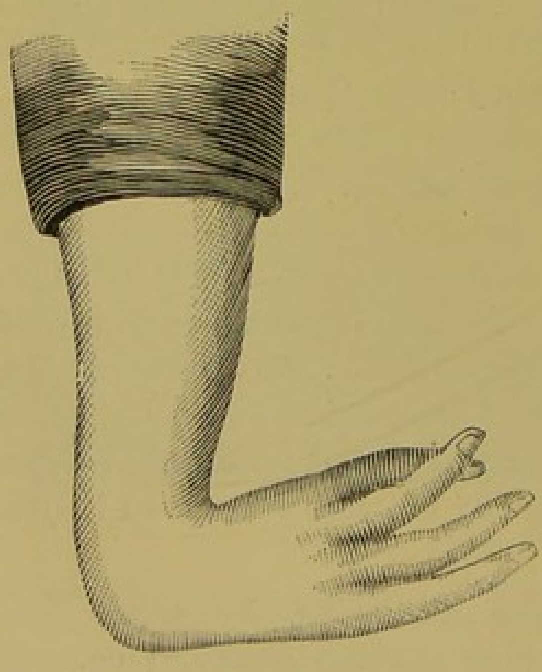


FIG. 132.—VARUS OF THE WRIST. After Dr. Clemente Romano ('Archiv. d'Ortopedia,' 1894, p. 91).

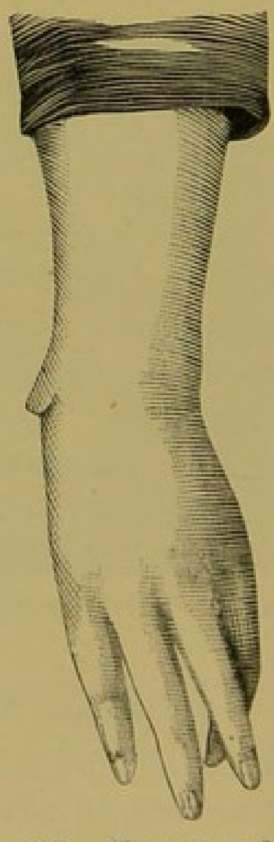
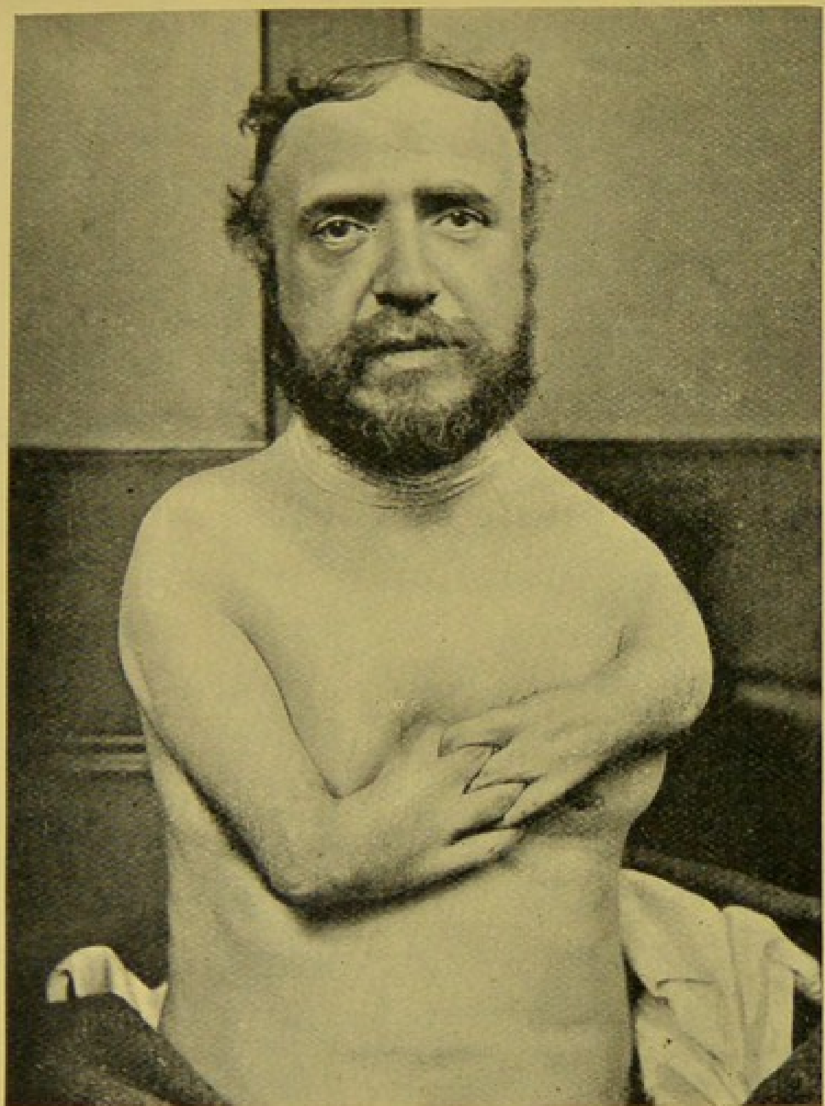
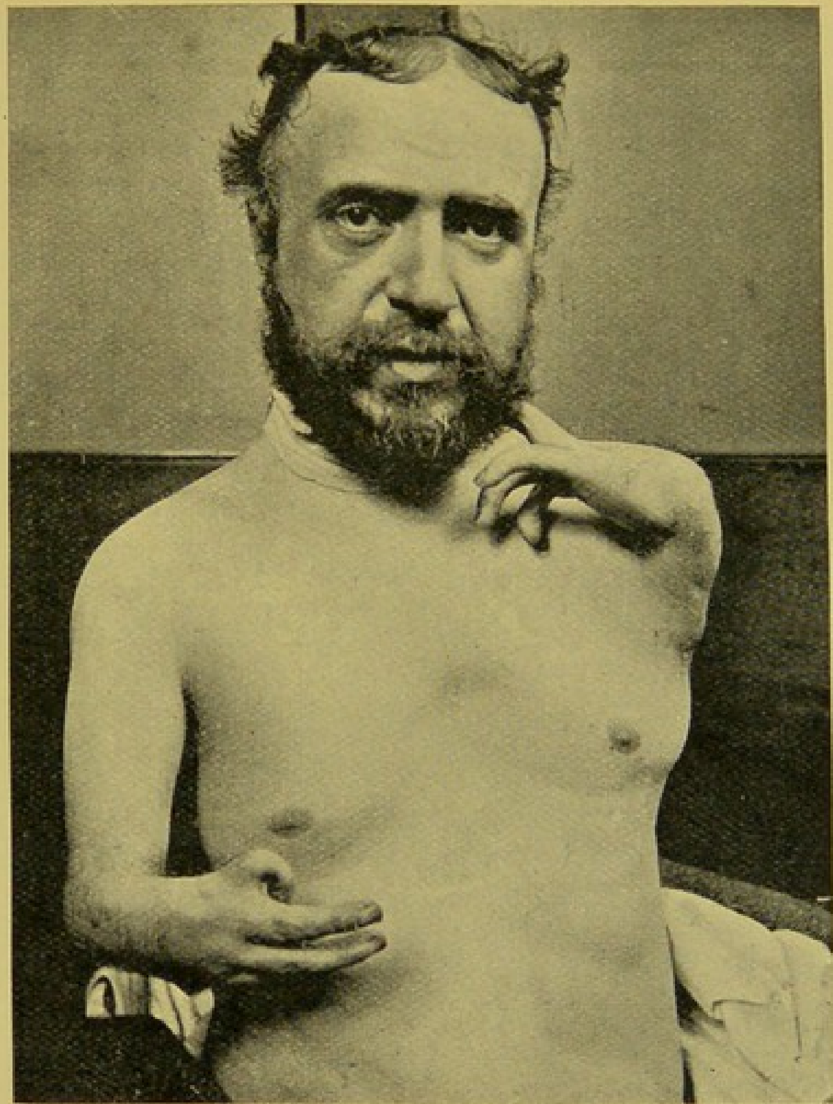


FIG. 133.—THE SAME CASE AFTER OPERATIVE TREATMENT.





FIGS. 134 AND 135.—CONGENITAL DEFICIENCY, MAINLY OF THE FORE-ARM ON THE RIGHT SIDE, AND OF THE UPPER ARM ON THE LEFT. Both the fore-arms are seen to be much shortened ; while, on the left side, the upper arm and the whole of the shoulder girdle are deficient. (From a Case of Mr. W. McAdam Eccles's in the 'West London Medical Journal,' April 1899.)

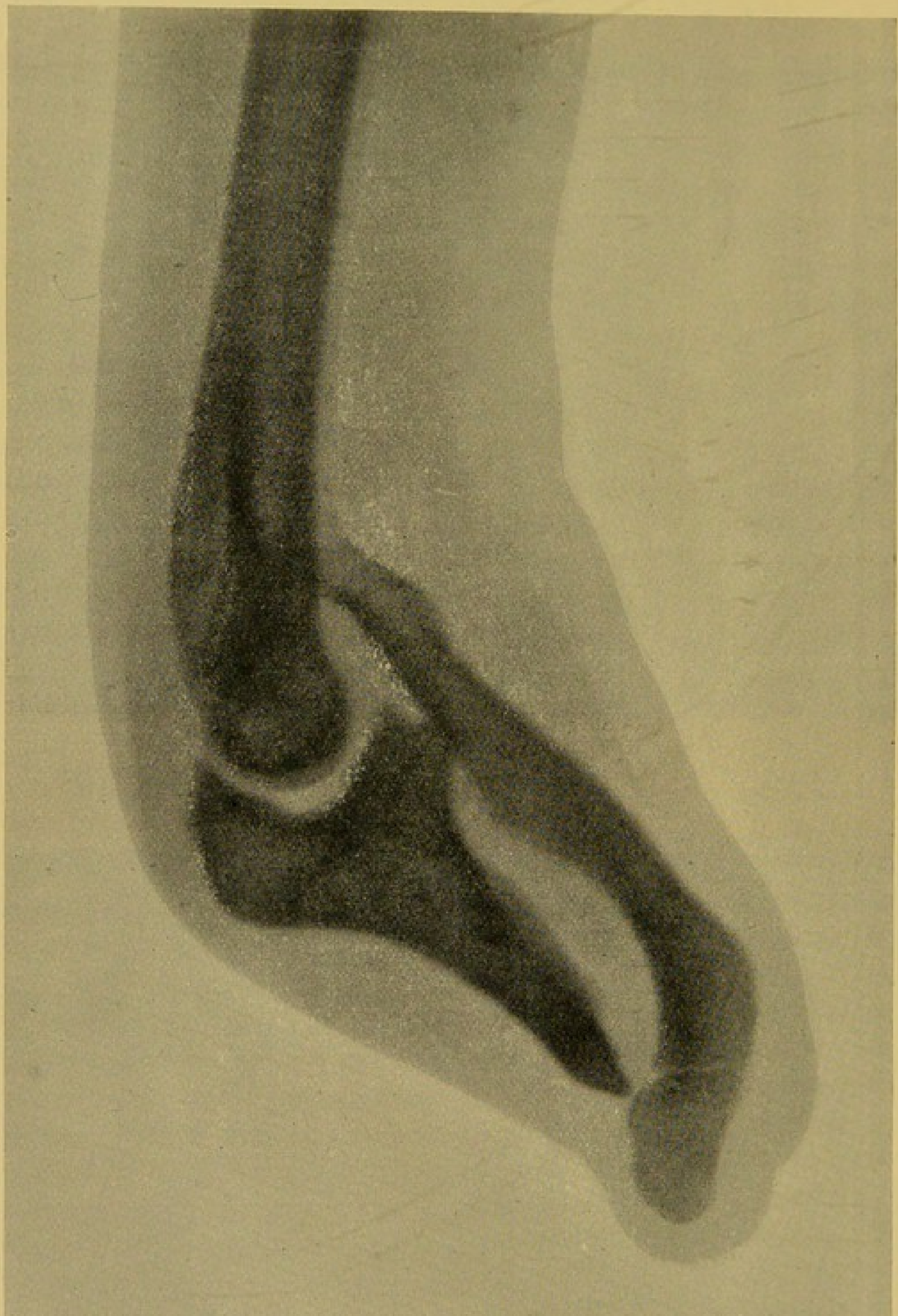


FIG. 136.—SKIAGRAM OF DR. S. D. CLIPPINGDALE'S CASE OF DEFICIENCY OF DEVELOPMENT OF DISTAL PORTION OF UPPER EXTREMITY. From a female aged 18. The bones of the fore-arm and hand are represented, on the ulnar side by the upper end and adjacent part of the shaft of the ulna, and on the radial side by the radius and a single bone at its distal extremity. Apparently, the ulna's having developed less than the radius has caused a dislocation of the latter bone upwards on the humerus. ('West London Medical Journal,' April 1899.)

preventing the extremity from being used. Nerve division and nerve resection are obviously quite inadmissible in these cases. And I should think nerve-stretching would be useless, unless pushed to the extent of producing paralysis. As the paralysis wore off the spasms would probably return.

These spasms, when occurring in connection with epilepsy, may be useful in diagnosis and in localisation of the central lesion.

Snap-finger

This is an affection in which one or other finger, or even the thumb (Reeves), cannot be extended by its owner unless he assists the extensor tendons in some way. Then the finger snaps open like the blade of a penknife. The cause of the affection seems to lie in some condition of the flexor tendon or its sheath—occasionally the presence of a small bursa. Whether a bursa be present or not, the first treatment to try should be rest on a splint, combined with warm fomentations to the flexor aspect of the finger and neighbouring part of the palm. If this fail after a fortnight's trial, the affected tendon and joint should be explored through a longitudinal incision, and any abnormality discoverable removed.

CHAPTER XIII

DEFORMITIES, ETC., OF THE TOES

THE deformities may be classified into—

Deviations, including

Lateral deviations (hallux valgus, &c.), and

Contractures (hammer-toe, hallux flexus, &c.).

Hypertrophy.

Excess in (1) number of digits, (2) number of phalanges.

Deficiency.

Union.

Abnormal location.

Of these, the lateral deviations and the contractures have by far the largest share of practical importance.

Metatarsalgia is, of course, an affection of the anterior part of the foot rather than of the toes.

Hallux Valgus

In this exceedingly common deformity the great toe is directed outward at its metatarso-phalangeal joint.

Causes.—It is agreed that short or narrow boots which do not give sufficient freedom to the toes are mainly responsible,

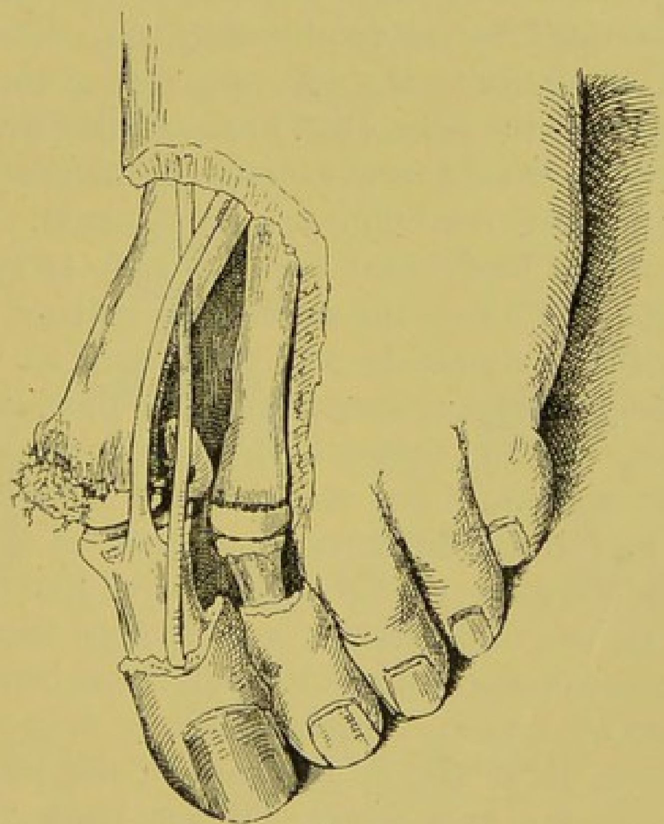


Fig. 137.—Hallux Valgus, with Arthritis of Metatarso-phalangeal Joint (Hoffa).

and especially the usual custom of shaping boots in such a way that their inner margins trend outwards anteriorly. But as many persons who wear such boots escape hallux valgus there must be other factors at work. Of these, an occasional one is a tendency to flat-foot. This permits the toes, during walking, to be more squeezed forward into the boot than occurs in the case of a person with a well-shaped, elastic plantar arch and well-developed flexor muscles.

The presence of hammer-toe of the second or third digit favours the development of hallux valgus by making room for the great toe to turn outwards. It is difficult to say, in such cases, whether the hammer-toe or the hallux valgus has been the primary deformity. Perhaps neither the one nor the other, any more than two peas lying together in a bag can be said to occupy their respective positions, the one primarily and the other secondarily.

In almost all cases of toe flexions and deviations the appearance of the parts suggests action and counter-action—an effort of each toe, of each phalanx, and of each joint to accommodate itself to its neighbours, and doubtless to the boot as well. I recently saw a case of valgus at the first inter-phalangeal joint of the second toe, in association with hammer-toe of the third. And the association of hallux valgus with hammer-toe of the second digit is very common.

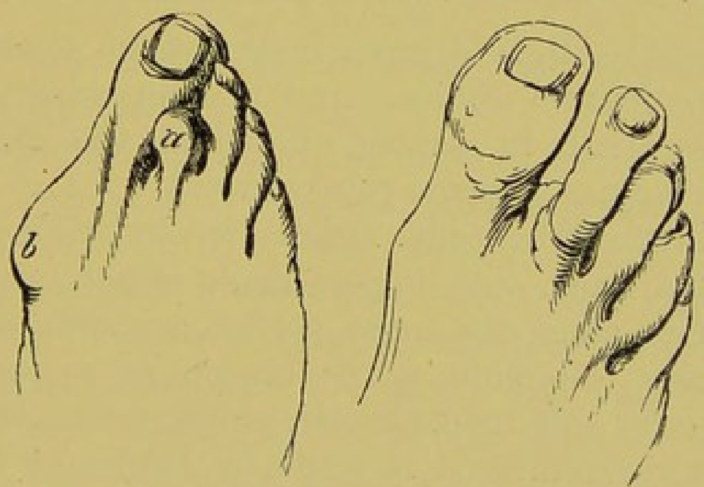
It is *a priori* likely that the affection termed rachitis adolescentium may affect the smaller as well as the greater long bones, the metatarsals and phalanges as well as the spine, the femur and the astragalus, and thus help to start hallux valgus. But the shapes of the joint surfaces concerned in this minor complaint are very different from those of the knee, and still more different from those of the vertebræ. Just as the scaphoid readily *slips round* the head of the astragalus, so the first phalanx readily slips round towards the outer aspect of the head of its metatarsal bone, deserting the inner aspect. Such a displacement is only possible to a minute degree, if at all, in the case of the inter-vertebral joints and of the knee-joint. Hence genu valgum and knock-knee are more purely bone deformities, while flat-foot and hallux valgus are, to a greater extent, joint deformities. But the difference is one of degree.

When a hallux valgus has begun to form, the extensor proprius pollicis, going straight to its insertion, lies towards the outer side of the metatarso-phalangeal joint, and gets newly acquired and increasing power of aggravating the valgus. I can scarcely believe, with Nelaton (according to

Paulet), that contraction of this muscle is the usual prime cause of the deformity. The affection rarely becomes marked before middle age is approached, and, when marked, changes in the joint similar to those of 'chronic rheumatoid arthritis' are frequent. There are pathologists who think the arthritis is the cause and the deformity the result. It is far more likely that the traumatic irritation to which the deformity exposes the joint brings on the arthritis.

Some surgeons, especially Malgaigne, Marjolin, and Verneuil, have attributed great importance to gout as a cause of lateral deviations of the toes. This cause may be a contributing one occasionally, especially in elderly patients, but the *commencement* of these deformities is not usually associated with any indication whatever of gout.

Pathology.—This has been to some extent indicated in the preceding remarks concerning causation. The cartilage-covered joint surface of the head of the metatarsal bone,



Figs. 138, 139.—Hallux Valgus with Hammer-toe and Bunion. (Dr. W. J. Little.)

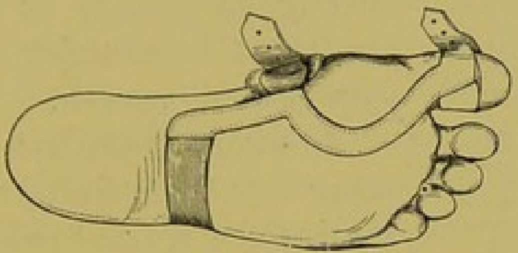
being gradually disused on its inner aspect, becomes proportionately degenerated on that side, and tends to form, with the internal ligamentous structures of the joint, so much fibrous tissue, in such a way that the internal ligament seems to, as it were, migrate outwards. In very extreme cases the external ligament has the appearance of having removed its metatarsal attachment outwards. The metatarso-phalangeal joint tends to be placed, not squarely on the head of the metatarsal, but obliquely on the outer aspect of its head. In advanced cases rheumatoid changes are found.

The inner part of the metatarsal head, released from the natural and equable pressure of the base of the first phalanx, and subjected to the irregular and irritating pressure of the boot, hypertrophies. The same influences produce a *bunion* in and behind this situation, and the thickened soft tissues make the subjacent bone look even larger than it really is. How this bunion, or enlarged bursa as it is, is apt to inflame and may suppurate is notorious. Suppuration may lead to fistula and the exposure of bone, or even, in rare and neglected cases, to diffuse inflammation with any of its possible results.

Symptoms and Diagnosis.—The nature of this affection is obvious at the first glance. It spoils the gait, and, mainly through the tenderness of the resultant bunion, or through crowding together or outwards the neighbouring toes, tends to cripple the patient, not so much continuously as periodically.

Prognosis.—Slight degrees may remain stationary and cause the patient no trouble. But a progressive tendency is frequent, especially in persons who will not be careful about their boots from a hygienic point of view.

Treatment.—The only radical treatment is operation. But suitable boots, with uppers made of soft material and soles straight along the inner border, are sufficient for the slighter cases, especially if the bunion be protected by an appliance, or by soft, thick plaister, properly cut. An appliance which I often recommend is made by Krohne & Sesemann, and is shown in the annexed drawing. The strap which goes round the great toe and holds it to the spring is of wash-leather. Socks or stockings with offsets for each toe, after the manner of gloves, are to be recommended. There are, unfortunately, very few shops where such can be got, excepting to order. When an appliance is to be worn, it is important to see that room is provided for it in the boot. The boot is the great and disheartening obstruction of the orthopædic surgeon; and next to it may be placed the not unfrequent conceit and disobedience, or reluctant obedience, of the so-called 'anatomical bootmaker,' who is sometimes a quack in disguise. An intelligent and honest bootmaker, who will co-operate loyally with the surgeon and subordinate his own prejudices, deserves every encouragement.



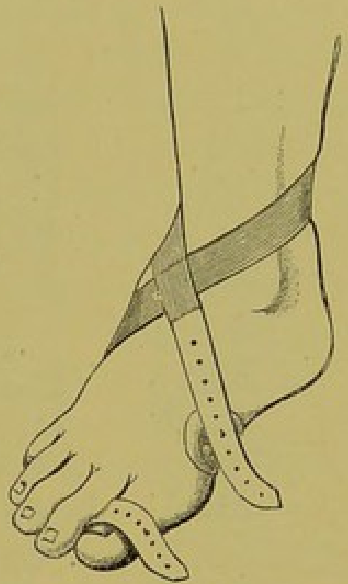


Fig. 140. Fig. 141.

Messrs. Krohne & Sesemann's Lever Spring for Hallux Valgus.

Passive movements of the great toe, practised daily, assist other treatment.

The *operation* I practise and recommend in cases severe enough to require it is removal, with a chisel, through a longitudinal incision, of a thick wedge from the metatarsal bone, just posterior to the metatarso-phalangeal joint. In the same patients I have tried this on one side and simple division of the metatarsal bone on the other, and seen how much better are the results of the former than of the latter operation. The bunion should always be excised at the same time.

Excision of the joint itself is only required in extreme cases; because, why remove the joint when excision of a wedge outside it will effect the desired object?

Lateral Deviations of the other Toes; also Hallux Varus (Pigeon-Toe)

The little toe is sometimes pressed inwards, lying beneath or above its neighbour. Varus of all the toes is sometimes associated with congenital talipes equino-varus. Fig. 142

shows varus of the four outer toes, as well as of the great toe, following excision of the metatarsal bone of the great toe. In such a case as this the deformity is not so much the result of cicatricial contracture, strictly so called, as of cicatricial obstruction to symmetrical growth.

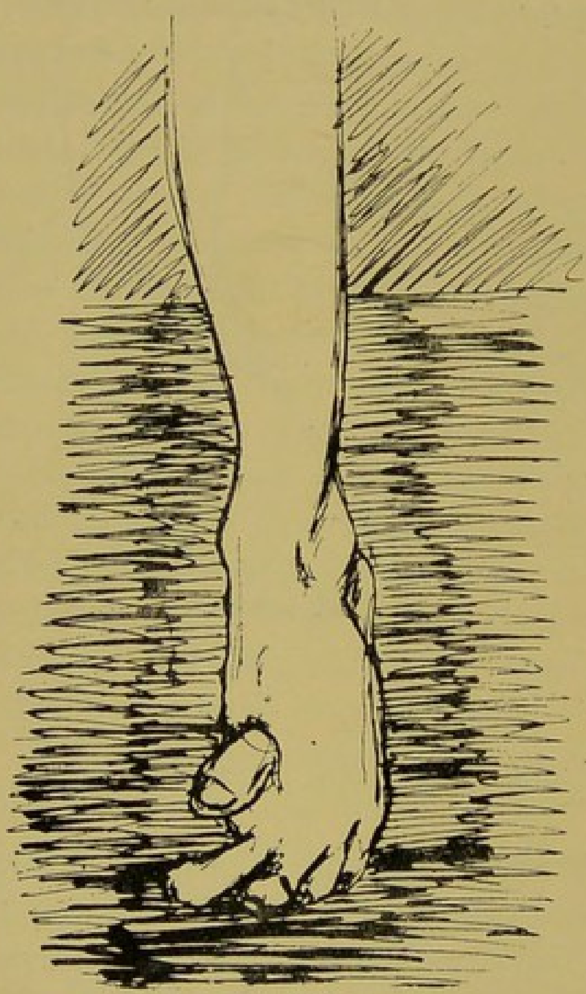


FIG. 142.—VARUS OF ALL THE TOES, RESULTING FROM REMOVAL OF FIRST METATARSAL BONE.

Lateral deviations of other toes than the great toe can be treated (when they require treatment) on the same principles as those applied to hallux valgus.

Pigeon-toe, or deviation inwards of the great toe, is unusual, except in talipedic feet, and practically unimportant.

Lateral deviation of the distal phalanges of one or more toes from the line of the proximal phalanx is frequent, and is then apparently the result of adjustment of the shape of the toe affected to the shape and situation of its neighbours. Even *rotation* of these phalanges is seen under similar circumstances.

FLEXION OF THE TOES—HAMMER-TOE

This important little deformity is characterised by hyper-extension—that is to say, dorsal flexion—of the first phalanx on the metatarsal bone, combined with flexion—that is to say, plantar flexion—of the second phalanx on the first. The third phalanx is in some cases extended, in some hyper-extended, and in others flexed. Various fanciful and useless names have been used to distinguish these varieties. One, *e.g.*, has been called the 'swan-neck' toe.

Causes.—Boots, and especially short boots, are usually blamed, and not unjustly. But, as in the case of hallux valgus, there must be some other cause at work. Valgus of one toe, generally the great toe, so frequently co-exists with hammer-toe of its neighbour, and the two toes then always fit to each other so exactly like the pieces of a puzzle, that it can scarcely be doubted one deformity has a tendency to cause the other. It is plain that nature regulates the processes of growth and development in such a way as to make the digits pack neatly together. This applies to the hand as well as to the foot, so it must be independent of the boot. When the boot assists, the packing comes to resemble that of multiple calculi, with facets shaped to fit those of their neighbours.

The theory that ordinary hammer-toe is of nervous origin is an hypothesis with no facts to justify it. When the toes

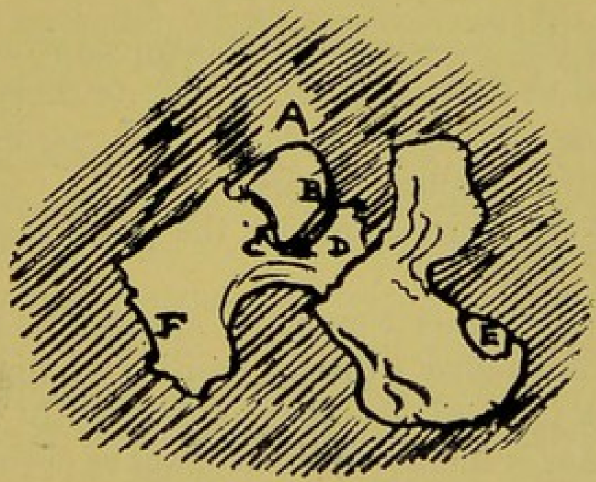


Fig. 143.—Dissection of a Hammer-toe, Amputated at the Meta-tarso-phalangeal Joint. Skin and tendons removed as far as middle of second phalanx. Joint exposed. A B C, joint-surface of first phalanx; note that A B is almost at right angles to B C. There is quite a transverse ridge at B, which, before the lateral ligaments were cut, made the joint like that of a penknife, *i.e.* D, the base of the second phalanx, slipped from B C to B A with a click and *vice versa*. F is the base of the first phalanx. E is the toe-nail.

are 'en grippe' in a case of infantile paralysis, the symptoms of present or past paralysis are plain. But that does not justify one in assuming past paralysis or spasmodic contracture in cases where only one or two toes, frequently only of one foot, are contracted. The most typical hammer-toe of the second digit is frequently seen associated with hallux valgus in one foot, while in the other foot a similar hallux valgus has room made for it by a totally different disposition of the second toe. Surely in such a case the causes responsible are most likely mechanical, nutritional, and developmental, and the tendinous and ligamentous shortenings are examples of the nutritive shortenings and secondary contractures seen in surgical practice every day.

Pathology.—The flexed joint is held in malposition mainly by the shortness of the lower (plantar) fibres of the lateral ligaments. But in marked cases the tendons are also shortened. Even when the flexed joint is extended after cutting all resisting structures, the extensor tendon may retain the toe pointing obliquely upward into the air. In very severe cases the skin on the plantar aspect of the flexed joint will give way or require cutting before the toe will open out.

Changes in the osseous and cartilaginous structures of the joint take place in time, and are similar to those found in all joints a portion of whose surfaces falls permanently into disuse. (See, *e.g.*, Hallux Valgus.)

A troublesome corn forms on the prominent knuckle of the flexed toe.

Diagnosis.—What is commonly meant by 'hammer-toe' must not be confounded with the position of slight flexion in which the last joint of the toes is frequently found. But when this flexion is increased, and cannot be opened out, either actively or passively, *a variety of hammer-toe* more deserving of the name, if resemblance has any force, than the deformity which usually receives it is produced. The extremity of the toe rests on the ground, and there is a liability to the formation of blisters on the prominent knuckle when much walking is done.

Treatment.—Excepting for the mildest cases, any treatment without operation is not worth the time, trouble, and inconvenience it costs.

A firm leather sole may be worn inside the boot, stiffened, if necessary, with a sheet of metal or wood on its lower surface. Poroplastic felt yields too readily. Through slits in this inner sole webbing is passed, carried over the hammer-toe, and then repassed through another slit in the movable sole. If more than one toe is affected, a separate loop of webbing is carried over each digit.

Elastic webbing is not well borne. It causes numbness and considerable pain if at all tight.

Operation.—Having thoroughly cleansed the toes, nails, and whole foot with soap, brush, and hot water, and soaked and rubbed the parts well in warm sublimate solution (1 : 2,000), insert a sharp-pointed tenotome at one side of the first inter-phalangeal joint, carry it across the plantar aspect, immediately beneath the skin, and divide, right down to and including the ligaments, all the soft structures, except the skin. Divide the lateral ligaments near the plantar aspect. Withdraw the knife and force the toe straight. If the skin tears open, it does not matter much. Indeed, if the skin be very tense, the surgeon may as well cut it, though the wound then made, of course, takes longer to heal than a mere puncture.

The joint may be found to act like a trigger, going straight with a click when forced, and remaining straight.

Dress with a little iodoform gauze dipped in sublimate solution. Fix the straightened toe to a plantar splint of some sufficiently stiff material with good strapping—*e.g.* Leslie's, Seabury & Johnson's, or Maw's brown plaisters.

Attend simultaneously to any displaced or deformed neighbouring toe, or to flat-foot, if present. I have already insisted upon the inter-relation of cause and effect, effect and cause, in which these deformed neighbours stand to one another. There are some cases in which you might almost as well try to purify half the water in a glass, leaving it with the polluted other half, as try to cure permanently one deformed toe without attending to its neighbour. When the great toe is in a state of valgus, at least retain it well inwards throughout the time of treatment of the hammer-toe.

Many surgeons habitually treat hammer-toe by excising the contracted joint through a transverse incision (Terrier) or through a longitudinal incision (Anderson, and most English surgeons).

This is a somewhat rougher and more deforming proceeding than that just described. The ends of the bone are expeditiously snipped off with cutting bone forceps, which, however, should be *sharp*. Antiseptic precautions, of course. The shortening it produces is an advantage, if the end of the toe affected has previously projected beyond the line of the others. The incision I prefer for this operation is a longitudinal one on the outer border of the tendon. The latter should be hooked to one side, the knuckle projected, one or both bone ends clipped off, and the wound closed with a silkworm-gut suture. Or amputation may be performed.

Hallux Flexus—Hallux Rigidus

The former of these two names is applied to a comparatively advanced grade of the affection denoted by the latter.

It is an affection of the great toe which in important respects, if not in all, corresponds with that called 'hammer-toe' of the second, third, and other digits.

Causes.—It is so generally associated with undeniable flat-foot that in such cases either the one must be the cause of

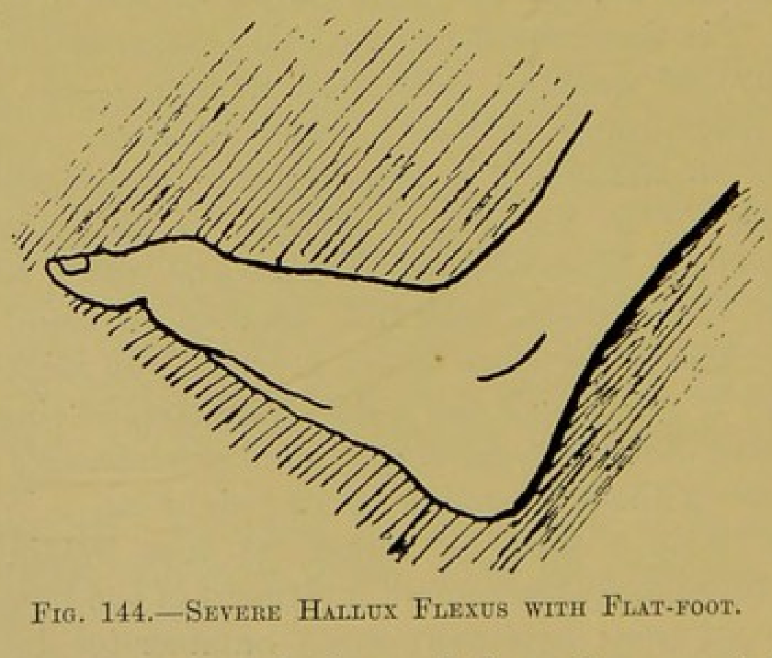


Fig. 144.—Severe Hallux Flexus with Flat-foot.

the other, or they must both result from the same influences. Fochier attributed it, at least 'in the majority of cases,' to paralysis of the peroneus longus, he being evidently, like many other Frenchmen, a believer in Duchenne's theory of the nature of flat-foot. It is strange that this disabling and not rare affection does not appear to have received the honour of a printed description before Fochier's paper in the 'Lyon Médical,' 1880, t. xxxv., p. 84 : 'Sur l'affection douloureuse du gros orteil.'

The most plausible explanation of the way in which flat-foot leads to hallux flexus may be given in the words of Ogston.[1] 'By the increased separation of the extremities of the arch the structures of the sole of the foot are made tense, and the muscles that flex the great toe, being put on the strain, and even atrophied by the pressure against the ground, flex the great toe at its ball,' &c.

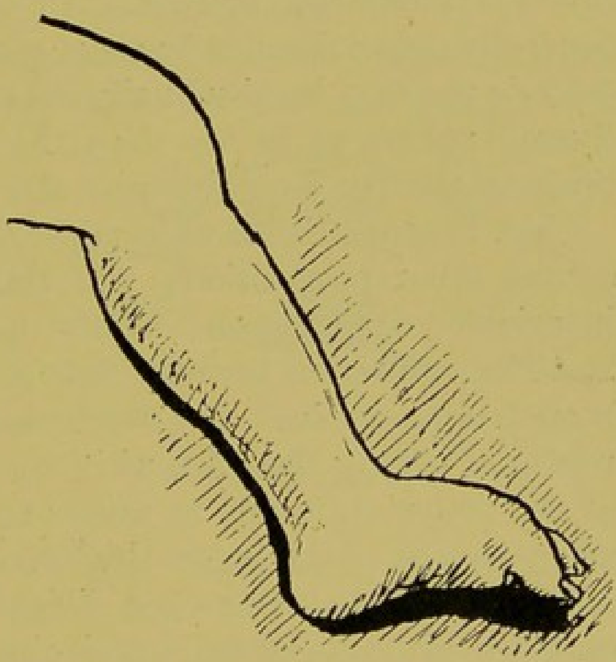


Fig. 145.—Spurious Hallux Flexus, due to Tuberculosis of the Metatarso-Phalangeal Joint.

Golding-Bird, the first English writer, so far as I know, who refers to the subject, writes as follows : 'Some cases of flat-foot complain of pain hardly, if at all, in the usual place, but in the ball of the great toe, and if this is examined it is found in a condition of ostitis.' 'The pathological condition present is arthralgia, with often an articular ostitis from pressure.'

It should be noted that hallux flexus bears the same relation to flat-foot that a secondary spinal curvature does to a primary, or that pes cavus and ankle varus bear to genu valgum. That is to say, it may be regarded as a *compensatory* curvature.

In the spring of 1887 attention was again called to this subject, simultaneously, by Mr. Reginald Lucy[2] and by Mr.

[1] *Bristol Med. Clin. Journ.*, 1884, p. 7.
[2] *British Medical Journal*, April 2, 1887.

Davies-Colley.[1] The former entitled his paper 'Stiffness of the Great Toe in Male Adolescents,' the latter wrote on 'Contraction of the Metatarso-phalangeal Joint of the Great Toe.' Neither of these authors thought flat-foot had much to do with the etiology of the affection. Mr. Lucy, in a much more recent paper, repeats this opinion.

Observers seem to agree as to the influence of the boot. Mr. Lucy, whose observations were made as surgeon to the General Post Office, in examining candidates for messengerships, writes: 'The patients are generally boys who have a great deal of walking and standing to do, with no history of injury, rheumatism, or gout. An examination of their boots generally shows them to be short where the weight of the body extends the foot longitudinally, while the vertical depth of the toecap appears to be less than the thickness of the terminal phalanges of the toe; the soles also are thick and stiff.'

Mr. Cotterill, in an able paper,[2] lays down the following, among other propositions: '1. Hallux rigidus is due to the invariable combination of flat-foot and boot pressure.' 2. 'The connection between flat-foot and hallux rigidus has been frequently denied or overlooked, owing to the imperfect means of testing flat-foot, while an inspection of the foot, or of the footprint, is apt to mislead; the most reliable test is an inspection of the boots which have been worn.'

It is true that there is a difficulty in deciding positively on the presence or absence of incipient flat-foot; but when a painful, stiff, and tender great toe joint is found in connection with a foot in appearance properly arched, and free from pain in the usual seats of suffering caused by flat-foot, is it not going too far to say the hallux rigidus is caused by flat-foot? Much of the difference of opinion among observers may be explained by the conditions under which they have observed. Mr. Lucy, examining a number of boys who wish to be considered healthy, discovers stiffness of the great toe for which they have not, in most instances, thought of going to the

[1] Clinical Society, March 25, 1887. Mr. Lucy's paper had been long in the possession of the *British Medical Journal*, and probably appeared the week after Mr. Davies-Colley's paper, through the latter awaking interest in the subject.

[2] *Edinburgh Medical Journal*, November 1887.

orthopædic, or even to the general surgeon, and finds that such cases, for the most part, have no flat-foot, or at least none that attracts his attention. I am somewhat inclined to think he would have found it oftener had he regularly and carefully looked for it in such cases.

Mr. Davies-Colley, finding his patients in their beds in Guy's Hospital, doubtless admitted by his assistants, sees them under circumstances wherein flat-foot is least obtrusive and most disguised.

Mr. Cotterill and others, approaching the subject from an orthopædic standpoint, find these cases in the flat-foot patients because there they look for them.

Nevertheless, of the frequent etiological relationship of both hallux flexus and hallux rigidus on the one hand, and of flat-foot on the other, there can be no question. It has been very positively asserted that barefooted nations with flat-foot do not suffer from hallux rigidus. I do not know on what evidence this rests; but while I can readily believe that *painful* stiffness of the great toe may be rare in the bootless, I should much like to learn whether or not the great toe of the flat-footed barefoot has its normal range of movement dorsally.

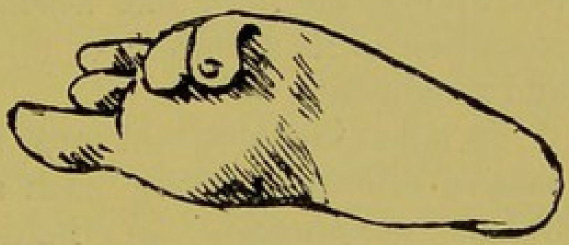


FIG. 146.—CONGENITAL HALLUX FLEXUS OF FOURTH AND FIFTH TOES, WITH HYPERTROPHY OF GREAT TOE.

In these remarks hallux rigidus—*i.e.* stiff and painful great toe—has been regarded as synonymous with hallux flexus. But it must be pointed out that actual transition from a mild grade of stiffness and pain to such severe cases as those, for example, described by Davies-Colley has been rarely observed, and that pain and stiffness of the great-toe joint are very likely sometimes early signs, not of hallux flexus, but of incipient hallux valgus. The influence of the diatheses—gout, rheumatism, &c.—though often asserted or suggested, is unsupported by evidence, except in isolated cases, usually occurring in middle life.

PATHOLOGY. — The ligamentous and the muscular structures on the plantar aspect of the ball of the great toe are shortened in proportion to the severity of the affection. The superior part of the cartilaginous surface of the head of the metatarsal bone is encroached upon. In confirmed cases the changes of rheumatoid arthritis are to be found, including not only degeneration of cartilage and thickening of the bone ends, but also the appearance of one or more pieces of new and movable bone in connection with the joint and fibrous structures in relation with it.

Treatment.—Flat-foot must be inquired for. If found, it must, of course, be treated. Even when not found a little support to the plantar arch may do good.

The choice of other measures depends upon the grade of the affection—viz. whether it is (1) incipient; (2) marked, but without anything like absolute rigidity of the joint and roughness of its surfaces; or (3) with nearly absolute rigidity and roughness.

In mild cases the joint must be protected against forcible passive extension during each step of walking. Professor Chiene recommends an inflexible sole, and the plan answers. I have sometimes applied a plaster-of-Paris case, with excellent results; but it must be absolutely rigid, fit like a glove, and be carried on the foot up to the instep. It, unfortunately, takes too much room in the boot. The upper leather of the boot should be soft, and not tight, and the boot should, of course, be long enough. The cases with great rigidity, roughness, and flexion to an actual angle with the sole of the foot are best treated by excision of the joint. This *operation* is best done through a single lateral and longitudinal incision.

Cases of intermediate severity should be treated first as mild cases, and afterwards, if necessary, by operation.

I have never tried simple division of the fibrous structures, including the ligaments and the flexor longus pollicis on the plantar aspect and neighbouring portions of the lateral aspect of the joint; but I think it would give as good a result as excision in many cases; and it is a less rough proceeding.

Hypertrophy of the Toes

Hypertrophy of the toes is usually congenital. In rare instances it develops later in life as one of the symptoms of acromegaly, a disease so well marked and so essentially different from orthopædic hypertrophies that it need not be further referred to here.

Although commencing at or before birth, the hypertrophies under consideration often increase and become more striking afterwards.

Sometimes they affect the bones as well as the more superficial structures; sometimes they affect the soft tissues, chiefly the cellular tissue and fat, only.

In the former variety the joints are apt to be stiffened, even if not ankylosed. In both varieties the hypertrophied digits are generally impaired in usefulness and strength.

The great toe and the second are more frequently affected than the others, the fourth and fifth less frequently. Sometimes one toe only, sometimes several, are hypertrophied.

Generally no treatment is required. Of course the boots must be made to fit properly. In exceptional and extreme cases amputation may be called for. The head or more of the metatarsal bone must then be removed, or left, according to the indications of the individual case; *i.e.* according to the extent to which it does or does not participate in the deformity of the digit.

Excess in Number of the Toes—'Polydactylism' of the Foot—Supernumerary Toes

Although the commonest congenital anomaly of the toes, it is not by any means absolutely frequent; *e.g.* only one case of polydactylism was noted by Blot in 10,000 new-born children; and in the midwifery department of Guy's Hospital and in that of the 'Gebär- und Findelhaus,' in Vienna, only one in 14,000 (Paulet).

This estimate may be a little below the mark, for when all the toes are well formed and naturally arranged a sixth toe, not specially looked for, may escape the observation of the accoucheur.

There is usually only one superfluous digit on each foot, but there may be two, three, or more.

Voigt and Rueff (quoted by Paulet) relate cases in which there were twelve toes on each foot.

Polydactylism of one foot is generally, but by no means always, accompanied by a similar affection of the other foot, and also of the hands.

When the additional digits are numerous, the numbers on

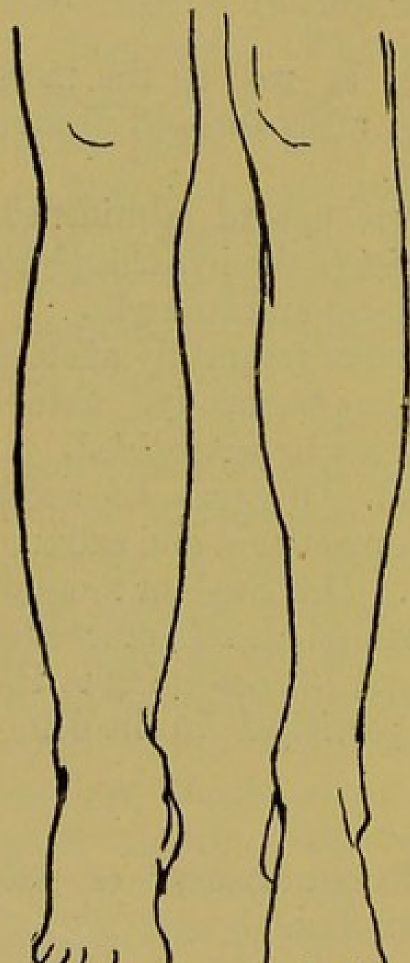


Fig. 147.—Congenital Hypertrophy of Right Leg and Toes.

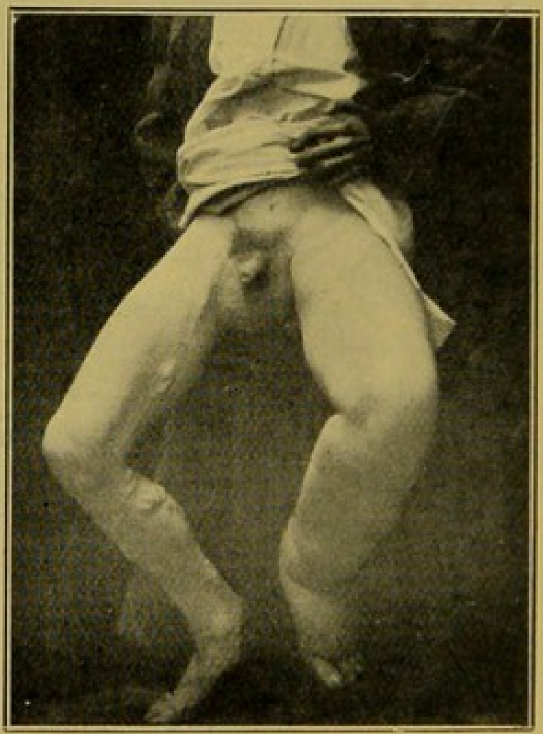


Fig. 148.—Acquired Hypertrophy of Left Leg and Foot, with a History of some Inflammatory Affection (of the Glands ?) in the Groin. The right saphena vein is varicose. (A Case of Mr. Bidwell's.)

the feet or hands as compared with each other, and on the feet as compared with hands, may be asymmetrical.

With regard to *causes*, the influence of heredity is frequently observed.

When the number of toes amounts to ten, or thereabouts, on each foot the fusion of two feet together is suggested.

Annandale materially modifies Gaillard's classification of these anomalies, and divides them into four classes:

1. Imperfectly developed toes attached by a narrow pedicle.

2. A more developed organ, articulating with the head of a metatarsal bone or of a phalanx belonging to another digit.

3. A developed organ having its own metatarsal bone.

4. As variety 2 or 3, but intimately united along its whole length with another digit. (Polydactyly with syndactyly.)

I have taken the liberty to simplify and shorten Professor Annandale's definitions a little.

It will have been inferred that the number of metatarsal bones may be equal to or less than the number of toes. A specimen in the Musée Dupuytren, noticed by Paulet, has eight toes and eight metatarsals. The scaphoid, very large, articulates with five cuneiforms, and each of these with one of the first five metatarsals. Two other metatarsals articulate with the cuboid; and the eighth is planted on the seventh.

Mason dissected a foot with nine toes, and described the curious arrangement of the muscles and tendons in 'St. Thomas's Hospital Reports,' 1879, p. 37.

The additional toe may be *set* upon the foot in one of various ways. It may project almost at right angles from the border of the foot near the great or near the little toe. It may resemble a small pedunculated tumour in its mode of attachment. The appearance may be that of a bifid toe, or of a toe belonging to a row of toes placed posteriorly to the normal ones on the dorsal aspect of the metatarsals.

In a remarkable case reported by Bull[1] the left foot was represented only by a heel divided transversely by a depression. Anteriorly were five normal toes. But further back there emerged, from the transverse groove, six other well-shaped toes.

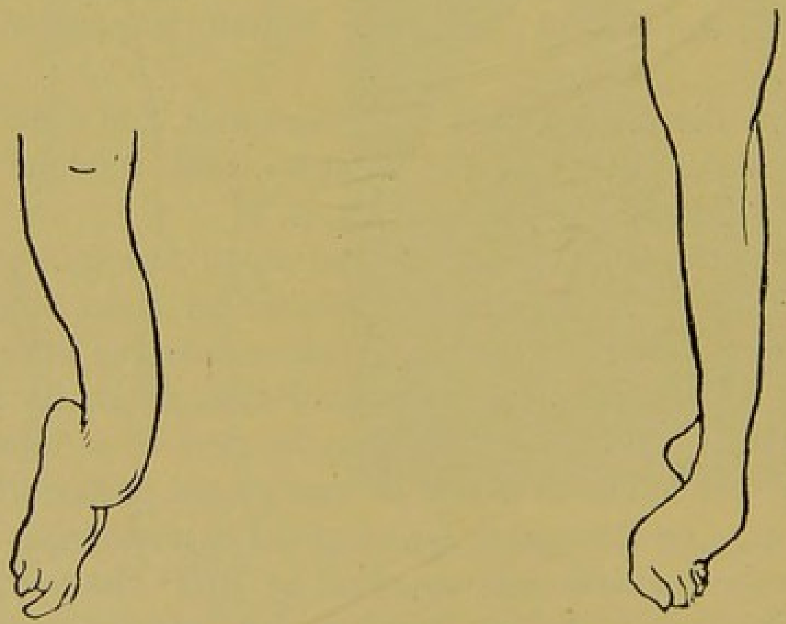
TREATMENT.—With carefully made boots many of these feet may cause no inconvenience. Otherwise, the question of

[1] *Boston Medical Journal*, 1875, vol. ii. p. 293, and *Dict. Encyc. des Sciences médicales*, xvii. p. 621 (article 'Orteils').

amputating the supernumerary part arises, and then each case must be considered by itself. It should be borne in mind that strength is the main quality required in the foot; that strength is apt to be materially diminished by interference with the metatarsals, and that the removal of one of these may be followed by cicatricial contraction and disturbance of the line of growth of the neighbouring toes. I repeat, each case must be considered carefully on its own merits. Supernumerary toes of the first variety may be cut off without hesitation.

Deficiency in Number of the Toes

This abnormality being, of course, less remediable than excess in the number of the toes, it is well that it is also less common. It usually coexists with other grave defects in the development of the lower extremity; *e.g.* with absence, or at least a rudimentary state, of the fibula or of the tibia, and



Figs. 149, 150.—Congenital Deformity of both Feet, associated with Deficient and Webbed Fingers of both Hands, as well as Deficient Toes.

with the congenital valgus or varus therewith associated. (See p. 154.)

The toes absent are those corresponding to the leg bone wanting.

When the middle toes are absent the condition is sometimes called 'lobster-claw' deformity ('pince de homard').

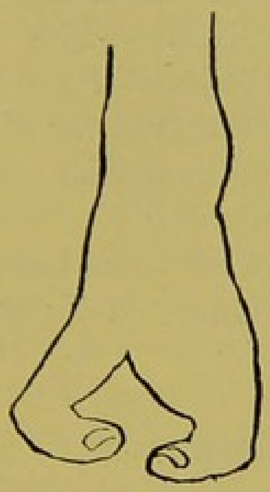


Fig. 151.—Lobster-claw Foot (Left). From a case in which the fingers of the left hand were absent and those of the right hand half-webbed.

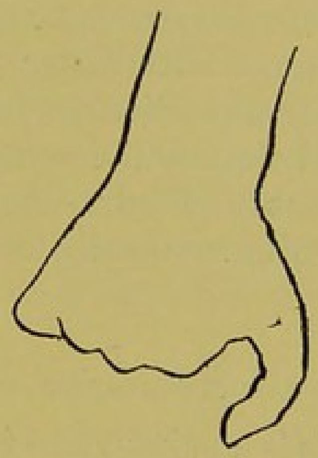


Fig. 152.—Left Foot of Case with Lobster-claw Deformity of Right. (For hands of same patient see Chapter XII.)

Union of the Toes (Syndactylism)

Toes may be united for only a limited distance or along their whole length.

The usual bond of union is a web of skin. Sometimes this is wide enough to permit a certain, though very restricted, amount of independent movement. Sometimes it is so short and thick that the united toes look almost or quite like one, except that even in this case they generally have two nails; and on palpation distinct phalanges may be felt side by side.

In rare cases even the phalanges are fused together, especially the distal ones.

These deformities, when not the result of burns, are, of course, congenital. They may be regarded as a persistence of a condition normal in the fœtus before a certain age.

They rarely require treatment. In this respect they contrast with syndactylism in the hand. Union of the toes generally coexists with union of the fingers, and often with the presence of supernumerary digits.

Abnormal Location of Toes

This has been already referred to in connection with supernumerary toes. Fig. 142 (Chapter XIII., p. 256) shows the great toe apparently springing from the base of the metatarsal bone. The latter bone had been removed for disease, and the malposition is due to subsequent cicatricial contraction and abnormal development.

In cases of intra-uterine amputation, or those known as such, rudimentary digits are frequently found on the stump.

Metatarsalgia ('Morton's Disease')

This is a painful and not uncommon affection, in which the pain starts from the neighbourhood of the fourth metatarso-phalangeal articulation. From thence it may spread to very distant parts—the knee, the hip, and even beyond. Dr. Thomas G. Morton, of Philadelphia, who first described it,[1] convinced not only himself, but all subsequent writers, that it was due to pressure on the plantar digital nerves. Yet the character of the pain as usually described differs from pain positively known to be due to pressure on exposed nerves, such as the ulnar, for example. Morton thought the nerves were compressed between, on the one hand, the head of the fifth metatarsal bone and the base of the corresponding first phalanx, and, on the other hand, the head and neck of the fourth metatarsal. The immunity of the inner three toes he attributed to the slight lateral mobility of their metatarsal bones. Poullosson,[2] Roughton,[3] and Grün[4] all blame descent of the tarsal arch. The reply which has been made to these observers, viz. that no laxity of the transverse ligament can be found, is not quite to the point, as such laxity is quite a distinct thing from descent of either tarsal arch. Such descent may coexist with excessive rigidity. Robert Jones and Tubby believe the nerves are painfully compressed between the bones and the ground.

[1] *American Journ. of Med. Sci.*, Jan. 1876.
[2] *Lancet*, 1889, i. 346.
[3] *Ibid.* 553.
[4] *Ibid.* 707.

It seems to me that compression of fibrous structures around the joint would fully account for the pain. The exquisite sensitiveness of aponeuroses, ligaments, and fasciæ may be witnessed when a catch-forceps is applied to them in an operation without anæsthesia.

Predisposing influences are heredity, female sex, middle age (*i.e.* thirty and upwards), working lathes or sewing-machines. Exciting causes are injuries, walking over rough surfaces, tight boots, or 'changing from a firm-soled shoe to one that permits great motion of the metatarsal arch.' The quotation is from Bradford; but I have observed the same thing myself also.

Symptoms.—The pain is described sometimes as a cramp, sometimes as 'cutting,' and often as 'intense,' 'frightful,' and the like. The patient feels constrained to take his boot off immediately. Its removal, if prompt, usually gives speedy relief, and if delayed entails the risk of a long-persisting attack radiating far above the foot.

As in ordinary talipes valgus, the foot is often cold, bluish, and damp.

Slight cases are common. Fortunately rare are cases of the highest grade of severity, in which extensive neuralgia, and even persistent neurasthenia, supervene, while total inability to wear a boot becomes one of the least evils such sufferers have to endure.

Prognosis.—Slight cases, in which the subject is quick to notice the exciting cause and to avoid it, cause little trouble and may recover without treatment. For more severe and recurrent attacks there is little prospect of spontaneous cure.

Treatment.—Rest, local and general, purgatives, careful diet. Hot fomentations if the part is tender. Boots with broad and strong soles and low heels. A narrow flannel bandage round and round the ball of the foot beneath the stocking. Instep of boot (or shoe) fairly tight.

When such treatment fails *operation* is very effective. The fourth metatarso-phalangeal joint must be excised. Longitudinal dorsal incision. Separation of soft parts from around bones of joint. Strong, cutting bone-forceps. Compression dressings, which may be loosened after twenty-four hours. When dressings are removed for taking out sutures, the wound should be found healed. In fact the operation resembles that for hallux valgus, except that there is no bunion to excise. It is almost always effectual.

Professor Thomas S. K. Morton's paper in the 'Transactions of the Philadelphia Academy of Surgery' (1893) gives an excellent account of this disease, and contains some most interesting reports by medical men who themselves had suffered from it.

CHAPTER XIV

CONGENITAL DISLOCATION OF THE HIP AND PARALYTIC DISLOCATION OF THE HIP

Congenital Dislocation of Hip

The term 'congenital' is technically applied to a number of cases of dislocation of the hip, some of which, it is acknowledged, are only congenital in the sense of depending upon a congenital abnormality of the joint, the dislocation not occurring until some time after birth; and Verneuil asserts that the great majority of so-called congenital dislocations of the hip do not deserve the name in any way, but are due to infantile paralysis.

The fact that the affection is rarely noticed before the child has begun to walk is, perhaps, the chief reason why the determination of the exact nature and origin of these cases is difficult.

Etiology.—It seems likely to conduce most towards further advances in our knowledge of the etiology to distinguish, if possible, between observed facts on the one hand and unproved hypotheses on the other.

1. It is a fact, for example, that Grawitz, according to Krönlein,[1] examined the bodies of seven newly born infants with dislocation of the hip, of whom five had both hips displaced, while in the remaining two only the right hip was affected. We may believe him also that in these cases he found the Y-shaped cartilage comparatively undeveloped, and the acetabulum disproportionately small in relation to the head of the femur.

2. It is also a fact that certain cases of unmistakable infantile paralysis, strongly marked, have one hip-joint, or both, in a condition strikingly resembling that of 'congenital dislocation' of the hip.

It is, however, only an hypothesis that the majority of cases of congenital dislocation of the hip are in origin similar to the cases observed by Grawitz, and the force of his observations is greatly weakened by the fact that all were made on non-viable children with other co-existent deformities, such as spina bifida, ectopia vesicæ, fissure of the abdominal wall, club-foot, club-hand, and scoliosis.[2]

And it is also only an hypothesis (of Verneuil's) that the great majority of cases of so-called congenital dislocation of the hip are not congenital in any sense, but are due to post-partum infantile paralysis of certain muscles of the hip.

Nevertheless, the above theory deserves special consideration, because quite a large number of instances, *apparently* identical with the general run of congenital hip dislocations, have been observed directly referable to such a cause.

[1] *Deutsche Chirurg.*, Lief. 26, p. 87.

[2] Mr. Jackson Clarke recently showed preparations from an undoubtedly congenital dislocation of the hip. 'The deformity appeared to have been caused by the acutely flexed position of the hip-joints of the fœtus in utero. The subject from which these specimens were obtained was a full-time fœtus

With other hypotheses it is different. For example:

3rd hypothesis.—Position in utero (Dupuytren) and deficiency of liquor amnii have been blamed (Roser).

which was born dead. The uterus of the mother contained many fibroid tumours, and the congenital dislocation was accompanied by deformities of

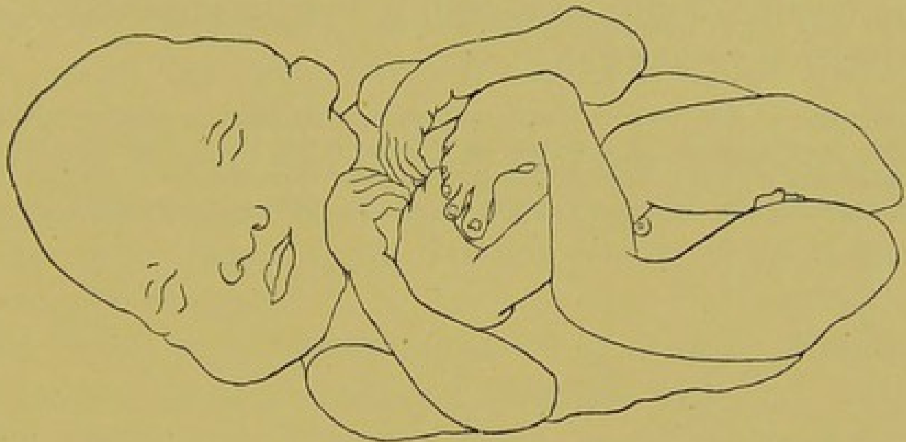


Fig. 153.

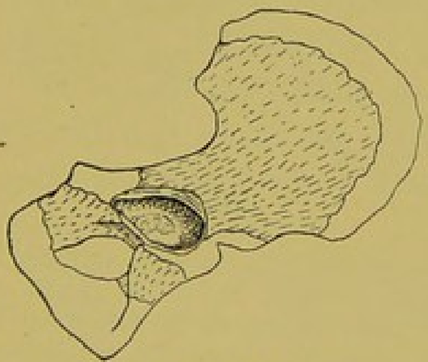


Fig. 154.

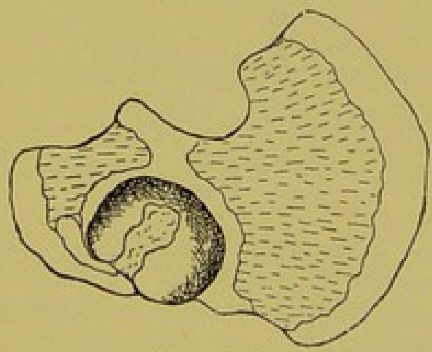


Fig. 155.

the chest and feet, which enabled the author to replace the extremities in the position which they had occupied when in utero. When this had been done

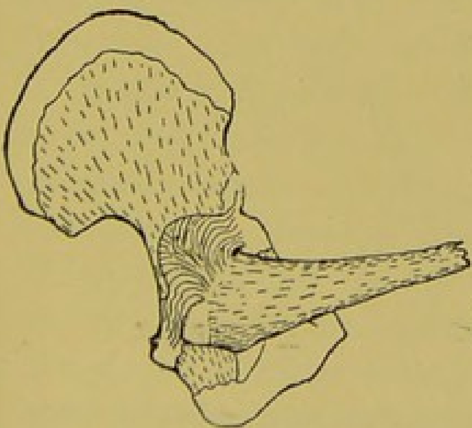


Fig. 156.

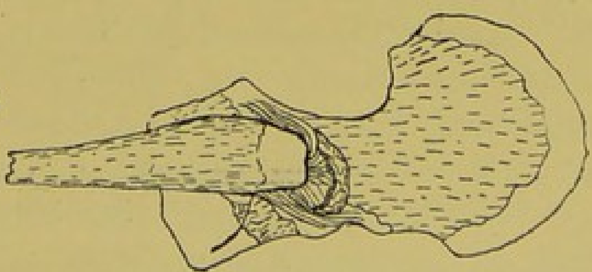


Fig. 157.

the fœtus had the appearance shown in fig. 153. Fig. 154 shows one of the innominate bones and the acetabulum. The latter is much contracted, and

4th hypothesis.—Intra-uterine injuries; *e.g.* falls and blows on the mother's abdomen.

5th hypothesis.—Fœtal muscular action.

6th hypothesis.—Violence to the fœtus itself during parturition, especially dragging with the accoucheur's hooked finger in the flexure of the groin with a breech presentation, and even traction on one foot.

the pubic part of the bone is bent outwards, as is seen on comparing fig. 154 with the normal bone of a fœtus, as shown in fig. 155. Fig. 158 shows the relation of the femoral head to the acetabulum when the parts were so placed that the joint was in the same state as when the fœtus was doubled up in the

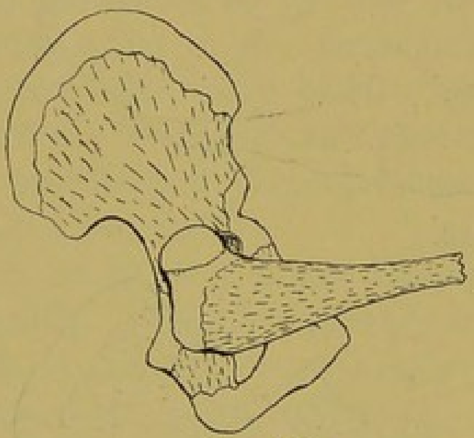


FIG. 158.

FIG. 159.

uterus. Fig. 156 shows the parts before the capsule was opened, and fig. 157 shows the joint with the deformity reduced by drawing down the femur and rotating it 90° inwards. Fig. 159 shows the head of one of the femora. The ligamentum teres is elongated and flattened. Fig. 160 shows the pelvis much

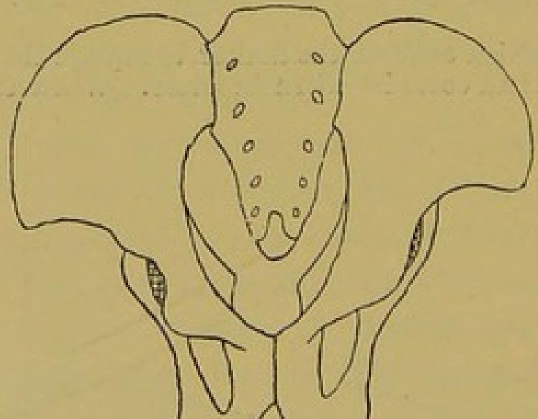


FIG. 160.

flattened from side to side. The author considered that the fact of the presence of numerous fibroids in the uterus of the mother supported his view that the deformities in this case had been produced by mechanical conditions, namely, the cramping of the fœtus by an abnormally inelastic uterus.'—*Transactions of British Orthopædic Society*, 1896, p. 36.

7th hypothesis.—Congenital 'absence of a rim to the acetabulum.'

Let us notice these hypotheses in the above order.

3rd hypothesis.—Almost every fœtus in utero is placed with its legs more or less in the position referred to by Dupuytren, and not only is deficiency of the liquor amnii not the rule in these cases, but sometimes the mother states there was positive excess (Krönlein).

4th hypothesis.—Several cases have been recorded in which the pregnant mother has received an injury.[1] Fracture would be a far more likely result, but the possibility of dislocation can scarcely be denied.

5th hypothesis.—This is supported by a single observation (Chaussier's), good in itself, but standing alone.

6th hypothesis.—Perhaps breech presentations are more common than usual in these cases; nevertheless, their absolute frequency is still small.

7th hypothesis.—The only observations are two by Lockwood. They resemble Grawitz's in that they were made on non-viable children. Therefore too much must not be inferred from them.

Then there remain the theories which refer the condition to *the class of so-called spontaneous dislocations.*

8th hypothesis.—Relaxation of the ligaments of the joint (Sédillot).

9th hypothesis.—Disease of the fœtal hip-joint. Actual cases have been observed and recorded by Parise, Verneuil, Broca, &c.; nevertheless, they are few and exceptional.

In advocating his own theory, Verneuil[2] shows, with some force, the weakness of the case for the theory generally accepted—namely, that of congenital maldevelopment of the acetabulum. He says that personally, and with the assistance of his pupils and friends, he has been for years searching vainly for anatomical specimens demonstrative of this theory. He offered 300 francs for every well-dissected specimen of the kind which might be produced between January 1890 and

[1] E.g. *Centralbl. f. Chirurg.* 1885, Barth, p. 500.
[2] *Revue d'orthopédie*, No. 1, 1890, p. 23.

January 1891. He, quite fairly, excepts such as may belong to the following classes:

1. 'Consecutive dislocations,' such as Parise, Broca, and himself have met with, and have furnished Padieu with the subject of his thesis.[1]

2. Malformations in which the head of the femur is completely absent.

3. Other malformations of the hip occurring in monsters or in non-viable fœtuses.

M. Verneuil added that if by January 1891 he found his offered francs had only been two or three times claimed, he should consider his views proved, and continues as follows: Supposing the above three excepted classes—namely, the 'consecutive dislocations,' absence of head of femur, and malformations in monsters, &c.—to be set aside, 'what particular variety will my contradictors henceforth oppose to our paralytic dislocation? On what will they rely to establish the relative frequency of these varieties? How can they recognise and distinguish their own from ours in the living? How, for example, in observing Peter and Paul, aged two or three years, and affected with dislocations of identical nature, according to us, will they proceed to prove to us that the displacement existed at birth in one and dated from some months afterwards in the other?'

It is doubtful whether the cause of science is much advanced by reasoning, or rather special pleading, conducted in the fashion of which the above is an example. If Peter presented distinct signs of infantile paralysis, probably few surgeons would think a coincident dislocation of the hip independent in origin of that paralysis, unless some other cause, such as traumatism, were known to have operated. But if Paul had an apparently similar dislocation, and no sign of either present or past paralysis, where is the identity between his case and Paul's?

There is a possible origin for such a case as 'Paul's,' which may be noticed as follows:

10*th hypothesis*.—So-called congenital dislocation of the

[1] 'De la Coxalgie chez le fœtus et le nouveau-né,' *Thèse de doct.*, Paris, 1865, No. 258.

hip may sometimes, or even often, be due to abnormal laxity of the ligamentous structures of the joint, the dislocation not necessarily occurring till long after birth.[1] This may itself be the result of either infantile paralysis or of other causes. (M. Verneuil's theory is that infantile paralysis acts by weakening the antagonists of the muscles which flex the thigh on the pelvis, and also the adductors. The tendency of the latter, when unopposed, is to 'displace little by little the head of the femur into the external iliac fossa.')

That otherwise healthy individuals vary enormously in the comparative tightness or laxity of the fibrous and ligamentous structures round their joints is a matter of common knowledge. Many persons can subluxate some of their finger and thumb joints painlessly and at will. Much more rarely men are met with who can do the same with the hip-joint, and replace it, some with and some without the assistance of their hands. I am writing of persons who have had no previous injury or disease to account for their peculiarity. Cases of easy redisplacement after previous dislocation have been numerous when the joint affected was the hip or the shoulder. In the latter the explanation has usually been non-union of ruptured ligaments. In the former, or non-traumatic cases, it is original laxity of the ligaments. It is a very notable fact that in the cases called 'congenital dislocations of the hip' (using the name because there is no other, and without any desire to beg the question), the ligamentum teres is generally intact, though thin, while in traumatic dislocations it is usually torn. The same observation applies to the capsule and external ligaments of the joint.

Let us imagine a young child with naturally lax ligaments. Might not the acts of walking, of striving to learn to walk, of playing, and of falling about as children do, tend to increase the laxity, until by-and-by the head of the femur would occasionally slip, first a little way, afterwards a greater way, out of its socket, remaining for a time on the rim of the acetabulum before it escaped altogether, pain being absent, because of the gradual nature of the change, and even of the

[1] Compare with the 8th hypothesis, *supra*.

very looseness of the joint itself, as tension is the great cause of pain ?

When we have to deal with a child in which the signs of congenital dislocation have not been discovered till a long time after birth, in which there are no symptoms and no history of infantile paralysis or of injury, and no coincident deformity of congenital nature, such as spina bifida or club-foot, I think we ought to consider the possibility of such a sequence of events as the above.

The reader will now be glad to pass from the fog of hypothesis out again into the clear atmosphere of fact.

Pravas *fils*[1] gave the following statistics of 126 cases observed by him in sixteen years :

	Total.	Double.	Right.	Left.
Males .	11	7	1	3
Females .	96	44	28	24

Drachmann, Krönlein, Bradford, and Lovett have given similar statistics. Out of a total of 313 cases there were—

		Double.	Right.	Left.
Males .	37	122	95	96
Females .	286			

Therefore nearly 9 patients out of 10 are females, and the dislocation affects one side only more commonly than both sides, but in a proportion of less than 3 to 2. The right and left hips are attacked about equally.

The explanation usually given of the disproportion between the two sexes is Dupuytren's, that females are more liable to congenital deformities than males. In a series of cases of anencephalous monsters described by Dr. P. S. Abraham, all were females. The great liability of females may be regarded as an argument in favour of the theory that the dislocation is due to congenital defect of development.

On the other hand, the female sex probably contains a larger proportion of individuals with 'loose joints' than the male, and the bony prominences and ridges in the female skeleton are on the average less prominent than in the male.

[1] *Gazette des Hôpitaux*, 1881.

In conclusion, it must be confessed, with regard to the majority of the cases classed together by surgeons under the name of congenital dislocation of the hip, it is easy to suggest many theories of their origin, and difficult, if not impossible, at present to prove one. If we grant this, we perhaps make the first step towards elucidating the whole subject.

Pathology.—The anatomical changes vary with the age of the patient—*i.e.* with the duration of the lesion; and it must not be forgotten, in reading about them, that it is anything but certain that the observations on which their description is based have been made on specimens identical in origin and nature.

In the newly born the head and neck of the femur are found smaller than natural, and also altered in shape, sometimes being short and round, sometimes long and conical. The acetabulum is always small, even in proportion to the diminished head of the femur. It is usually narrow and oval. Fat occupies its cavity. The more or less deficient and depressed posterior margin is encroached upon by the cartilaginous surface of a new acetabulum.

The ligaments and joint-capsule are stretched and not torn; except, rarely, the ligamentum teres, which is usually long, thin, and flat, and not always attached precisely in its normal situation. A smooth groove conducts it from the old acetabulum towards the femoral head lying on the new one. The joint-capsule encloses both the old and the new acetabula. The pelvis is said to be usually yet unchanged, but that is not always the case. For instance, in a case described by Krukenberg[1] 'the pelvis is compressed in the direction of the right oblique diameter (dislocation on left side); or, which comes to the same thing, it is twisted around an axis passing through the left wing of the sacrum, the latter bone being regarded as fixed. Also, the tuberosity of the left ischium is bent outwards and forwards.'[2]

But this observation was made upon a hemicephalous fœtus; all Grawitz's were made on monsters, and Malgaigne's

[1] *Deutsch. Archiv f. Gynäkol.* Bd. xxv. p 2, and *Centralbl. f. Chirurg.* 1885, p. 840.

[2] See diagram (fig. 160) from Jackson Clarke's case.

collection of 8 cases is thus summarised by Gurlt. All the children were under two and a half months old. Five were boys, and of the remaining 3 the sex is not recorded. Four were double, the other 4 left-sided only. Three times there was abundance of synovial fluid, but in other cases were found sanious or sero-purulent fluid, and even false membranes. Five were incompletely, one completely, dislocated.

In all these cases, although they probably differed essentially in nature and in origin, the cartilage was intact, the joint-capsule and the round ligament lengthened, the luxation readily reduced and quickly returning. In the Y-shaped cartilage of the acetabulum Grawitz found exceedingly defective development of the ossifying border.

In older children, such as have learnt to walk, the changes are similar but more marked. The acetabulum is proportionately narrower, smaller, and shallower, and it assumes a three-cornered shape, fills up with fat, and no longer will receive the femoral head when reduction is attempted. Previously incomplete dislocations now become complete. Gurlt says that after the tenth year none of the former have been observed.

The capsule and ligamentum teres are longer even than before, and permit a greater range of movement to the femoral head and neck. The last is more and more horizontally set on the shaft, and often very short.

In exceptional cases, and especially in older patients, the capsule gives way, probably through pressure and consequent absorption, and then a regular false joint, resembling that of an unreduced traumatic dislocation, but very inferior to it in completeness, forms on the dorsum ilii.

With the approach to puberty the pelvic changes develop and increase. The ilium of the affected side (of both sides in double cases) grows more perpendicular ; the transverse axis of the upper part of the 'false pelvis' lessens, but that of the pelvic outlet increases ; the bony parts of the affected side in 'single' cases lie each at a higher and more posterior level than the corresponding ones of the normal side, and are more or less atrophied. The horizontal ramus of the os pubis is lengthened.

In double dislocations the changes are similar but symmetrical.

With regard to the question as to whether or not the acetabulum entirely disappears in time, my own observation is that ultimately no trace of it can be felt during operation on the living subject. Professor Ogston's experience is the same. Mr. Openshaw thinks that an acetabulum will always be found, if looked for with sufficient care. That possibly

FIG. 161.—CONGENITAL DISLOCATION OF RIGHT HIP. (Girl aged 12.) At operation a very small triangular acetabulum covered with muscle was found, and a rather large and conical femoral head. Free myotomy and fasciatomy and free division of the capsule permitted the head to be placed in the acetabulum, previously enlarged with the gouge and sharp spoon; but only when the limb was inverted. Eversion prized the head out of place, because the neck pointed forward, as is usual in such cases. The final result of operation was good.

some trace of the pre-existence of an acetabulum might be discovered I am not prepared to deny. But, *for practical purposes*, the acetabulum gradually becomes obliterated.

SYMPTOMS.—Upon inspection of a patient with double 'congenital dislocation of the hip,' especially if in the standing position, the surgeon is struck with the abnormal height of the great trochanters and the apparent breadth of the hips at their level. The former lie considerably above and behind Nélaton's line. The trunk is sometimes obviously long in comparison with the legs. The lumbar spine is always lordotic and the belly prominent. The thighs are usually thinner than normal, the legs fairly well developed. Sometimes the patient stands and walks on her toes, sometimes on

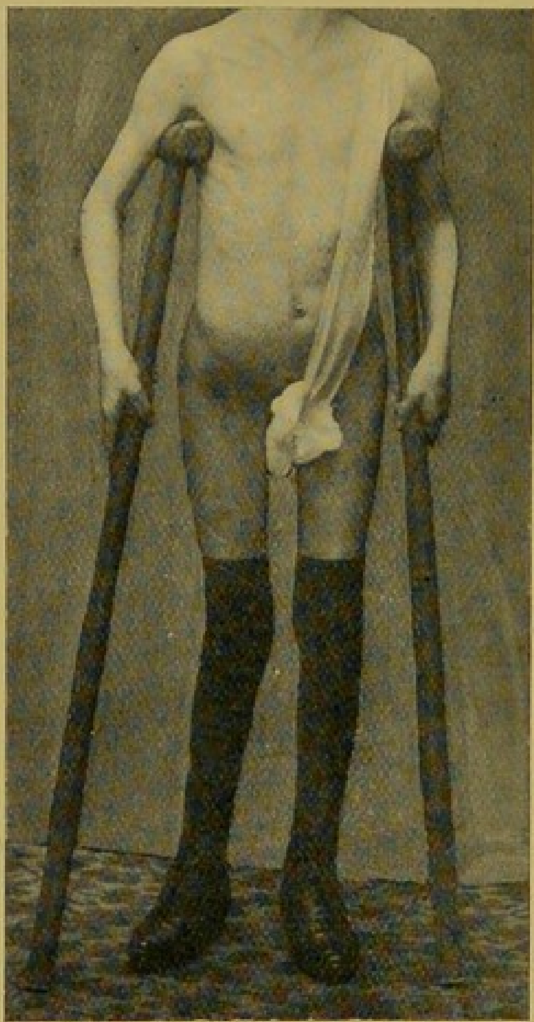


FIG. 162.—CONGENITAL DISLOCATION OF RIGHT HIP, from the same patient soon after operation, shows mark of (anterior) incision. The right heel now touches the ground, and the femoral head is firmly placed in the new acetabulum. The range of movement of the joint was fair and still improving when the patient, at her home in the country, was last heard from. A patient of Dr. Wood's, of Boston.

the heels and soles in the normal way. The thighs, separated above, approach each other towards the knees.

The patient should lie down. It is then found that traction increases the length of each leg by pulling the trochanter nearly into its normal position. Upon palpation the head of the femur can be felt on the dorsum ilii, sometimes not far below the crest of the ilium, where it is found not at all fixed, but readily slipping about between or beneath the gluteal muscles as the thigh is flexed, extended, and rotated. In thin patients the smallness of the head and the shortness and square position in reference to the shaft of the neck can be recognised.

After being pulled downwards the head spontaneously returns to its former position beneath the iliac crest, and both in ascending and descending it is sometimes distinctly felt to cross a ridge, probably the imperfect acetabular rim.

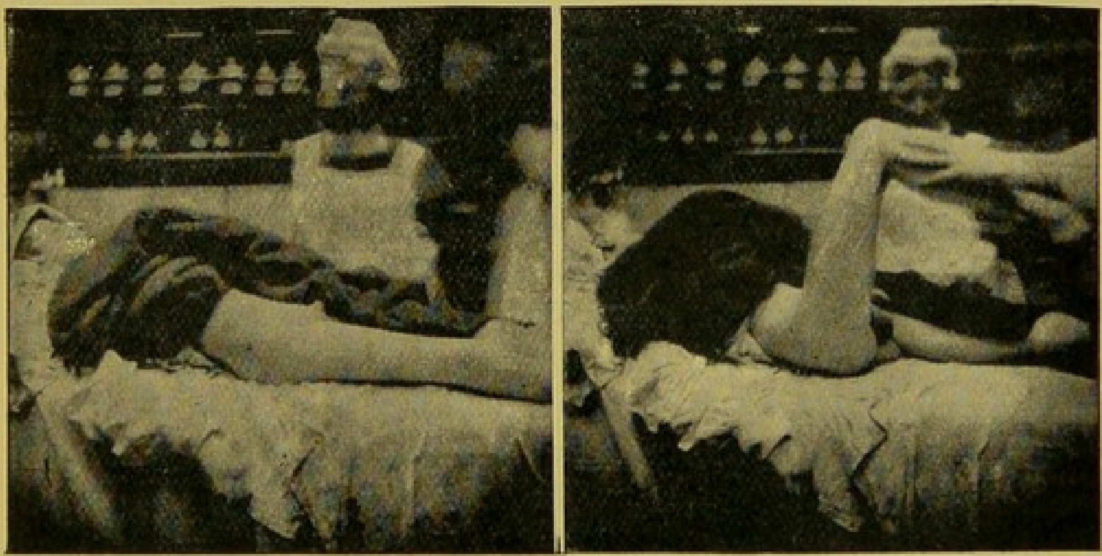


FIG. 163. FIG. 164.

A CASE OF CONGENITAL (?) DISLOCATION OF RIGHT HIP. In fig. 163 a black dot marks the summit of the great trochanter. In fig. 164 a second and lower black dot marks point to which the top of the great trochanter has moved during flexion.

The idea conveyed to the surgeon is precisely what is the truth—namely, that the femur, instead of being articulated in a bony cup, is now merely slung to the ilium by strong but lax ligaments, and that the exact position of the femoral head at a given moment depends on the resultant of such forces as the weight of the body, the weight of the lower extremity itself, and the action of the hip muscles, especially the latter.

Therefore, *when the patient walks* the femoral head slips up and down on the ilium alternately, according to which leg is for the moment bearing the weight of the body. She sways from side to side—*waddles*, in fact, like a duck.

It is this peculiar gait which usually first awakes in the parent's or nurse's mind a suspicion that something is wrong. The younger the child, the less marked it is, and as so many children waddle a little, especially those with bow-legs, it is sometimes not regarded at first with due attention either by the parents, or even by the medical man first consulted. These children are not bow-legged. They sometimes show an appearance of knock-knee—partly a pseudo knock-knee due to inversion at the hips bringing the slightly flexed knees together.

When only one hip is affected the above symptoms are, of course, confined to that side. The gait may not be quite so characteristic, but it is peculiar enough. Only the toes of the affected side reach the ground, and the limb is usually inverted. Each step, as it brings the weight to bear on the affected side, causes the patient to sink over in that direction ; and, to use an exaggerated simile, the result is as if the thigh of that side were to alternately telescope itself into the corresponding hip, and then slip down again. Nor can any high boot or patten wholly do away with this.

Measurements show a shortening in comparison with the sound side. And inspection shows the pelvis lowered on the lame side ; and, as a result of this, the spine shows, in addition to some lumbar lordosis, a lateral curvation, which, however, is usually only temporary, disappearing when the pelvis is made horizontal by some such means as placing books or slips of board beneath one foot.

Prognosis depends above all upon the age of the patient, as may be inferred from the anatomical conditions. Before the age of five or six there is good prospect of a cure resulting from persevering non-operative treatment. The older the patient, —*i.e.* the greater the pathological changes—the less chance is there of any such success, and, indeed, it may be difficult to prevent from getting worse a heavy adult or adolescent patient.

Nothing approaching to a cure had until recently been achieved in the great majority of recorded cases. Very few of the cases claimed as cures had been subjected to serious examination and criticism by impartial and competent observers.

It would have been contrary to all analogy if many of the sufferers from a complaint so resistent to honest treatment as 'congenital dislocation of the hip,' an affection, moreover, of such disputed and perhaps various origin, had not become the prey of quacks, both inside and outside the profession. Nevertheless, a certain number of children had undoubtedly been greatly improved, and some absolutely cured, by treatment.

Even in the worst cases benefit can be obtained from palliative treatment, including orthopædic appliances.

And there are also many cases in which great practical benefit, though not an actual restoration to the normal, can be conferred by operative measures, presently to be described.

TREATMENT.—This may be considered under the usual heads of 'general' and 'local,' the 'local' being divided into 'non-operative' and 'operative.' 'Non-operative' treatment may also be divided into 'palliative' and 'radical.' It will be convenient to leave till last the description of operative measures. And it will be both interesting and instructive to treat the subject historically.

Dupuytren,[1] who was the first after Palletta,[2] the great Milanese surgeon, to properly describe congenital dislocations of the hip, recommended their treatment by cold baths and exercises; and if these be combined with vigorous friction, massage, and the wearing of woollen socks and drawers, their recommendations may be endorsed to-day.

In cases apparently paralytic in origin electricity may possibly be indicated. (See 'Treatment of Infantile Paralysis.')

But little should be expected from such measures.

The only mechanical apparatus employed by Dupuytren was a *pelvic girdle of leather*, well padded, lined with doeskin, held down by perinæal straps, and fitting over the trochanters. 'It should,' he writes, 'occupy the narrow interval between the great trochanters and the crest of the ilium.'

The shape and material of Dupuytren's belt have both been modified by various writers, the most important changes being

[1] *On the Injuries and Diseases of the Bones.* Old Sydenham Society's Translation, 1847. But the original *Leçons Orales* were published twenty years before.

[2] *Adversaria Chirurgica prima*, Mediolani, 1788.

the substitution of *plaster of Paris* and of *poroplastic felt* for leather, and the extension upwards of the apparatus, even as far as crutches in the axilla.

Other surgeons and instrument-makers have carried *steel supports* down, some to the thigh, and some even to the foot.

In paralytic cases it may be necessary to fix even the knee by one of the methods described elsewhere. For descriptions of appliances, refer to the chapter on 'Infantile Paralysis.'

In unilateral cases a *high boot* with a cork sole is generally indicated, although its beneficial action is greatly discounted by the tendency of the leg to alternately lengthen and shorten as the femur slips up and down on the os innominatum.

In some cases treatment must be confined to a selection from the means above enumerated. Of course, no one will be so unreasonable as to expect a curative action from any of them. But in young children the possibility of effecting reduction of the dislocation and an ultimate cure must be considered.

The facts published and authenticated are not sufficent to fix anything like an absolute limit of age beyond which no attempt to effect permanent reduction must be made. After infancy the chances of success diminish rapidly; and I believe few surgeons would recommend the methods next to be described after the seventh year, unless there were specially encouraging signs present in the individual case.

The circumstances, patience, intelligence, and wishes of the parents are important factors to be considered.

The typical non-operative radical method is the original one of Pravaz the elder.

It consists (1) in reduction by long-continued gradual extension, followed by manipulation, a proceeding occupying, not hours, but months; and (2) restoration of the muscles, &c., of the limb by appropriate exercises, before any weight at all is allowed to be pressed down on the hip-joint.

The method followed by Dr. Buckminster Brown in his well-known case was essentially similar to that of Pravaz. That case is so fully and clearly described,[1] and so accessible,

[1] *Boston Medical and Surgical Journal*, June 4, 1885.

that every English surgeon will study it carefully before attempting the treatment now being noticed.

Counter-extension was made by means of a belt similar to Dupuytren's, described above. Four long straps, two anterior and two posterior, anchored it to the head of the bed.

Extension was made by weights pulling from 'stiff leather bands, 3½ inches wide, padded and lined, encircling the legs above the knees and above the ankles, accurately fitted.' To the lower edge of the bands leather loops 3 or 4 inches long were fastened, one on each side.

The cords of the weights and pulleys were sometimes attached to the knee-bands, and sometimes to the ankle-bands, the alternation making continuation of the extension more bearable. Of course the pulleys were at the foot of the bed; 3-lb. weights were used at first. After a few days the head of the bedstead was raised 8 inches.

We are told that in ten or twelve days the bones could be placed every morning 'in their natural position, where they were maintained by the weights for some hours. On the following morning, however, they were invariably found displaced.' A sensation was now felt as if the head of the left femur slipped over 'a segment of the rim of an undeveloped acetabulum.' Nothing like this was ever noticed on the right side.

After six weeks' treatment it was found that the tendency to slip upwards was greatly diminished.

'Two long narrow strips of wood were now attached to the foot of the bedstead, a few inches from the corners. Near the top of each a pulley was inserted 27 inches from the mattress.' By means of these traction could be made in a direction which would be described as forwards and downwards were the patient standing instead of lying down.

This direction was alternated with the horizontal, one or the other being used day and night.

While the bands were being changed an assistant always kept up the extension.

Compresses were now placed beneath the pelvic girdle, 'across the dorsum ilii, immediately above the trochanter major.'

The limbs were now rarely displaced, and passive exercises were begun. To aid in accomplishing these, two additional pulleys were now erected at the head of the bed. The cords from these pulleys were attached to the knee-bands in front, and when drawn upon raised the thighs to an angle with the body. The cords over the lower pulleys at the bed-foot were tied posteriorly to a soft roll of padded linen, which passed round the upper extremity of the thigh. When the hip was flexed to an obtuse or a right angle by drawing on the pulleys at the bed-head, the lower pulleys at the bed-foot thus acted on the femur as on the extremity of a lever, preventing the femoral head from rising. Thus were obtained flexion and extension of the hip without displacement. Four hours a day this exercise was continued, two hours for each limb. Dr. Brown calls this, with very little warrant, 'the stage of excavation.' The blocks were exchanged from the head to the foot of the bed, and an additional wider pelvic belt was put on. The long straps were removed from the head-rail. The course here indicated was pursued, the amount of daily exercise being diminished, until July 1883. In October 1883 it was found that a pressure upwards equal to the weight of the child's body could be borne without the femoral heads slipping up. The patient now used active movements of flexion and extension. On January 14, 1884, the patient sat up in bed for the first time for thirteen months. She next began to take exercise in a 'go-cart,' in which she sat astride on a saddle at such a height that her toes just touched the ground. It was furnished with crutches. From time to time both saddle and crutches were let down, until she walked squarely upon her feet. In June 1884 she began to walk, little by little, without assistance. In May 1885 she is reported as walking normally without assistance.

Such is the history in brief abstract of this interesting and important case.

Many plans have been devised for effecting extension without confining the patient to bed. Excepting that of Reeves, perhaps the most interesting and important of these are German. The following is a brief notice of those of v. Volkmann, Schede, Hoffa, and Miculicz.

In treating congenital hip dislocation by long-continued extension in bed von Volkmann used to place the limb in a position of abduction. In many cases he used extension at night only, letting the patient run about by day, but cautioning the parent against fatigue.

Schede placed the patient in walking-irons which were provided with a screw bearing on a pad over the trochanter. As the outside iron through which this screw worked was fixed at the upper end by a pelvic girdle, and at the lower end to the outside iron strapped to the thigh and leg and fixed in the boot, each turn of the screw pressed on the trochanter. As the latter could not yield, the leg had to assume an abducted position—was, in fact, tipped outwards. The object of the splint is, by the combined pressure on the trochanter and abduction of the limb, to so fix the head of the femur against the ilium that it will not slip up and down.

Hoffa combined Hessing's apparatus with this, thereby getting extension as well as abduction. Hessing's apparatus is one of leather and steel for ambulatory extension, which makes extension by pulling or rather pushing against the heel and instep, and counter-extension by a perinæal crutch or loop. Above, it ends in a laced corset.

Miculicz recommends the following apparatus :

Two boards have a hinged union at one end, but are separable and approachable below. The patient's legs are placed each in a trough sliding in a groove in the corresponding board. The troughs can be rotated each on its own long axis. Counter-extension is made by a block in the perinæum. By these means the degree of extension (made by weights), abduction, and external rotation can be adjusted. The patient is kept in bed, but is only placed in the apparatus a limited time, commencing with two and increasing up to twelve out of the twenty-four hours. Three out of five cases are said to have been cured, in twelve, seventeen, and eighteen months respectively. Only children in whom the dislocation is reducible are thus treated.

So numerous are the cases in which treatment by extension and passive exercises either fails, or is not worth trying, or produces an improvement which is not found to be lasting, that surgeons have naturally attempted by operation to at least alleviate, if not cure, the disability produced by congenital dislocation of the hip.

With this object the following procedures have been employed:

Division of soft structures only—muscles, tendons, aponeuroses, fasciæ (Guérin, Bouvier, &c.).

The same, with subcutaneous scarification of ilium (Guérin).

Simple resection of head of femur (Margary).

The same with enlargement of acetabulum (De Paoli).

The same with reflection of flaps of periosteum from ilium, afterwards sutured to periosteum of trochanter, or of femoral neck, or to fragments of capsule (suggested by Hüter, executed by Margary and Koenig, in both cases with fatal results, one ascribed to scarlatina, the other to septic catgut).

The same with refreshing of the acetabulum and immobilisation, as if aiming at ankylosis (Reyher).

Excision of the *lower* part of the head of the femur (Lampugnani).

Excision of head of femur and of part of great trochanter, with deepening of acetabulum (Heusner).

Excision of the upper extremity of the femur, above level of the lesser trochanter, and making an artificial acetabulum in the form of a complete perforation of the ilium (A. Ogston).

Excavation of the acetabulum and reduction into it of the femoral head, without any excision of the femur, but with free division of muscles and aponeuroses, especially of those inserted into the great trochanter: posterior incision (Hoffa).

The same without division of muscles: anterior incision (Lorenz).

(It is obvious that some of these methods are not applicable to certain cases; *e.g.*, when no acetabulum or no femoral head exists, the former cannot be deepened and the latter cannot be excised.)

The treatment by division of muscles and aponeuroses had its origin in the theories of orthopædists like Guérin and others less distinguished, that all, or nearly all, congenital deformities are primarily due to muscular contractures. These hypotheses are dealt with in other parts of this book. Whether true or false, there is strong reason to believe that the practice based upon them was the reverse of successful. A committee of the Academy of Medicine reported unfavourably of Guérin's cases. Many people, even at this day, believe in Guérin's theories, but none ever produce at any of the medical societies cases satisfactorily cured, or even improved, by myotomy pure and simple.

There are a few authentic cases which may be exceptions; but it must be remembered that not all cases of so-called 'congenital dislocation' of the hip are truly congenital, and it is easily to be understood how cases of infantile paralysis with contracture of the adductors and of the psoas and iliacus might be improved by division of the tense muscles.

Doubtless, also, in very young children, before the acetabulum has become filled up, myotomy with extension, manipulation, and careful after-treatment, might lead to genuine reduction of the dislocation and practical cure.

But it is clear that something more must be required for older cases, in which the acetabulum is either small and filled up with fibro-cellular tissue, or else altogether obliterated.

Antiseptic surgery and the activity of Margary of Turin are the chief influences which have led to the operative interference of modern surgery with such cases.

On November 2, 1882, the Italian surgeon just named performed the operation of making a new acetabulum with the chisel or gouge in the case of a patient fifteen years old. He at the same time sutured with catgut a portion of the capsule of the joint to the periosteum of the ilium, reflected in the form of a flap. The patient unfortunately died on the thirteenth day of pyæmia, attributed to septicity of the catgut used.[1] Margary then tried a more simple plan, which he had previously followed in a case of traumatic dislocation. He excised the head of the femur. He has repeated this operation many times. The results do not seem particularly good. They are briefly indicated in a table in Hoffa's paper, of

[1] *Proceedings of the International Congress held at Copenhagen in August* 1884, and *Archiv. di Ortopedia*, i. 381.

which a French edition is in 'Revue d'Orthopédie,' Nos. 1 and 2, 1891.

Heusner's patient, a girl of twenty years, with both hips affected, suffered greatly from pain in them. The right was resected after the left, and the pains persisting, she eventually underwent oophorectomy.

In the after-treatment of his second case Motta employed extension in a position of strong abduction and external rotation. Ogston writes that he is 'satisfied from repeated trials that Volkmann's method of after-treatment in the abducted position of the lower extremity, whereby he hoped to direct the femur towards instead of past the acetabulum, and utilise the contraction of the soft parts to press the bone into the acetabulum, instead of upwards behind it, is a mistake. It is almost impossible to carry it out, as the discomfort which it causes leads the patient to alter the position of his pelvis and sound extremity, which we cannot properly fix, and so avoid the irksome direction of the diseased limb. In a word, it seems to' Ogston 'to possess no advantage and many disadvantages.'[1]

Ogston was the first British surgeon to record any experience of this class of operation, and his paper is worth careful reading. He found that the position of the pelvis was rectified by operation, and its ungainly projection backwards no longer existed when the legs were put straight down. In the left leg of the first young man operated on the cure was rapid, and a good, firm, movable new joint resulted; but in his right hip uneasiness and weakness remained for many months, although they eventually disappeared. On the second patient, also a young man, the same uneasiness was complained of in both the weak joints. The upper end of the femur stood decidedly away from the pelvis, and when the knee was moved described an arc of a small circle in the inverse direction, as if the bond of union with the pelvis, on which the motions centred, were an inch or so below it. In the left hip of the patient, where the result was so satisfactory, the upper end of the femur did not stand out from the os

[1] *Annals of Surgery*, viii. 163, August 1888.

innominatum in the same way, but lay close to it, and was the centre of the movements of the new joint.

It must be particularly noted that Ogston's experience differed from that of the other surgeons mentioned in the above table, in that he found neither acetabulum, nor head, nor even neck of femur. Nor did he in his first three operations attempt to make an acetabulum. He simply cut off the top of the trochanter obliquely from above downwards and inwards, and with weight extension sought to keep the femur against the site of the acetabulum until a strong fibrous union should form.

His experience of these cases, and of two of spontaneous dislocations in which he performed resection, led him to devise and execute an operation based on the known tendency of perforations in the os innominatum to fill up with fibrous tissue instead of bone. 'Accordingly, a gouge was entered on the outer surface of the os innominatum, just above where the acetabulum should have been. It was thought better to do so there than at the site of the acetabulum, so as to avoid undue tension. The bone was easily pierced by the repeated removal of small portions. The opening was enlarged round its edges by the gouge until it was big enough easily to admit the point of the thumb. The projecting point of the cut femur was readily placed in it, and was found to remain there even on moderate flexion and extension. Buried sutures in layers, Listerian dressings, and plaster of Paris were employed. The result was excellent: the child had no pain, and was walking about with a movable but not lax hip-joint in seven weeks. The deforming flexion and adduction had quite disappeared.'

An important paper is that of Hoffa of Würzburg. Dr. Hoffa, in his very brief reference to Ogston's work, speaks of the case in which a perforation of the os innominatum was made as one of 'traumatic dislocation.' It was really one of spontaneous dislocation. And Hoffa says not a word about either the good result achieved in this case or about the absence of the acetabulum in this and Ogston's other cases. Probably he does more justice to the cases published in his own language and in Italian, of which he gives abstracts, which are apparently very good.

Hoffa lays down the axiom that 'the obstacle which is opposed to the reduction is found much more, and indeed solely, in the retraction of the soft parts around the joint.'

He is not content with simply dividing soft parts, but also reflects upwards the soft tissue on and in the site of the disused acetabulum, and further deepens that cavity with the gouge. He says the essential point is the division of the soft parts all around the great trochanter. This immediately permits the femoral head to be brought down to the level of the acetabulum. Occasionally other soft parts require division —*e.g.* the fascia lata, &c.—below the anterior iliac spines. A posterior incision is employed.

The number of Hoffa's operations amounted to twelve,[1] performed on seven patients. One died of epidemic influenza commencing three days after operation. That disease was at the time very severe at Würzburg. The orthopædic results appear to have been exceedingly good. The fatal case permitted an anatomical examination of the parts to be made. The two femoral heads were found solidly fixed in their several cavities, and requiring a distinct effort to dislodge them. The cartilaginous investment of the one on the side operated on six weeks before was intact. The new acetabula were covered with cartilage, except at a place the size of a cherry-stone, corresponding to the insertion of the round ligament. The movements were not altogether free, because of the deformity of the head and the shortness of the neck of the femur. The muscles separated at the operation from the trochanter had become re-attached, but at a somewhat higher level than their original insertions.

Hoffa's patients were very much younger than the average of those recorded as operated on by other surgeons.

Lorenz concluded, from an anatomical study of the question, first, that it was not the glutæi or any other pelvi-trochanteric muscles which hindered reduction, and afterwards that no muscles at all absolutely needed dividing. He operates through an anterior incision external to the tensor fasciæ femoris. He has that muscle retracted inwards, passes

[1] Many others have been performed by various surgeons recently.

down to the capsule, separating the deeper muscular fibres with a blunt instrument, incises the capsule from near the anterior inferior spine along the femoral neck nearly to the anterior inter-trochanteric line, makes another cut in the capsule transverse to the first incision, makes a new acetabulum (or enlarges the old if any trace of it be present), and, helped by assistants making extension, counter-extension, and abduction, puts the femoral head into position to see how it fits, removes it again, and, guided by the information thus obtained, returns to the process of cutting and shaping the acetabulum, taking care to give it as sharp an upper and posterior border as possible. When the new acetabulum is satisfactorily formed, the head is finally placed in position. The capsule is not sewn up again; the wound is closed, and the limb fixed in a position of abduction.

The site of the acetabulum is perhaps more easily reached by Hoffa's operation; but in other respects I think Lorenz's is preferable.

Lorenz's operation, except in regard to the particular muscle selected for division or for preservation, is not essentially different from that previously executed by Karewski of Berlin [1] for the reduction of paralytic dislocations. I have already referred to Verneuil's belief that nearly all so-called 'congenital' dislocations are really paralytic. Karewski employs the anterior incision for sub-pubic dislocations, and the posterior for the ordinary backward and upward dislocations.

After taking proper precautions against sepsis, the danger to be most careful of is hæmorrhage. There can be no question but that Lorenz is right in discountenancing free division of muscles; but I think the assistance to be got from cutting the straight head of the rectus femoris and the resistent part of the joint-capsule is greater than the harm resulting. The glutæi do not seem to be on the stretch at all. With regard to hæmorrhage, it is not so troublesome from cutting the muscles—which in these cases are sometimes supplied by abnormally small vessels—as from the gouging out of the

[1] *Centralblatt f. Chirurg.* 1892, No. 36; *Deutsche med. Woch.* 1889, No. 6.

acetabulum. This, therefore, ought to be done smartly, and sponge pressure skilfully employed. The operating-table should be raised a few inches at the foot. A strong sharp Volkmann's spoon with not too long a handle is a convenient instrument for the purpose. Hoffa uses a bayonet-shaped gouge.

I make a point of reflecting the soft tissues which cover the site of the new acetabulum upwards and outwards and *replacing* them, after gouging out the acetabulum. They then keep the head of the femur off the part of the rough acetabulum on which it presses most.

Many fatalities and much suppuration have, even in the last few years, followed this class of operations. They must have been the result of imperfect asepsis and of insufficient special experience in operating on the hip—a common cause of hæmorrhage and shock. There is scarcely any region where the well-educated but unwary young surgeon, or even the older surgeon accustomed to a different class of operations, is more likely to cause dangerous shock than about the hip-joint. There are many small arteries; the site of operation lies deep; an elastic or any other tourniquet is in the way; pressure on the aorta is inconvenient for several reasons.

A prolonged after-treatment is used; first, to secure the head in the new acetabulum. This requires nearly two months of more or less complete fixation, varied with a little passive exercise towards the end. Next passive and active exercises are used to get mobility, adduction being either used with very great care or avoided altogether.

Ankylosis sometimes occurs, especially in the older patients; and, when only one hip is affected and the patient is not young, it is perhaps the best thing that can happen. For in such patients a new movable hip is not like a normal one, or accompanied by a really normal gait. Good results even in younger patients are not perfect.

Nevertheless, the successfully conducted operative treatment of a case of congenital dislocation of the hip does often cause a great and striking improvement.

I have already said, and it has been repeatedly noticed by various observers, that in young children, during manipulation or extension of the limb, the head may be felt distinctly slipping sharply over what is probably the edge of the acetabulum. This occurred on one side in the classical case published by Dr. Buckminster Brown. It is strange that until eight years ago no one seems to have thought of making the production of this phenomenon the first step in the non-operative treatment of the deformity, and then fixing the head in position for a month or two by some simple means, so as to give the restored joint time to tighten up.

But, at last, *Paci* proposed such a plan, and described a special mode of manipulative reduction similar to one used in cases of traumatic dislocation. He divides his method into four stages: (1) The knee is bent and the thigh brought up towards the abdomen; (2) with the limb in this position, it is thrust for some time steadily downwards, in order to force down the head of the femur to the level of the acetabulum and to stretch the muscles; (3) the limb is abducted, and (4) it is rotated outwards.

I doubt whether any more can be done in this way than by a *simultaneous* and sustained combination of extension, abduction, rotation, and limited circumduction, especially if an assistant fix the pelvis to the table and the surgeon, flexing the thigh on the abdomen with his right hand, at the same time presses with his left hand downwards, close below the trochanter, so as to prize the head into the acetabulum. I have found this plan succeed when I have carefully followed Paci's directions and failed.

Lorenz recommends as the best method of reduction:

(1) Steady extension for a few minutes with his screw machine;

(2) After leaving off this extension, bending the knee;

(3) Abduction.

(4) Extension.

He warns against rotating outwards. He says that by so doing the head is turned away from the acetabulum. In cases of extreme anteversion of the femoral head and neck this probably would be the case. In ordinary cases, Miculicz is probably right in saying that external rotation is harmless, because the centre of rotation is not the trochanter, but the head.

Lorenz fixes the limb of the reduced hip in strong abduction for two months, then cautiously adducts a little and fixes again.

He puts a high boot on the foot of the sound side (in unilateral cases), lets the patient run about from the first, and calls the whole proceeding 'Die Lorenzsche funktionelle Belastungsmethode.' His plan is a scientific and a practical one, but he has perhaps made a mistake in writing a 60-page, large 8vo, small print pamphlet to demonstrate that all was darkness in the non-operative treatment of congenital hip dislocation till the light of his method burst on the world. The world, in so far as it is represented by his German brother-surgeons, has proved a little ungrateful, not to say resentful; and *Signor Paci*, after being elaborately stripped by Lorenz of all other merit, is magnanimously pronounced by him to have been the first to invent a 'surgical' non-operative treatment for the affection—*i.e.* a χειρ-urgical treatment. But Paci is not thereby soothed—pacified I was about to say. To read that one method is 'surgical' and another not should always excite our suspicion. If a cranium could be trephined best with the foot clad in a steel-shod boot, the foot ought to be used. It is not the hand, but the mind, which dignifies a mode of operating.

It is, also, scarcely more than guesswork to assert that getting about on the limb will deepen the acetabulum by thrusting the femoral head into it. Probably all the methods which keep the femoral head safe in the acetabulum act about equally well.

At the same time, I believe Lorenz's method to be a good one, and his industry, his powers of observation, and his great experience will dispose most surgeons to try it.

Let us now consider the *choice* of treatment. For this purpose cases must be classified, and especially according to age.

1. In children of one to four or five, or even six, years of age an acetabulum may be expected to exist, and a fair-sized femoral head and neck can nearly always be felt.

In these a non-operative treatment should be employed, according to the rules of Lorenz, of Schede and Miculicz, or of Paci. There are obviously various modes, such as any intelligent surgeon should be able to devise, of fulfilling the essential indications of this treatment. These indications are: (1) to get the head down and forwards over the edge of such acetabulum as still exists; (2) to keep it there for some months; (3) to then exercise it cautiously in its new place until both joint and muscles, especially abductor muscles, are strong.

2. In older children and young adolescents, in whom practically no acetabulum exists, the X-rays can be usefully employed to accurately determine the state of the case. They showed, in one of my cases, now under treatment, a distinct though shallow acetabulum when none could be felt or made out in any other way, the patient being ten years old.

In such the capsule may have become hourglass-shaped, the head and neck smaller and more misshapen. (Here again the X-rays are useful.) And generally an operation is indicated. The method of Lorenz should be preferred. But I think the straight head of the rectus should be cut, and extension by very considerable weights, up to 14 or even 20 lb., should be used for a month before the new acetabulum is cut out or deepened.

3. In still older cases, in whom not only no acetabulum may exist and the capsule be quite hourglass-shaped, but the head and neck of the femur may be turned directly forwards instead of inwards as normally, or even may be absent altogether.

These, again, should be operated on. When the head and neck are absent or almost sessile, Ogston's operation should be done.

But when there is a fair-sized though very wrongly directed head and neck, the direction should be first corrected by osteotomy, and then the steps of Lorenz's operation followed. Should ankylosis occur in a position of slight abduction, so much the better, at least in unilateral cases. Where there is much atrophy, and weakness and paralysis, or pseudo-paralysis, of the limb, with pain and disability in walking, the question arises whether ankylosis should be deliberately sought and the cartilage removed from the femoral head. Each case should be judged on its own merits. Many considerations have to be weighed, such as those of age, sex, occupation, social position, health, suitability for appliances, means, &c. When for any reason the above-mentioned treatment cannot be recommended, or will not be submitted to, appliances must be used. No really effective one has yet been devised which in an adult, or even an adolescent, will permit walking, and at the same time prevent the trochanter from slipping up at each step, unless the common crutch or walking-stick can be counted as such. Sometimes a combination of crutch and side-irons is used. Mr. Benham showed me one on a patient of his, who seemed to be well pleased with it. In paralytic cases, when the knee is affected and the extensors weak, a leather thigh-and-knee case should be combined with hip irons.

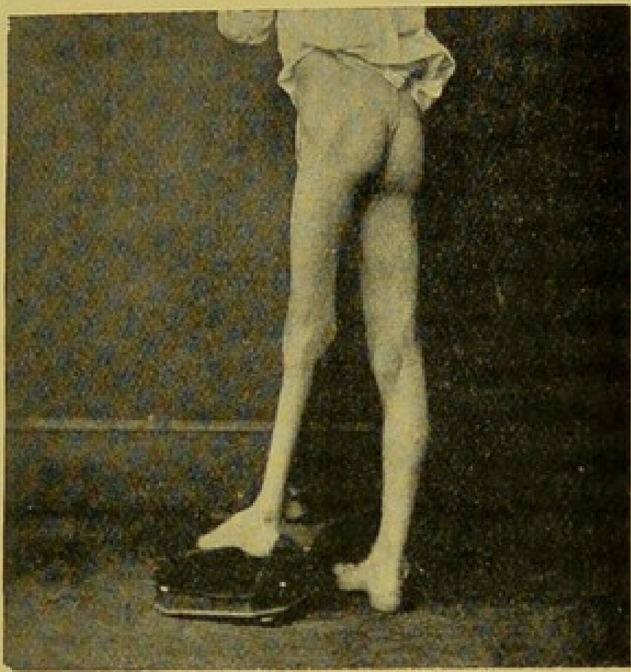
Coexistent talipes equinus or equino-varus is seldom in need of surgical treatment. Its action is compensatory.

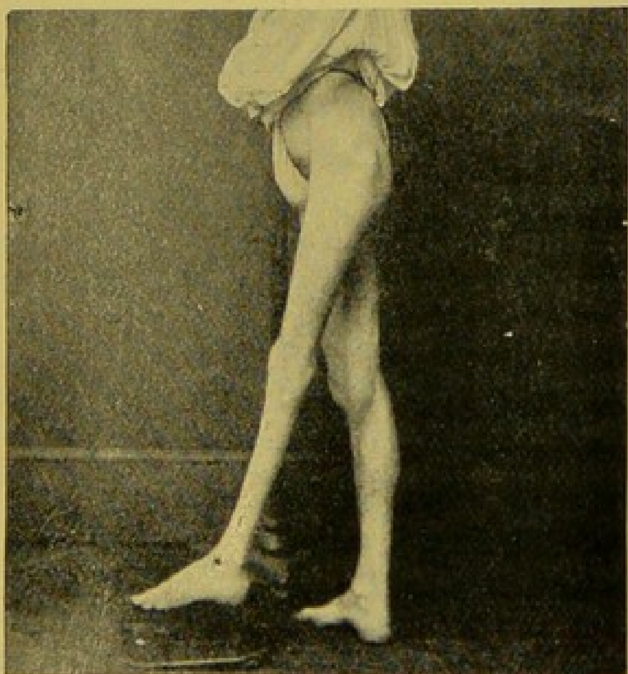
It need hardly be said that double congenital cases present more difficult problems of treatment than single ones. But the principles on which relief or cure should be sought are mainly the same. Even in adult patients with the double affection ankylosis should be avoided, at least on one side, while it may be beneficially (so far, at least, as the power of standing erect and walking well goes) sought on the other.

In younger cases complete reduction is as possible in double as in single cases, though the lordosis and the limping are, at best, not so thoroughly removed.

Paralytic Dislocation of the Hip

This subject is noticed in the chapter on 'Infantile Paralysis.' It is referred to again because of the striking resemblance, if not identity, in apparent characters of 'congenital' and paralytic dislocations. I have referred in the present chapter to Verneuil's views as to the paralytic origin of 'congenital' dislocations. Whether the latter, or a small or a large proportion of them, are of paralytic origin—are, in fact, cases in which infantile paralysis has retrogressed to the point of disappearance—or whether they are not, there remain a few words to be said about *hip dislocation in limbs undoubtedly*





Figs. 165, 166.—Infantile Paralysis in a Young Man, affecting the Left Lower Extremity. Paralytic Dislocation of Hip. The head of the femur lies directly in front of the great trochanter, and its position can be plainly *seen* in the second figure. The appearances are practically identical with those presented by a 'congenital dislocation.' Of the two white patches on the hip, the lower and posterior is the skin over the great trochanter, the upper and anterior the skin over the femoral head. (From a patient of Dr. Andrew Elliot's and mine.)

showing persistent signs of infantile paralysis. The sketches and photographs illustrate such cases.

It is only when the displacement is dorsal that the up and down mobility recalls congenital dislocation. In infrapubic and obturator cases the head of the femur lies more or less firmly in a new socket; the thigh may be abducted, and is generally more or less flexed, with more or less shortening of the muscles descending from the superior and inferior anterior iliac spines and of the neighbouring fascia lata.

Such cases are probably due to the head of the femur slipping out of its socket some time before the little patient begins to stand or walk. The first patient I ever had in this condition was a girl six years old with infantile paraplegia, who had never stood in her life. The left hip was dislocated in front of the thyroid foramen. Both hip and knee were flexed, the latter to a right angle. I had just straightened out the knee after cutting the ham-strings, and applied a straight splint, when, to my surprise, the limb stuck out in the air at an angle of 45°, and the heel only remained on the table when it was held down. I then, for the first time, noticed the dislocation. I brought the limb into a line with the body by osteotomy between the trochanters. With a suitable apparatus she was soon walking about. Osteotomy was preferable to free division of muscles, &c., as it did not further weaken the already paralytic and feeble limb.

The appliance used was a poroplastic jacket, with outside irons descending on both limbs down to sockets in the boot heels. It has been said already that the case was paraplegic. The power still remaining in the muscles rapidly increased with exercises.

It was in a one-sided case of this description that Karewski did the first operative reduction on record of a dislocated hip. It need not be pointed out that such a case is more favourable for the purpose than one of dorsal dislocation, as reduction tends rather to shorten than to lengthen the limb and its muscles.

The treatment of dorsal paralytic dislocations would be exactly the same as that indicated for congenital dislocations but for the complications often present in the former, such as loose knee with paralysed extensors, club-foot, &c. It is necessary to consider each case by itself. It is always desirable to stiffen a loose knee, either by a leather case or by side-irons with a ring-bolt, or by operation ; but a talipes equinus may often be let alone, with advantage, owing to its affording compensatory increase in length of the extremity.

The most severe cases may require a combination of an appliance reaching from the waist, if not from the thorax, to the heel, with a high boot and a crutch as well. The wasting and shortening of such limbs are usually very marked.

In no case that I have ever seen do I think an ordinary excision of the femoral head and neck would have been correct practice, though that operation has been done for the condition. I have seen adults in which Ogston's operation would have been applicable; but because of their complications I forbore to press it, except in one instance. But the patient, a young woman, declined operation, mainly because the appliance—a leather and steel one from hip to heel, and stiff at the knee—answered as well as she desired.

If the dislocated hip itself is to be attacked, it should be dealt with as nearly as possible as if it had been 'congenitally' dislocated ; that is to say, the head brought down, and the old acetabulum deepened or a new one made, and the joint-capsule divided as much as may be necessary, but the muscles spared as far as is found consistent with effecting the reduction.

These cases are also often well adapted for anthrodesis. (See chapter on 'Infantile Paralysis.')

CHAPTER XV

COXA VARA OF ADOLESCENTS

Definition.—A deformity of the upper epiphysial region of the femur in which the head of that bone sinks to a lower level than normal, in extreme cases almost touching the lesser trochanter. Coxa vara has been named also 'curvature of the neck of the femur,' while the terms 'bending' and 'incurvation' have also been used instead of curvature. '*Coxa vara*' has the merit of being short and handy. Objections can easily be taken to it; and an attempt, which appears to me mistaken, has been made to limit it to a particular form of the deformity evidently not different in nature from others, and corresponding in most symptoms. It is not likely that so handy a name as coxa vara will be displaced by any phrase including seven words.

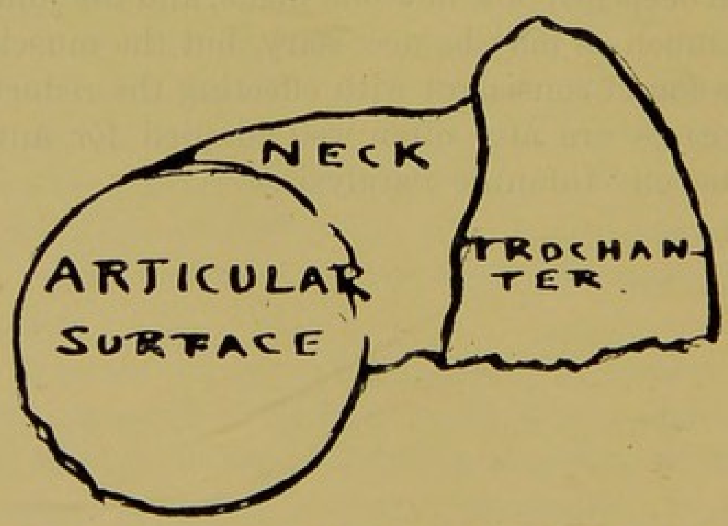


Fig. 167.—Diagram of Posterior View in Coxa Vara.

In coxa vara the upper border of the neck of the femur is longer than normal, and the lower border shorter than normal (see figs. 167, 168, 169, and 171).

In well-marked specimens the difference is very great; *e.g.*, the upper border of the neck may be of three times the

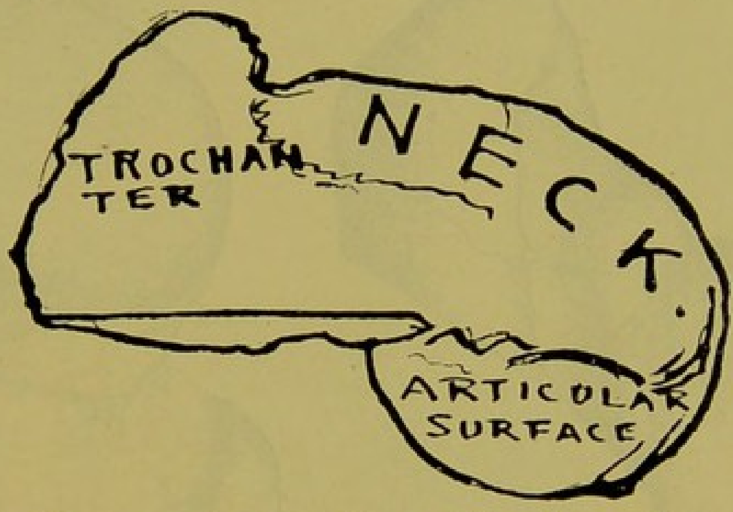


Fig. 168.—Diagram of Anterior View in Coxa Vara. These diagrams are based on Kocher's engravings ('Deutsche Zeitschrift,' Bd. xxxviii. p. 536, 1894).

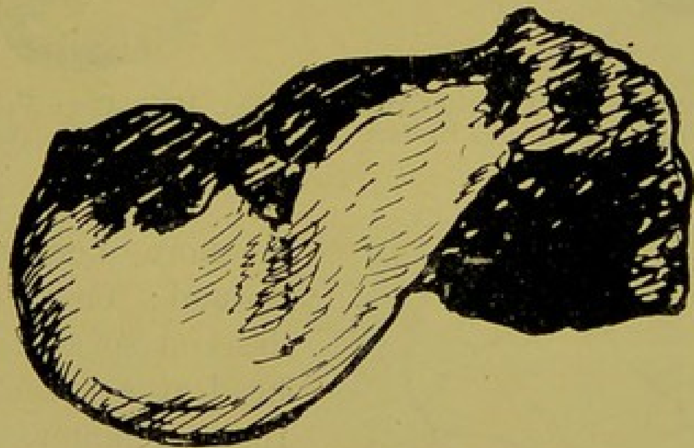


Fig. 169.—View of Specimen from Coxa Vara (from above). Pen-and-ink sketch after Kocher's engraving.

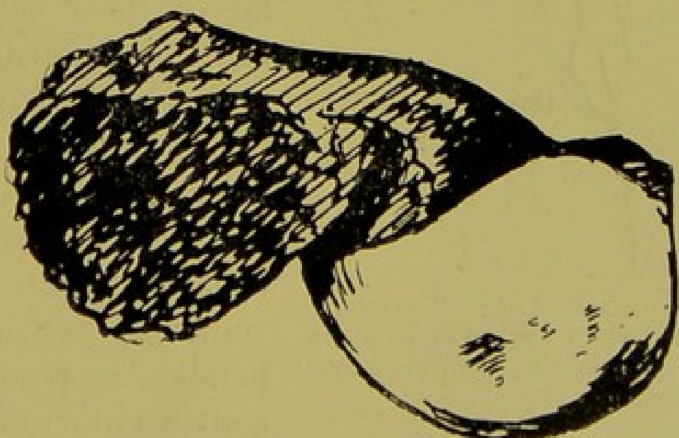


Fig. 170.—Specimen from Coxa Vara. View from below. (After Kocher.)

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normal length. A necessary corollary of this is that the neck

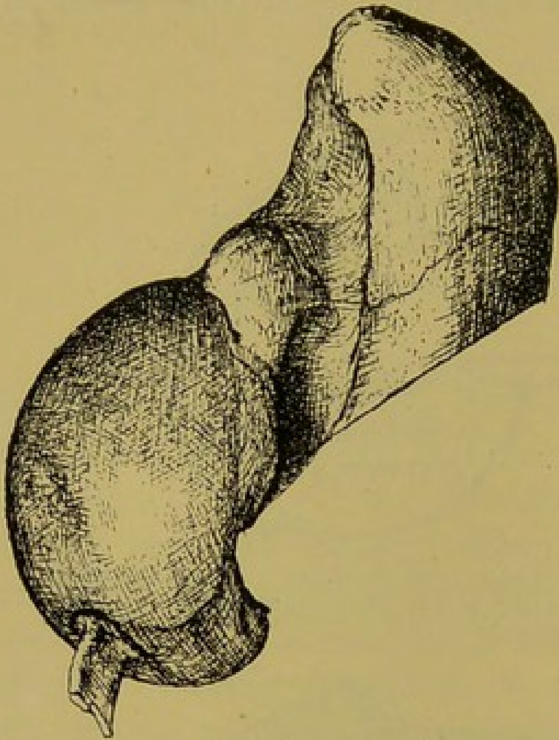


Fig. 171.—Coxa Vara. Posterior view of head of femur, &c. (After Hoffa.)

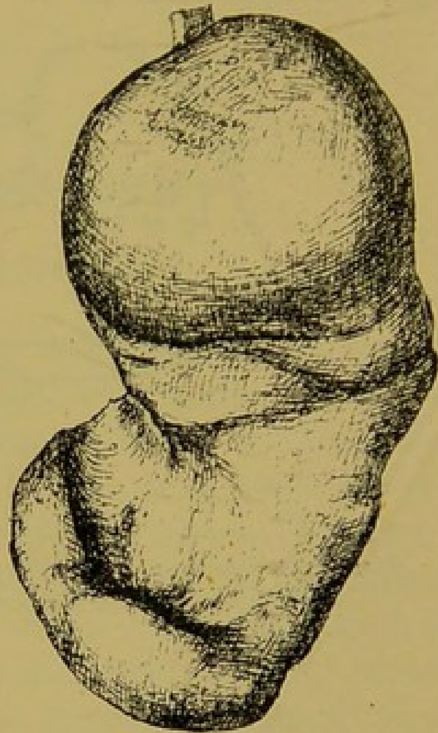


Fig. 172.—Coxa Vara. View of head of femur, &c., from above. (After Hoffa.)

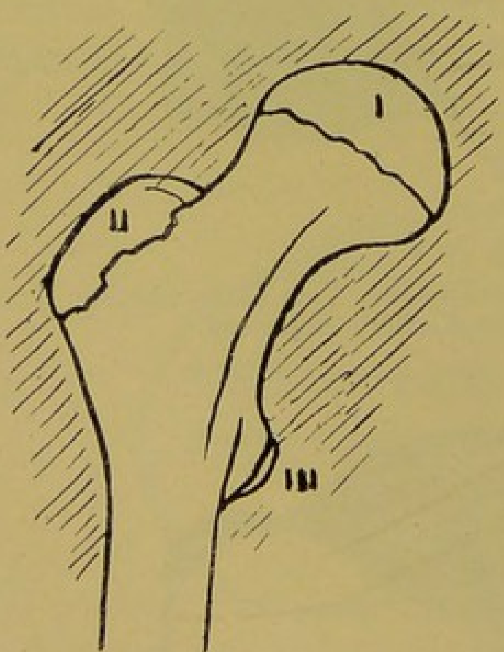


Fig. 173.—Diagram of Upper Epiphysial Region of Femur with Epiphyses in situ. (From a Specimen in the Royal College of Surgeons.)

is more horizontal than normal; or it may even descend so as to place the head at a lower level than the trochanter, instead of ascending in the usual way. Further, the articular surface of the head looks downwards instead of upwards and inwards.

And there is another remarkable and practically important change. The neck is bent in a horizontal as well as in a perpendicular plane, with the convexity forwards (figs. 170 and 172). Coxa vara does not consist of a mere diminution

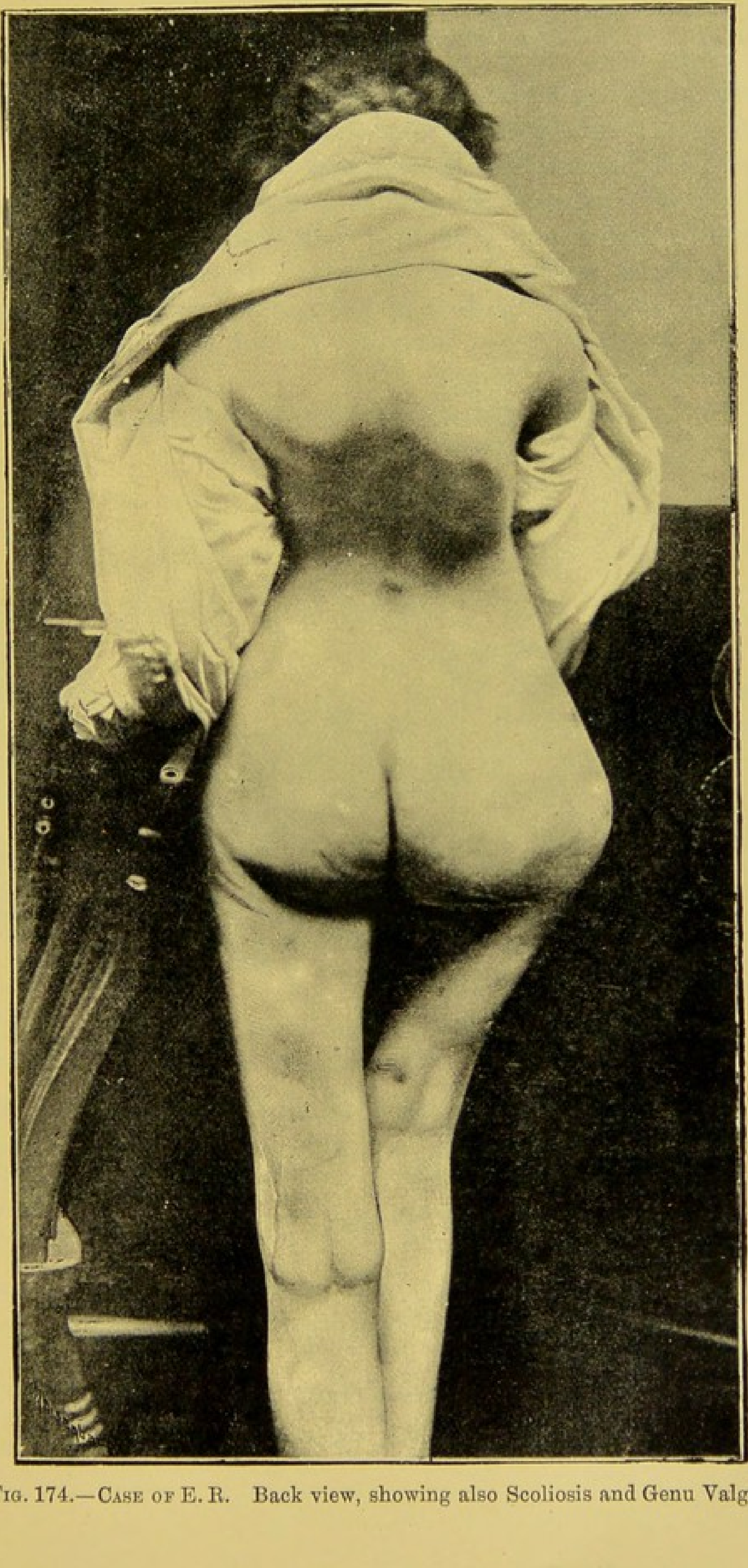


FIG. 174.—CASE OF E. R. Back view, showing also Scoliosis and Genu Valgum.

of the angle formed by the long axis of the neck with the long axis of the shaft of the femur.

The horizontal change is perhaps not constant. It manifests itself clinically by producing eversion and diminished range of inversion of the limb. Now, cases have been reported in which the reverse is said to have been observed. In such we may infer that the neck of the femur was not curved in a horizontal plane, or at least not curved with the convexity forwards.

Hofmeister arranged a collection of recorded cases (fifty-five in number) into three groups :—

I. With no outward rotation.

II. With limb outwardly rotated.

III. (Rare, only three cases) With inward rotation.

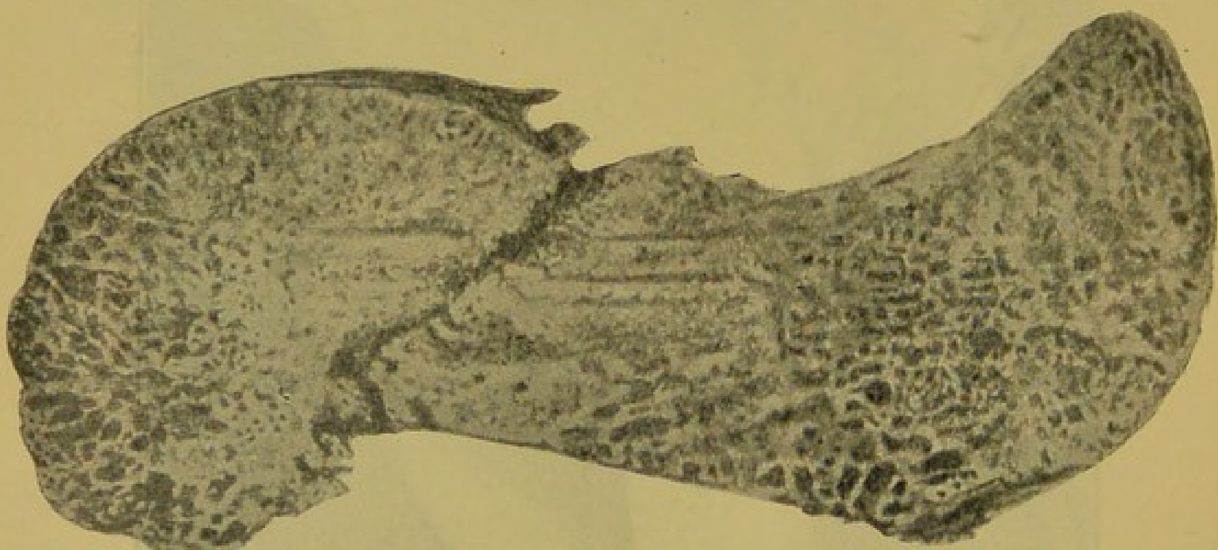


FIG. 175.—SECTION SHOWING STRUCTURE OF NECK, &C., IN COXA VARA. (From Frazer, after Schulz.[1])

Groups I. and II. have no sharp line of demarcation. No one but Hofmeister himself had, up to the date of his paper, met with examples of Group III. In one striking case of his, in which both limbs were affected, one belonged to Group I. and the other to Group III.

Coxa vara is, in fact, as I said in describing the first case ever recognised clinically, a deformity of 'the upper epiphysial region of the femur.'

The deforming influence sometimes extends a considerable

[1] *Zeitschr. für orthopäd. Chirurg.* 1891, Bd. 1.

way down the shaft, exactly as in genu valgum it sometimes affects and curves the lower third or half of the shaft.

When a perpendicular section is made, the strongest and most compact part of the bone is seen to be not the lowest part of the neck, but the upper part, near the epiphysial cartilage, on both the distal and proximal side of that cartilage. The articular cartilage is either unchanged, as in

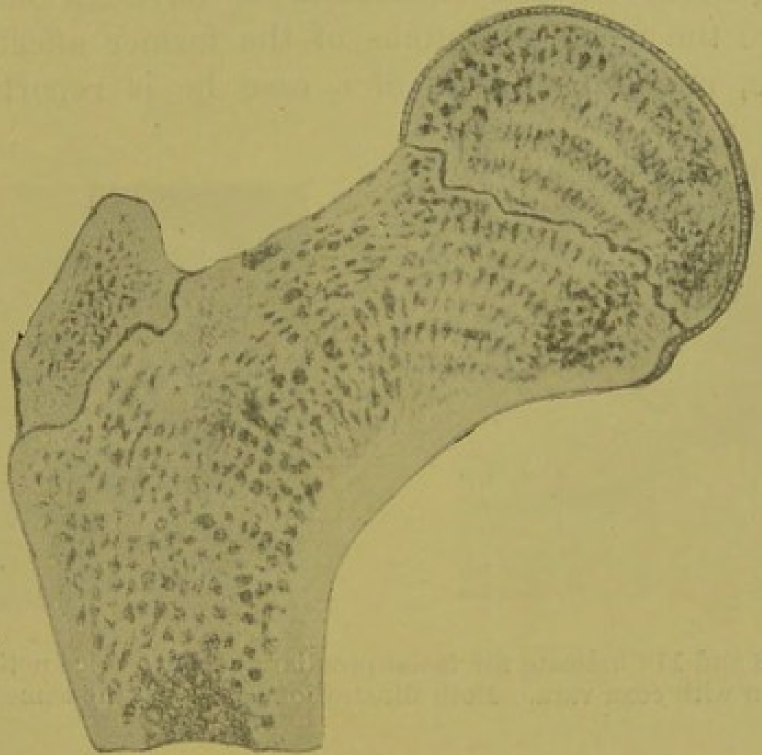


FIG. 176.—SECTION SHOWING STRUCTURE OF NORMAL NECK, &c., OF FEMUR. (From Frazer, after Schulz.)

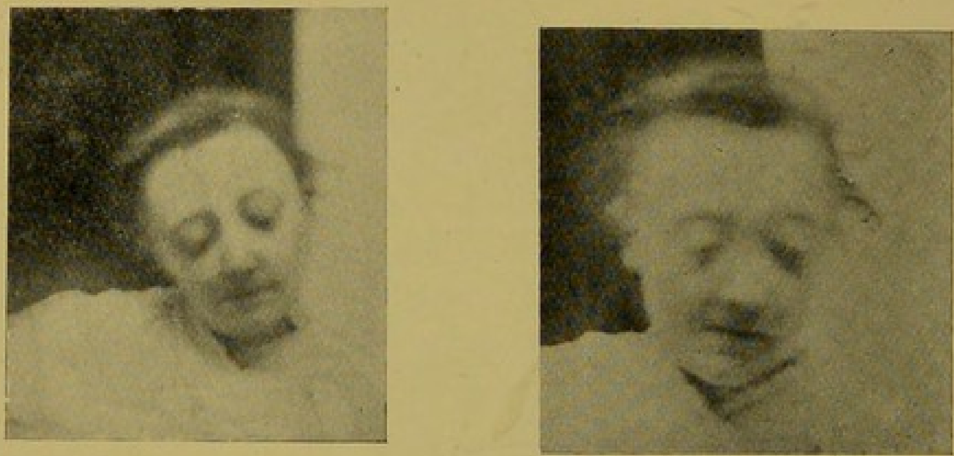
Müller's case, or thinned in the centre of the head and thick round its borders, as in Kocher's case.

Usually there are no osteophytic growths, and, with the exception of my own case, no recent signs of rickets have been seen on microscopic examination, perhaps because the rachitic process was over, though leaving the resulting deformity behind.[1] But very frequently other, probably rachitic,

[1] A microscopic examination of the wedge of bone removed in my case was made by Dr. W. S. Colman, then house physician at the West London. It showed 'exactly such changes as are seen in bones known to be affected with rickets.'

Deformity of the upper end of the femur, including increased angularity of the neck, has been recognised for many years as a common symptom of *general rickets in young children*. Jenner referred to its commonness in his deformities coexist. In my first case there were genu valgum and scoliosis. The coexistence of these deformities first suggested to me the correct diagnosis of my first case. It also appeared to Müller an argument in favour of the rachitic origin of coxa vara. On the other hand, to Kocher it meant simply an argument in favour of the 'Belastungstheorie.'

Writers who do not believe in the relation of rachitis adolescentium to coxa vara seem to have curious ideas of what are the usual symptoms of the former affection. For instance, one author says of a case he is reporting: 'No



Figs. 178 and 179 indicate the facial peculiarity I have twice noticed in connection with coxa vara. Both illustrations are from the same patient.

evidence of rickets; genu valgum present on both sides'![1] Surely the conjunction of coxa vara and genu valgum is itself evidence of rickets, though, of course, not conclusive.

Adolescents attacked with rickets do not present the same clinical picture as infants. They are not visibly rachitic in every bone. They are not pot-bellied, bow-legged, beaded-ribbed, &c., any more than they are unable to walk, and collapse in the spine when they sit down. The older a person is when attacked with rickets, the more limited and localised are his resultant deformities likely to be.

Another thing which I have twice distinctly noticed in

Lectures. What has attracted so much attention in the last ten years is the deformity when observed in *adolescents*, with few or no other signs of rickets elsewhere.

[1] Frazer, *op. cit.*

cases of my own, and believe I can trace in the portrait given by Kocher of one of his cases, is an alteration in shape of the bones of the face and forehead. I do not like to call it a

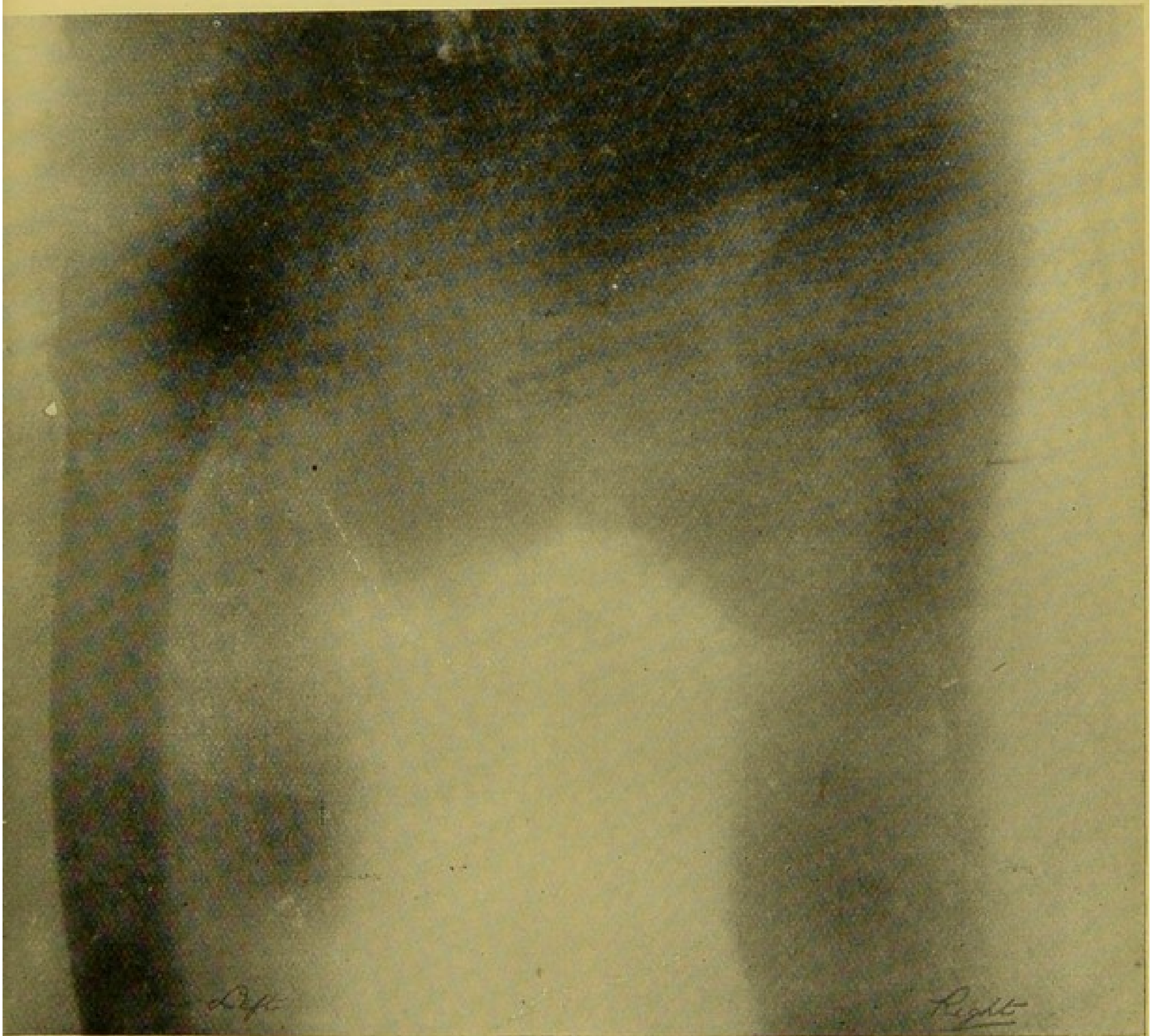


Fig. 180.—Skiagram (back view), Left Coxa Vara, Male, æt. 18. The left femoral neck is horizontal. The right neck (its lower margin is shown distinctly in the original skiagram) is oblique. The pelvis is horizontal, and the right lesser trochanter is seen an inch lower than the left. Both negative and process block untouched by either skiagrapher or engraver. Compare with fig. 181.

deformity. It is not necessarily unpleasing. It is most marked in the case of E. R. The facial bones seem thin and expanded, especially in the orbital and nasal regions. I do not say that they *are* thin, only their appearance of expansion suggests it. The orbits are shallow and the eyeballs inclined to be prominent. The ridge of the nose does not rise sharply.

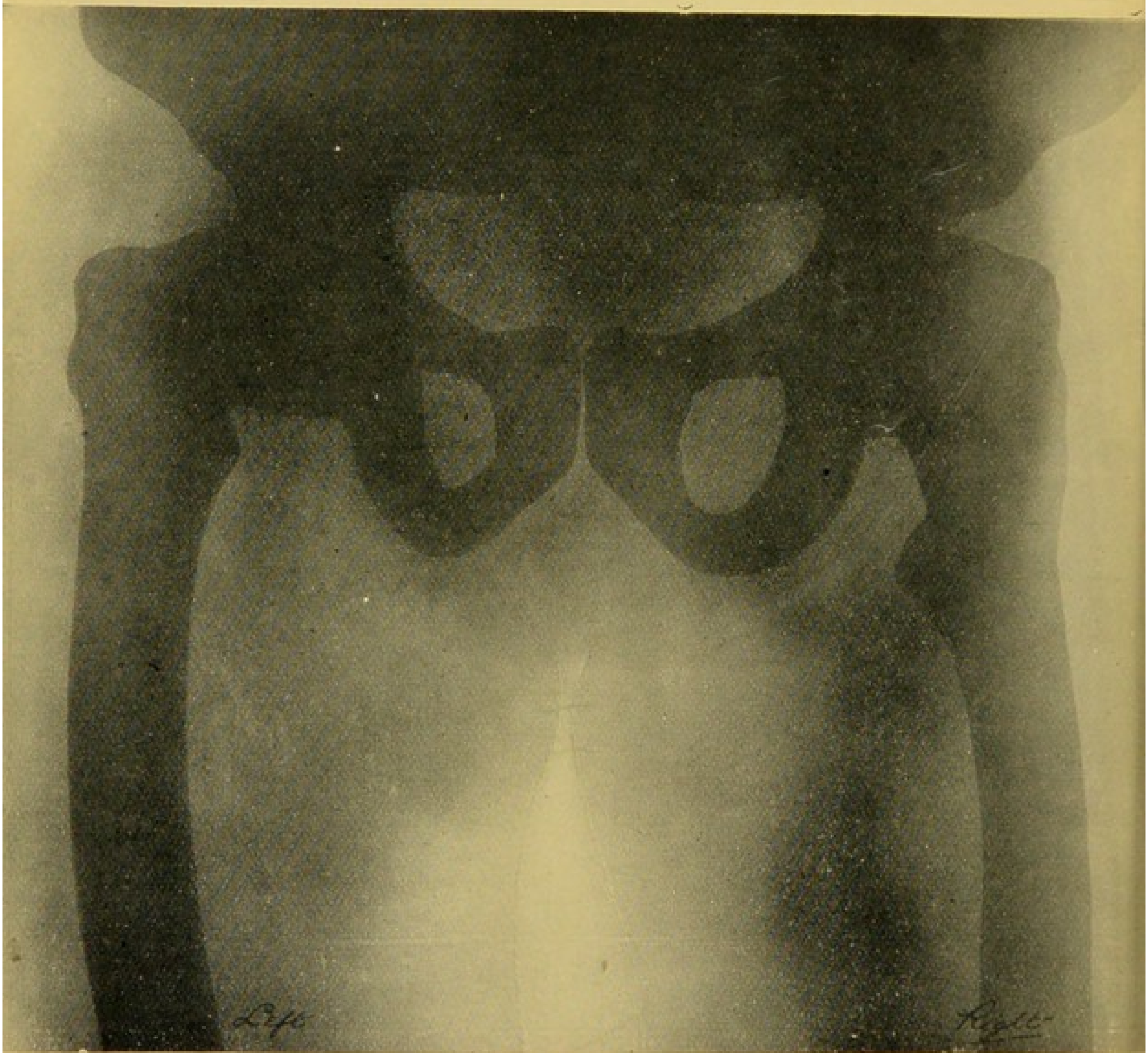


Fig. 181.—This is the same skiagram as fig. 180, but retouched by the engraver in the usual way. I give it as an example of how such retouching falsifies. The right great trochanter is quite imaginary. It can be seen in the original skiagram much lower (the right femur is quite normal), but its shadow is too faint for process reproduction. Nine skiagrams out of ten reproduced in medical journals and books are faked up in this way.

In fact there is a lowness of relief about the features, but something essentially different from the ordinary 'flat face.'

Symptoms.—Pain in the hip, brought on or increased by walking, is almost always the first symptom noticed. This pain may extend down to the knee; which is perhaps one

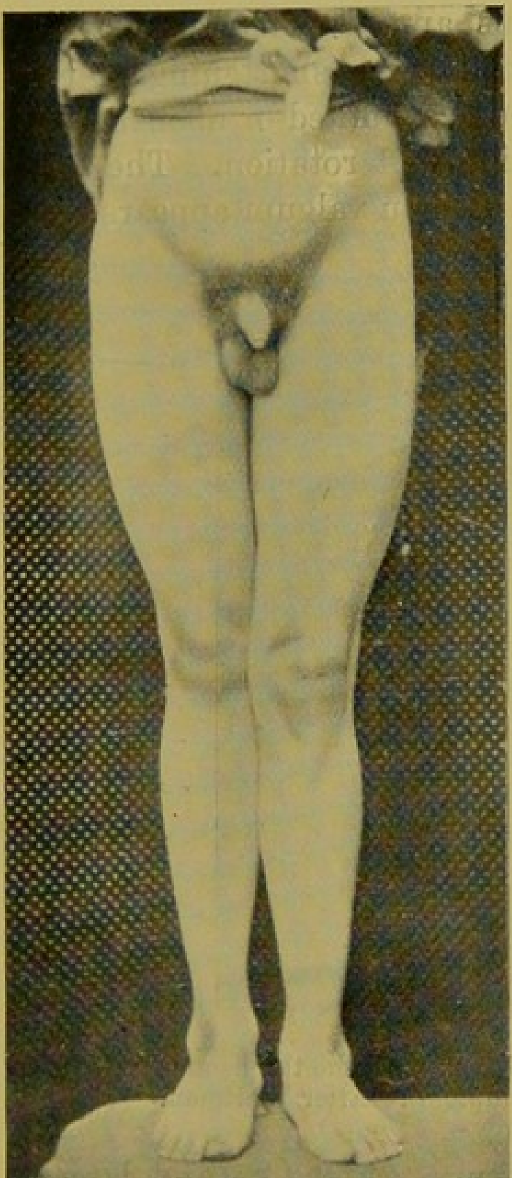


Fig. 182.—Case of medium severity. Front view of same case as fig. 183. The chief symptoms were great limitation of flexion and adduction and fatigue of the right limb after walking a mile or less, dating from the age of fourteen.

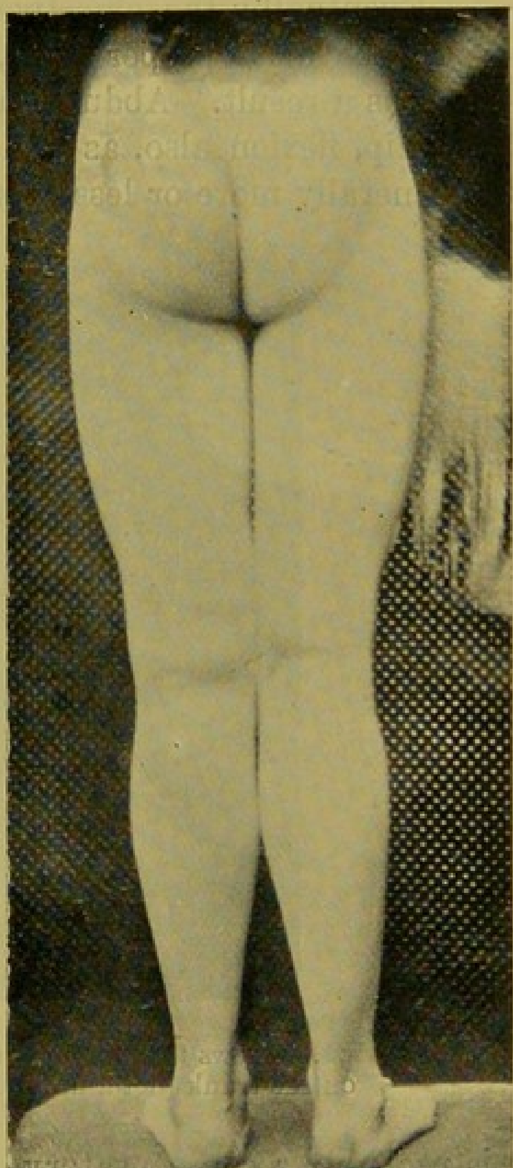


Fig. 183.—Coxa Vara of the Right Hip. Skiagram showed the femoral neck horizontal. Shortening compensated in this case by increased growth below the knee. Difference of level in trochanters is shown and slight right genu valgum. Youth of eighteen.

reason why these cases have been so often confounded with hip disease. Soon afterwards the patient begins to limp, and soon tires on walking. In bilateral cases the second hip is generally attacked soon after the first, at, *e.g.*, an interval of three or four months. The usual age at commencement is from twelve to eighteen, especially about fifteen.

Eventually the objective signs appear. The trochanter rises above its proper level, usually with shortening of the limb as a result. Abduction becomes limited or abolished at the hip, flexion also, as well as internal rotation. The foot is generally more or less everted. Genu valgum appears. It

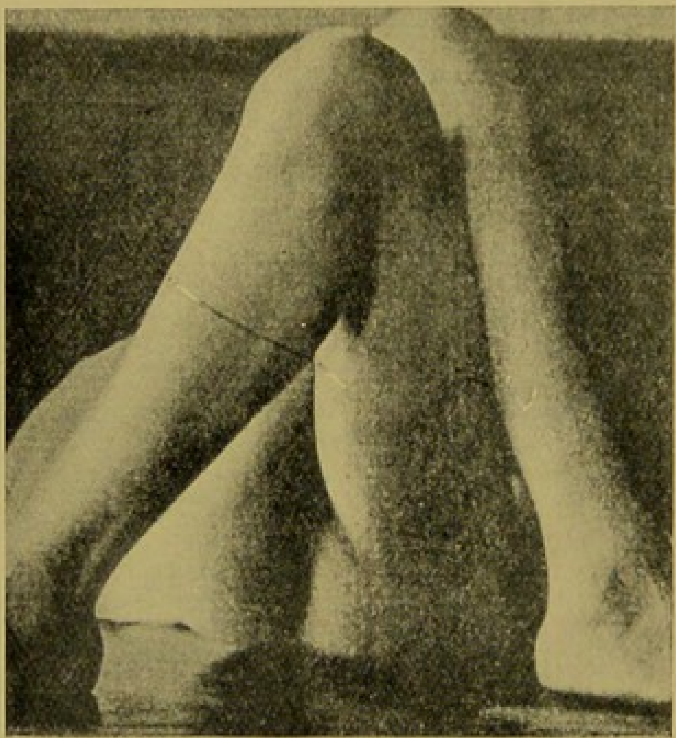


FIG. 184.—Shows the crossing of the knees when the thighs are flexed on the trunk (not a universal symptom). After Whitman.

is probably a compensatory curvature. Flat-foot and lateral curvature of the spine are occasionally seen. In severe cases the movements of the hip become extremely limited, so that it may easily be supposed by mistake to be the seat of fibrous ankylosis. In a small proportion of cases external rather than internal rotation is reported to have been limited. Sometimes flexion is comparatively free. The range of flexion can sometimes be increased by everting the limb. Passive mobility generally seems to be greater than active. As is apt to be the case with ordinary flat-foot, the venous circulation is often not good, and the extremities tend to be rather cold and blue when allowed to hang down.

When the thigh is much adducted, the knees are thereby brought one in front of the other. It is then especially that genu valgum is likely to coexist.

A single-hip case limps; but when both are affected the sufferer waddles, shuffling one knee round the other as he walks. When the hips and knees are flexed in such a case the thighs cross.

DIAGNOSIS.—My first case, which had visited various surgeons and hospitals, had been diagnosed as respectively—

Periostitis of the femur (the trochanter was broader as well as higher than normal).

Other cases have been diagnosed as

Sarcoma of the femur.

Dislocation of the femur on the dorsum ilii.

Arthritis adhesiva.—I am afraid I do not know the meaning of this term, unless it means ankylosis secondary to inflammation of the joint. According to Frazer, it was the diagnosis made by Kocher of his first case, before he had excised the joint and seen the nature of the case explained by the specimen.

Separation of epiphysis.—I have seen a case exhibited at a society as one of separation of epiphysis, and when I asked for the points which distinguished it from coxa vara, the distinguishing symptoms pointed out to me were exactly those of coxa vara. This case, or rather the skiagrams of it, are published as a case of separation of epiphysis. I have tried, unsuccessfully, to see the patient.

Congenital dislocation.—The waddling gait suggests the mistake. The looseness of the joint in most cases of congenital dislocation contrasts with the stiffness of coxa vara.

Coxa vara contrasts with *hip-disease* in the following points: Gentle passive movements and pressing the head into the acetabulum are not painful. There are no startings at night. As a rule, wasting of the thigh is much less marked, though not absent. The head can be felt in the acetabulum, however high the trochanter may be, and it is not tender to direct pressure. Pain is easily relieved by rest without fixation.

Röntgen's rays are of the greatest value in finally settling the diagnosis. The skiagram should be studied in connection with the general clinical picture presented by the case. Nothing is more misleading than a skiagram studied by itself.

Prognosis.—The disease is progressive at first, but tends ultimately to come to a stop. The deformity remains. In the worst cases, not only is there great shortening, but the joint is so stiff that the patient has difficulty in lacing his boots and in sitting down comfortably, especially on a low chair, and is easily fatigued by walking. The general health does not suffer, except indirectly through pain and want of exercise.

Treatment.—An obvious indication is to restore as far as possible the natural shape of the bone by osteotomy. Another is to relieve the pain by rest. A third is to increase the range of movements by passive exercises, and even by forcible movements under anæsthesia. One of my patients said he was thus benefited by a bone-setter, who, I need not add, was quite mistaken as to the nature of the case he had to deal with. Palliative measures are rest in bed, with or without extension. Two or three weeks generally suffice to remove the pain and some of the stiffness. In old-standing cases iodide of potassium and salicylate of soda, as well as the systematic use of purgatives and massage, might be also tried. I am referring to middle-aged, or at least cases of, say, ten years' standing, in which there is sometimes a suspicion of complication by gout or rheumatism. In the early years of the case, sea air, Parrish's food, and other anti-rachitic remedies should be tried. It is impossible to say when such treatment ceases to be useful. Although I think that the influence of weight pressure is a factor that has been greatly exaggerated in explaining this deformity, I think carrying weights to the extent of causing fatigue should be avoided, and that, if the patient's occupation necessitates this, he had better change it. None of my own cases followed occupations requiring them to carry weights.

The relief of pain and stiffness by rest is apt to prove of only temporary value. Both are liable to recur after exposure to fatigue or on the occurrence of damp weather. Massage is frequently recommended. It can at best only relieve aching and lessen stiffness. It cannot affect the deformity.

Operative Treatment.—In some of the earlier cases a mistaken diagnosis led to the excision of the head and neck of the femur and part of the trochanters. As the joint is practically healthy, excision is now pretty generally condemned. The original excisions served a useful purpose, however, because they furnished the specimens from which first Müller, and afterwards Kocher, gave accurate accounts of the anatomy of the disease.

What is to be thought of reports like the following (a reference to one of Schneider's cases)? 'Patient limps, but has no pain. Treatment: Resection of the hip-joint. The patient was discharged cured.' Cured! What of? Not of the limp, we may be sure; not of the adduction either, unless bony ankylosis ensued; nor of the shortening. Increased mobility may have been obtained, but at the expense of increased weakness and diminished length.

The practical question at present is, how and where to perform osteotomy. 'Kocher, Hofmeister, and others have advised a subtrochanteric osteotomy,' writes Frazer. He might have added that subtrochanteric osteotomy had been performed for coxa vara some years before by myself. It has recently been done and strongly recommended by Watson Cheyne. I removed a wedge. The patient herself was much pleased with the result, mainly because it greatly diminished the shortening. Watson Cheyne directed his attention chiefly to remedying the eversion, and effected great improvement. He used a silver plate and steel pins to fix the fragments in the corrected position. The seat of the deformity being mainly above the trochanter, the obvious indication would be for supra-trochanteric osteotomy, but for the comparative depth and difficulty of controlling the upper fragment, consisting only of the head and part of the neck, after that operation. It has been recommended by Kraske, whose operation consists of the removal of a wedge from the neck, with the base upwards, through anterior longitudinal incision. Budinger says linear supra-trochanteric osteotomy does just as well, if the limb be kept well abducted and everted during the after-treatment. My experience of osteotomy in general is that, if the operator be a practised osteotomist, a better result can generally be obtained from a wedge than from a linear osteotomy, except where, as in Macewen's operation for genu valgum, the bone is comparatively deep and slender and the correction desired very simple. The neck of the

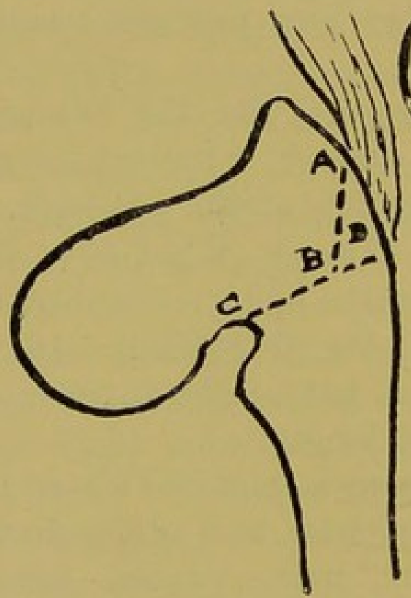


Fig. 185.

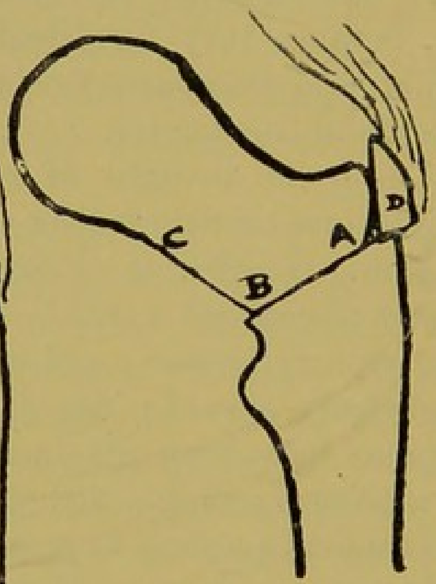


Fig. 186.

femur is deep and slender, but the correction desired is not simple. The abnormally great length of the upper border of the neck of the femur invites strongly to a wedge osteotomy. But it must be remembered the lower border of the femoral neck is also abnormally short. No operation hitherto devised would cure the shortness, which constitutes a part of the deformity of great practical importance.

If the problem were merely one of joinery, such a procedure as the following might be adopted. The femur would be divided obliquely, from without inwards and downwards, just above the lesser trochanter. The outer surface of the upper fragment (D, fig. 185) would be cut off and turned upwards with the muscles, which would be left attached to it.

Then the surface A B would be brought down into the original position of B C, and fixed there with pins. The result, as shown in fig. 186, would be to bring back the articular surface of the femoral head almost into its normal position. To make the articular surface look sufficiently forward, *i.e.* to remove the evil effect of the horizontal curve in the femoral neck, a wedge with the convexity forward would also have to be removed from either the lower fragment at B C, or the upper at A B. Otherwise the external rotation of the limb would have to be corrected by a separate simple osteotomy, done after the first osteotomy was recovered from. Mere rotation inwards of the limb would disturb the fit of the fragments, if done as a part of the first osteotomy. But surgery is not mere joinery, and such an operation as I have sketched out would never be popular with practical surgeons. If carelessly or awkwardly done, there would be risk of imperfect fixation, and even of splitting the bone, in fixing the pins. Nevertheless the operation is a practicable one, and properly executed would almost certainly give a first-class result, better than any got from simple osteotomy.

Pins are extremely useful in fixing bony fragments after either fracture or osteotomy; but they should never be trusted to alone. They should be properly supported by splints, bandages, and extension apparatus. And the action of these should be carefully superintended. The pins should be made of thickly silver-plated steel. The holes for them should be bored by sufficiently large gimlets or American bits, as the insertion by force of pins into small holes will result in splitting the bone. Of course, when the bone is soft and tough and the pin small in diameter, a bradawl suffices for boring.

Historical.—My chief object in adding a few words under this head is to make a small claim for priority. The position as regards this point was clearly and concisely put by Ernst Müller, of Stuttgart, in the 'Centralblatt für Chirurgie' for September 1, 1894. His first work on the subject appeared in Bruns's 'Beiträge zur klin. Chir.,' published in November 1888. He reported therein two cases in which the head, neck, and part of the trochanteric region of the femur had been excised; he gave a very good description of the clinical histories and of the specimens, and expressed the opinion that the affection was of rachitic origin. Afterwards v. Lauenstein,[1] Hoffa,[2] Rotter,[3] all in 1890, and, later, Hofmeister [4] and others, published additional cases and described fresh specimens.

Then Kocher, in 1894, published a paper—'Ueber Coxa vara, eine Berufskrankheit der Wachstumperiode'[5]—of the highest intrinsic value, but doing scant justice to Müller and others.

Müller wrote ('Centralbl. für Chir.,' September 1, 1894, p. 818): 'Even if Kocher had not read my work in the original, the others' (viz. the papers of Hoffa, Lauenstein, &c.), 'which all referred to mine, could not have escaped his observation.'

And further: 'Kocher has, therefore, no right to assert that he published his cases without knowing anything about my work; since otherwise he lays himself open to the reproach of not inspecting (surgical) literature, which is the first thing which an author should do before he describes a new disease.'

Kocher[6] defended himself with his usual ability, but not, I think, with complete success. He persuaded himself (I think erroneously) that his cases differed essentially from Müller's, and that, because they presented at the hip certain analogies with the changes at and near the ankle in talipes varus, only cases *precisely* like his ought to be called 'coxa vara.'

I must now point out that Müller himself could scarcely have exhaustively 'inspected surgical literature' before publishing; because what, to him at least, should have been obviously a case of coxa vara was published by me in the first number of the 'Illustrated Medical News' (of date September 29, 1888. Müller's first publication appeared the following

[1] *Archiv f. klin. Chir.* 1890, xl. p. 244.
[2] *Münch. med. Wochenschrift*, 1890, 32.
[3] *Zeit. f. orthopäd. Chir.* 1890, Bd. i., Heft 1.
[4] *Beiträge zur klin. Chir.* 1894, Bd. xii. 245.
[5] *Deutsche Zeit. f. Chir.* 1894, xxxviii. 521.
[6] *Deutsche Zeit. f. Chir.*, Bd. xl. 1895, p. 411.

November). My paper was entitled 'A Case of Rachitis Adolescentium in which the disease was for several years localised in the trochanteric and infra-trochanteric region of

Fig. 187.—Severe Case of Coxa Vara. (From 'Illustrated Medical News,' Sept. 29, 1888.) Skiagraphy shows neck of femur at acute angle with shaft, which is itself curved. The prominence seen is *below* the trochanter, which can be felt higher up and far above the level of the head of the femur, easily felt from the front.

the right femur, and afterwards attacked the spine; wedge osteotomy for the femoral deformity, and plaster-of-Paris jacket for the spinal.'

In the text I wrote of the case that it was 'one of *rachitis adolescentium, attacking* first *the upper epiphysial region of the femur*' (see fig. 173), 'and secondly, after some years, the epiphysial regions of the vertebral bodies.' Two photographs attached show very plainly the adduction at the hip, the eversion of the foot, the shortening, and the compensatory knock-knee (figs. 174 and 187).

My case was the first, therefore, in which the nature and seat of the disease were diagnosed correctly during life and before operation, and it was also the first to be treated by osteotomy. An infra-trochanteric wedge was removed.[1]

There are several reasons why I have not hitherto received credit for this: (1) The next observations were made in Germany; indeed, for some years the literature of the subject was purely German. (2) I did not make the mistake of diagnosing the affection to be one of the hip-joint, and then, by excising the upper end of the femur, put myself in a position to give an anatomical description of the specimen. (3) I omitted to give any clinical account of the objective symptoms, and left the photographs to speak for themselves. (4) The art editor of the journal added a misleading diagram 'to explain the nature of the operation.' I pointed out its erroneous nature in the last paragraph of my paper, but in terms rather too mild.

Lastly, the journal in question lived only two years; its production was found too expensive. It was the largest and most copiously illustrated medical journal of its time. Various Continental and American surgeons have written to me, asking for the loan of the journal, but the bound volume in my possession was too cumbrous to send abroad.

Previous to the date of my case Dr. Monks[2] had given an excellent clinical description of a case which was most likely one of coxa vara, and he had, moreover, distinctly recognised

[1] Frazer writes of the diagnosis having been made *after* operation. The text of my report proves that it was made *before*. In fact, it was made *months* before.

[2] *Boston Medical and Surgical Journal*, November 18, 1886.

that the trochanters had risen above their normal level with regard to the heads of the femora. He had, however, believed that the femoral heads were also dislocated, and that the cause of the changes was rheumatoid arthritis. Assuming the case to be one of true coxa vara, I think Dr. Monks must have been mistaken on these points.

Various pathological specimens had also from time to time been preserved or described, but had been supposed to be due to rheumatoid or to inflammatory changes, or to traumatism.[1]

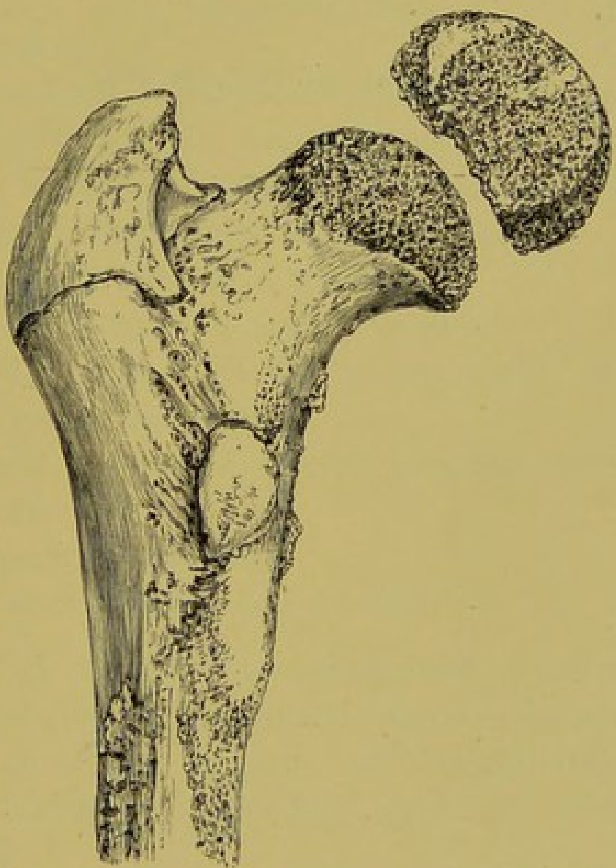


FIG. 188.—TRAUMATIC SEPARATION OF EPIPHYSIAL HEAD OF FEMUR. (Howard Marsh on 'Diseases of Joints and Spine.')

Lastly, the existence of coxa vara in rachitic children had been long known; indeed, it could be seen in almost every pathological museum of importance. Jenner referred in his Lectures to the great frequency with which the upper extremity of the femur is deformed by the rickets of childhood. It was, however, reserved for Ernst Müller to give the first

[1] Zeis: *Beiträge zur patholog. Anat.* vol. i. (1851); Richardson, *Trans. Philadelph. Path. Soc.* 1857: both references from Frazer.

complete description of coxa vara; and Kocher's paper is so valuable from the exactness and fulness of its anatomical descriptions that, with or without priority, it must also remain a classic.

The fullest account in the English language is probably Frazer's, in the 'Annals of Surgery' for June, 1899, and the most elaborate in any language is Hofmeister's (*op. cit.*). Whitman, Bayer,[1] and others have made valuable contributions, and, as well as Frazer, give references to the literature of the subject.

[1] *Deutsche Zeit.* 1897, xlv. 562.

CHAPTER XVI

DEFORMITIES OF THE SPINE

Classification

Lateral curvatures:

1. *True scoliosis.* (Whenever the term 'lateral curvature' is used without qualification, either in this or in any other book, almost without exception, this form may be understood to be meant.)
2. *Lateral contractures* of the spine.

Antero-posterior curvatures and projections:

1. *Lordosis* and *kyphosis,* independent of destructive disease or accident.
2. '*Angular curvature,' Pott's curvature, vertebral tuberculosis.*
3. *Traumatic* curvatures.

Deformities resulting from new growths.

Note.—With the genuine deformities of the spine may be associated and contrasted neuromimetic simulations of them.

Lastly, there are certain deforming influences of a destructive character, especially syphilis, which act with extreme rarity.

Each of the above divisions admits of subdivision. The further classifications will be given in the sections treating respectively of each main division.

Lateral Curvatures

Scoliosis

This is the true and ordinary 'lateral curvature of the spine' of almost all authors, the only one which leads to a succession of lateral curves, one above the other, each accompanied by 'rotation' (a term to be presently explained).

The numerous cases of this common malady may be classified according to (1) the age at which they begin, (2) the stage they have reached, and (3) the appearances they present as regards the number and the relative position and extent of the individual curves. The subdivisions thus obtained are practically useful, though not always well defined.

First, there are (1) congenital, (2) rachitic, (3) ordinary, and (4) scolioses of middle age and advanced life.

Congenital Scoliosis

It occurs either in association with congenital rickets, or else in monsters.[1]

Congenital rachitic scoliosis.—This form is frequently complicated with dorso-lumbar kyphosis. The dominant curve is usually dorsal and to the left,[2] its summit being about the eighth or ninth dorsal vertebra. But many of the vertebral bodies are found wedge-shaped laterally, if a pathological examination is made. The intervertebral discs are similarly affected.

The anatomical changes in the spinous processes and laminæ are analogous to those found in ordinary scoliosis, but more marked. Yet there is so little 'rotation' that scarcely any postero-lateral bulging of the ribs is to be seen, probably because the growth is not now conducted on the rigid lines which guide it afterwards, when every bone is sharply divided into epiphyses, &c. The fact in question confirms the explanation which will be given hereafter of the cause of the rotation in ordinary scoliosis.

Scoliosis in monsters is usually a deformity associated with defects so grave as anencephaly or eventration. Among the questions which arise are—(1) How does anencephaly cause scoliosis? (2) Is eventration the cause or effect of the lateral curvature.

[1] It is also said to be sometimes the result of intra-uterine pressure.

[2] That is, with its *convexity* to the patient's left. Throughout this book the same signification will attach to this mode of indicating the position of a spinal curve.

I have had no opportunities of studying the subject myself, and the state of the spinal region at the period of intra-uterine life at which scoliosis in monsters must begin to develop is so very different from its condition even at birth that I should scarcely expect the study of scoliosis in monsters to throw any light on the etiology of ordinary scolioses.

Rachitic Scoliosis

Scolioses which commence in early childhood are not only all or nearly all of indubitably rachitic origin, but they present peculiarities which give them a title to be regarded as a distinct class from the scolioses of adolescents, whatever may be the truth about the origin of the latter. The exact age at which to separate one period from the other must be chosen somewhat arbitrarily. But as the vast majority of cases of ordinary rickets occur in very young children, and as the later forms of lateral curvature very rarely begin before the seventh or eighth year, we may safely take the sixth birthday as a reasonable point of division.

Causes.—Only a small minority of rickety children suffer from lateral curvature. Why do they suffer and the rest escape? No question is easier to answer after a certain method, which may be termed the *un*-scientific use of the imagination. Whether a rickety child is to be scoliotic or not is said to depend upon whether or not it is always nursed on one arm, or always sleeps on one side, or has one leg shorter than the other, or one arm heavier than the other, or the muscles of one side weaker than those of the other, or some reason of that kind—a reason which has been put forth over and over again for years, but which has never been backed up by anything resembling a careful investigation.

So, also, when we ask why in one rickety child the dorsal or dorso-lumbar curve is to the left, and in another to the right, we learn that it depends on *which* side the child is habitually nursed, *which* leg is shorter than the other, &c. But if we ask for proof, we get none.

Now I do not wish to be accused of denying altogether the effect of statical forces in contributing to the causation and in guiding the direction of spinal curves. On the contrary, I shall presently proceed to demonstrate it; but I wish to say that in the vast majority of cases of rachitic scoliosis the surgeon has no more clue to the reason why the disease has attacked the spine than in most cases of specific palmar psoriasis he knows why the syphilis has shown itself in the hands. And, further, in the few cases wherein he has a clue, he finds it very difficult to prove that what he suspects of being a relationship of cause and effect is really more than a mere coincidence.

The rachitic nature of the scoliosis which is seen at this age is beyond doubt. Although comparatively few rachitic children are scoliotic, almost all young scoliotic children are markedly rachitic, being deformed in their limbs as well as in their backs.

Thus the one essential fact we know about the etiology of lateral curvature commencing in early childhood is that it is due to rickets.

Characters and Symptoms.—The symptom which usually first calls the attention of the child's mother in a case of rachitic scoliosis is the postero-lateral hump formed by the ribs, or the antero-lateral prominence of the rib cartilages. She sometimes fears that a tumour is forming, and even medical men have been known to fall into the same error.

In this respect the lateral curvature of rickets contrasts with that of adolescents, the first sign of which noticed by the patient's friends is usually a prominence of one hip or of one shoulder.

A very early symptom, which often first attracts attention in all forms of scoliosis, is the apparent projection of the inferior angle of one scapula.

It thus happens that rachitic scoliosis seldom comes under the surgeon's notice before the osseous changes are well advanced. I shall therefore, to avoid repetition, reserve an account of the symptoms of incipient scoliosis till I come to write of the form which appears in adolescence, a form frequently brought for diagnosis in its earliest stage.

If the surgeon desire to study commencing rachitic scoliosis, he must search for such cases himself by examining the backs of children brought to him with general rickets, especially those of severe cases.

The appearances presented by the trunk and spine of a patient suffering from rachitic scoliosis are almost the same as those seen in cases of ordinary scoliosis with a right dorsal principal curve, excepting that—

(1) The principal curve and the gibbosity are more frequently to the left than to the right;

(2) They frequently do not extend so far either upwards or downwards (especially upwards);

(3) The prominence of the gibbosity and the strong arc formed by the part of the spine most curved sometimes give a more localised and less general and sweeping character to the deformity of the spine and back;

(4) The trunk is short, and, as it were, compressed perpendicularly.

Diagnosis.—For the diagnosis of lateral curvatures in general, see p. 358. The diagnosis of rachitic from other forms of lateral curvature depends primarily upon the age at which the deformity commenced. If that is uncertain, the peculiarities just enumerated should be looked for, as well as the presence or absence of signs of old rickets in the limbs, shape of the head, chest, or other parts. It must not be forgotten that in rachitic scoliosis the principal dorsal curve, though usually to the left, is frequently to the right, and that even when the principal curve is to the left, it may be so low (*i.e.* lumbo-dorsal) as to leave room above for a considerable dorsal or dorso-cervical curve to the right, with a corresponding gibbosity beneath the right scapula.

Prognosis.—Rachitic scoliosis does not seem to have so great a tendency towards spontaneous improvement as rickety curvature of the legs. It may not advance perceptibly after early childhood, but the little patient's friends should know that even this hope *may* be disappointed, and that not only may a scoliosis of rachitic origin increase without visible intermission throughout the period of growth, but that it may even be aggravated again in middle age or later.

With regard to amenability to treatment, this form of lateral curvature presents the following favourable considerations :

(1) The patient being at an age comparatively free from vanity and self-consciousness, as well as not free to act to its own disadvantage, may generally be submitted to the best treatment suggested by the surgeon's judgment, without being persuaded by reckless quacks or other ignorant and interested persons to waste time over apparatus supposed to be 'elegant and comfortable,' though often neither, and always useless and delusive. But even this advantage must, of course, depend on the mother—on the amount of common sense she possesses and on the character of the influences to which she may be subjected ;

(2) The principal curve in rachitic scoliosis being usually low in the dorsal, or even dorso-lumbar region, is advantageous for treatment ;

(3) So also is the activity with which growth is taking place ;

(4) At this early age it will be easy to get the patient to wear a jury-mast if necessary.

Treatment.—The rickets must be attacked with Syr. Ferri Phos. Co., or 'Parrish's food,' with cod-liver oil and a suitable diet. The latter must contain plenty of animal food, and not consist of a disproportionate share of bread, rice, or other starchy compounds. Meat beaten to a pulp in a mortar and mixed with sugar is recommended for very young children, who, however, cannot always be got to take it. A not insignificant objection to raw meat is the possibility of its containing germs of infection. Independently of anthrax and of the *Trichina spiralis*, Galtier, so long as eleven years ago,[1] demonstrated that the juice of muscles can be virulently contagious when taken, for example, from a tuberculous cow. The large proportion of cattle which are tuberculous is now well known. One of my little patients did, while resident in India, get tapeworm, which, however, was easily cured. The appetite, digestion, and well-being require for their improvement plenty of fresh air ; and they can also be greatly

[1] *Académie des Sciences*, July 4, 1887.

improved by the regular use of massage. Prolonged horizontal rest, which in the case of very young children is more likely to cure this than any other form of lateral curvature, is, unfortunately, liable to injure the appetite and general health, more especially if that rest has to be taken in the stuffy interior of a town house. Residence at the seaside and salt-water baths are beneficial. In cold weather, at least, the clothing next the skin should be woollen, and the limbs as well as the trunk should be so protected. About one teaspoonful of Parrish's food, three times a day, is a usual dose. Cod-liver oil should be given to as great an extent as the digestion and the child's good-nature will stand. Usually a teaspoonful three times a day is the dose. Some children can only be got to take it about once a day. Both the Parrish's food and the oil are best given after meals, and they may be administered either separately or together. One dose of oil at bedtime will sometimes be borne in cases where it is very difficult to get it taken or kept down at any other time.

Local Treatment.—See the chapter on that of Lateral Curvature in general.

Ordinary Scoliosis, or Lateral Curvature commencing after the Age at which Infantile Rickets occurs, but before the Osseous Union of the Epiphyses of the Bodies of the Vertebræ.

The vast majority of cases of lateral curvature belong to this class. To it, therefore, must be devoted the fullest and most detailed consideration.

Pathology and Etiology (of Scoliosis).—There have been no thorough and elaborate investigations of the essential nature of scoliosis which can compare with those of Miculicz into the pathology of genu valgum. But the points of resemblance between true lateral curvature and knock-knee are so strong that one is almost compelled to recognise in the known facts about the latter the key to the true pathology of the former. Fig. 189 represents diagrammatically a transverse perpendicular section of the body of a vertebra in one of the curves of a scoliotic spine. It is wedge-shaped, with the apex of the wedge towards the concavity of the curve. There has evidently been inequality of development on the two sides of the main bony mass of the vertebra, analogous to the inequality in growth of the two sides of the diaphysis of the femur, which is seen in genu valgum. The epiphyses are developed unequally in the same way. Just as in knock-knee the result is an angular curvation with the apex towards that side on which the bone has grown the faster, so in scoliosis we have a lateral curvature with the convexity towards the side on which the vertebral bodies have grown the faster. However, in the latter case the curvature is not angular, but rounded, in consequence of a row of superimposed bones being similarly affected. A number of wedges with straight sides can, as everybody knows, be arranged to form together a curved line, as in fig. 190, every single line of which is straight, but the whole effect an arc.

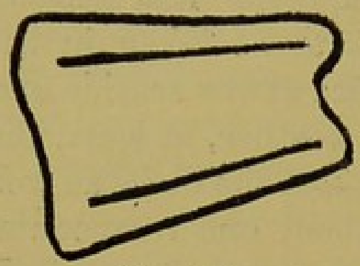


Fig. 189.

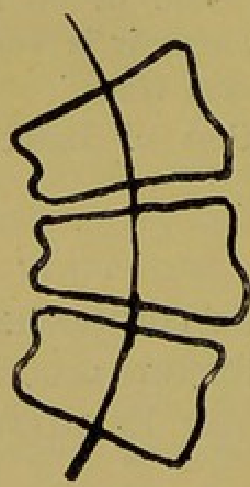


Fig. 190.

To see these facts in their true light it is necessary to realise that *more or less of this osseous deformity, of this wedge-shaped alteration in the vertebral bodies, exists at the very first onset of the disease.* It is present in those cases of scoliosis which are only recognisable by the existence of the slightest possible degree of projection of one shoulder-blade, or of one hip. It has been found in every specimen of scoliosis, mild or severe, in every museum in the world in which it has been looked for. It has been found to exist in a marked degree in specimens in which it has been declared to be absent by surgeons who believe in such a thing as scoliosis of a merely ligamentous origin. Take, *e.g.*, Specimen No. 521 of the Musée Dupuytren. P. Bouland[1] has given careful and conclusive

[1] *Dict. Encyc. des Sciences Méd.* 3e Section, tome 1, p. 558.

measurements of the asymmetry of the bones in this specimen, thus refuting statements of no less a surgeon than Malgaigne.

It may be said, in fact it has been said, that these osseous changes are the results of the continuance of a lateral curvation produced by other causes. I have already pointed out that they exist from the very first; therefore the influence of the other causes on the shape of the bones must be practically instantaneous. Let us consider what these other causes are said to be, and then try to judge if they can do what they are credited with.

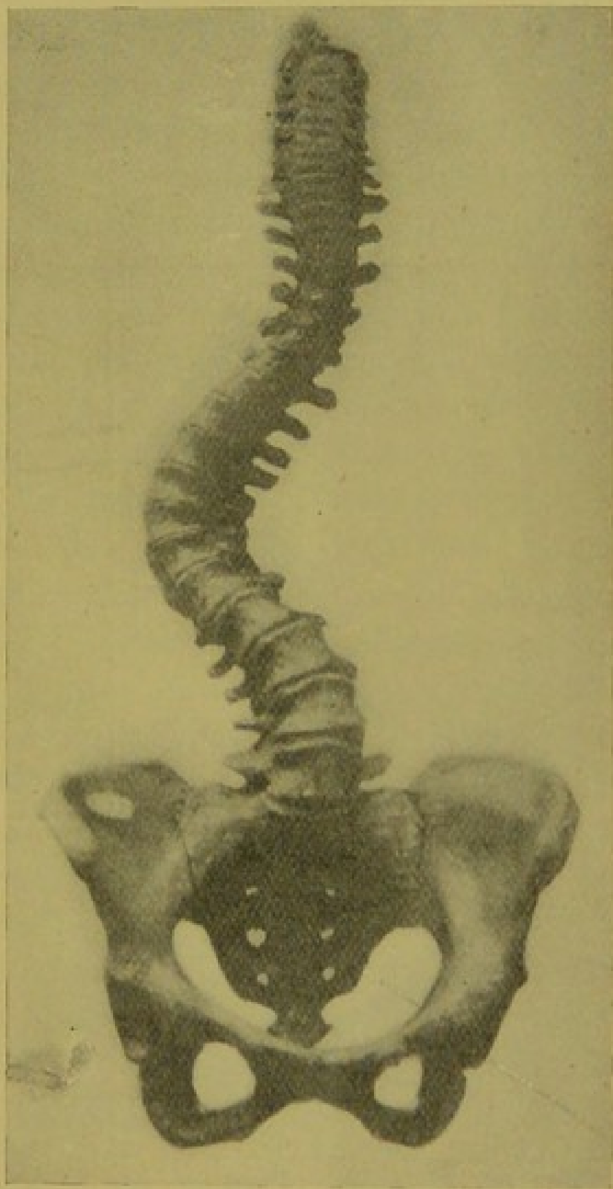


Fig. 191.—Front View of Scoliotic Spine, showing Wedge Shape of Bodies and Rotation. The anterior surface of each body is seen turned towards the side of the convexity of the particular curve in which it takes part. The curvature and rotation affect the sacrum, coccyx, and pelvis.

First, we are constantly told that faulty positions, if habitual, will produce scoliosis. And among the chief agencies which produce these habitually wrong positions, the greatest stress is laid on (1) muscular weakness, (2) inequality in length of the lower limbs, (3) the practice of carrying weights on one shoulder or one arm.

With regard to muscular weakness, it does not exist in a very marked degree at the onset of scoliosis. In many cases it does not exist at all; on the contrary, considerable and even exceptional muscular vigour is occasionally coincident with progressing lateral curvature. And—which is more to the point—it has never yet been shown that such weakness as is sometimes found is not the result rather than the cause of the disease. By 'the disease' I do not mean the deformity, but the essential disorder which possibly exists, and causes both the deformity and the muscular weakness. Moreover, let us remember the countless number of instances of great and prolonged muscular weakness which every one may see absolutely uncomplicated with deformity of the spine. How small is the proportion, even of young people, who, when convalescent from fevers, or whilst exhausted with long chronic illness, or who, from congenital want of vigour, have to crawl feebly through life—how small is the proportion of such in whom true scoliosis may be detected!

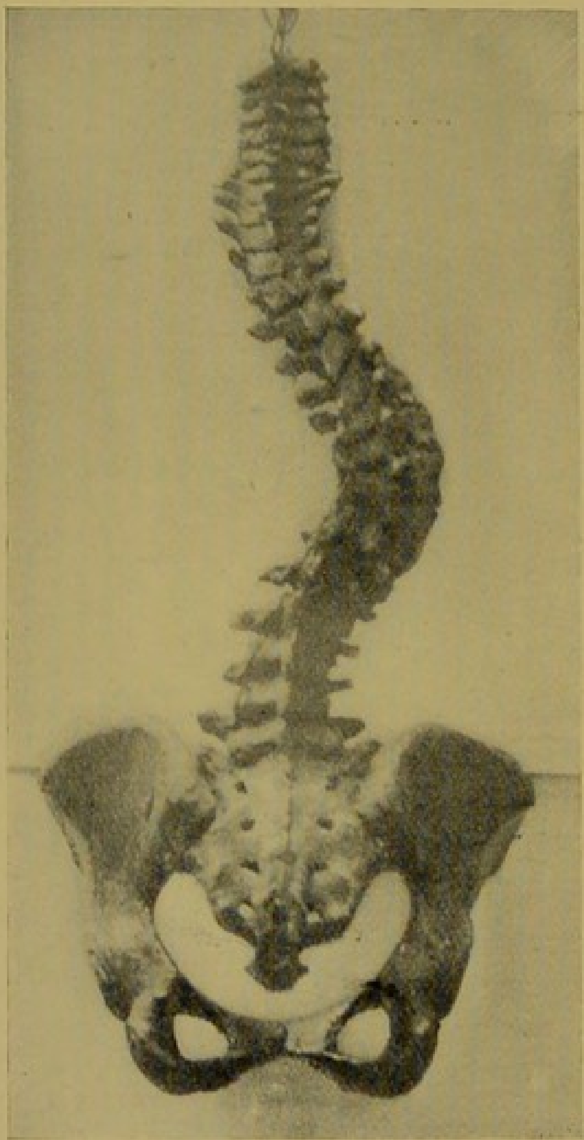


Fig. 192.—Posterior View of the same Spine. Note how much less curved is the line of spinous processes than the column of vertebral bodies. (From the Museum of St. Bartholomew's Hospital.)

Perhaps it may be urged that this is merely because some exciting cause is wanting. But what are the exciting causes most favoured by the musculo-mechanical theorists? They are, inequality in the length of the lower limbs, and habits of lazy or sidelong sitting, standing, and the like.

Now the class of weak young people I have just referred to is crowded with individuals who from hip or knee disease habitually walk, and even sit, with a laterally curved spine ; it is crowded also with persons who are clerks, pupil-teachers, and the like because they are fit for nothing which makes greater demands on the physical strength. It is crowded with seam-stresses and machinists, who habitually sit to one side ; with shop-girls, who are always reaching up to high shelves with the right hand, or standing at ease on one leg.[1] Yet it would be a monstrous and palpable misstatement to say that any but a small minority of these people are scoliotic.

It may be replied, 'Exactly so ; it is only persons who are subject to an excess of the influences in question who get lateral curvature.' This statement is as baseless as the rest. There happens to be a class of so-called 'hysterical' people who will loll all day long, for years, with their backs arched sideways almost to a semicircle, fancying they have lateral curvature, and frequently encouraged in this fancy by mistaken friends and advisers. Often these young women have very weak muscles. But it is the rare exception for anything like genuine scoliosis, with its osseous deformity, to supervene. Now, how could any mere statical arrangement be devised more favourable for putting to the test the theory I am attacking than that a weakly young woman should keep up by the hour, for several years (at least when observed), such a position? Then again, with regard to inequality of the lower limbs, long series of cases come under my observation of persons with only one leg, or with one leg 3, 4, 5, 6, &c., inches shorter than the other, usually from disease, sometimes from congenital peculiarity, and it is exceptional to find one of these with scoliosis. In most of these cases the inequality has existed for years, at the very age at which scoliosis usually develops.

Lastly, with regard to carrying and lifting weights almost exclusively with one arm, who is there who works at all, whether scoliotic or not, who does not use one arm more than the other? When we are told that a certain nursemaid con-

[1] Both these postures are frequently blamed as 'causes' of scoliosis.

tracted lateral curvature from always carrying the child on one arm, let us ask ourselves, Have we any reason whatever to assert or think that non-scoliotic nursemaids are free from any partiality for one arm or the other? How many young black-

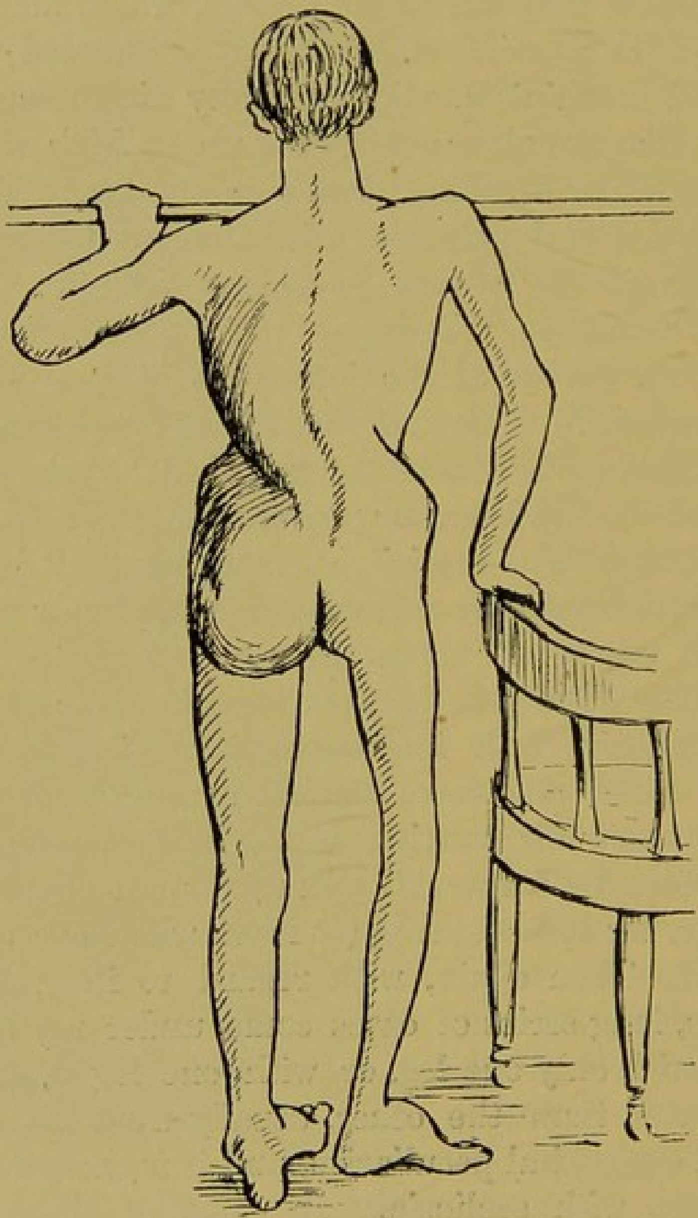


FIG. 193.—LATERAL CURVATURE FROM HEMIPLEGIA; CONCAVITY TOWARDS THE PARALYSED SIDE.

smiths become scoliotic from using, as they do, the small hammer almost exclusively with the right hand? It has been said that their muscular development protects them. But it does not protect them from knock-knee and flat-foot. And, indeed, they do occasionally have lateral curvature, like other people, but only like other people. Let us remember also, that the young women who form the largest proportion of scoliotics are not given to using either arm very much.

Secondly, lateral curvature has been attributed to an absence of balance between the strength of the muscles acting on opposite sides of the spine. Now, in an ordinary case, the most careful examination will fail to detect any sign of such an inequality. And, moreover, in the rare cases where such an inequality undoubtedly exists, namely, in cases of hemiplegia, it is not usual for lateral curvature to supervene; or it may supervene, but in the opposite direction to that in which it should occur according to this, the so-called 'antagonistic theory' (fig. 193). Moreover, although it is impossible to find any noticeable asymmetry as regards the muscular strength of the trunk, we may (as the parts of the body are scarcely ever perfectly symmetrical) be sure that some degree is almost always present in non-scoliotic as well as scoliotic persons.

In short, no mere mechanical or muscular theory will account for scoliosis as we ordinarily meet with it. We must not allow ourselves to be misled by any teaching of the kind, if we are ever to get at the true etiology and pathology of the disease.

Upon reflection we are struck with several facts which may not improbably have, individually or collectively, an important bearing on the question. In the first place, the deformity begins almost always either during early childhood, or between the ages of eight and sixteen or seventeen. In the former case its rachitic origin is undoubted. In the latter case it commences at a time of life marked by the approach or onset of puberty. The very great majority of the persons attacked are females. Putting aside for the moment the difficult question of the real or imagined relations between syphilis and rickets, the latter may be described as a disease of nutrition and growth, especially of the nutrition and growth of the osseous system. It will be granted also that the nature and amount of the food have a great influence on the course of rickets, even if faults in the matter of diet are not wholly responsible for its onset. I am not acquainted with any inquiry, if such has ever been made, into the dietetic habits of adolescents with lateral curvature.

It would be worth making, though perhaps difficult. Young girls of the upper and middle classes, who furnish so large a relative proportion of scoliotics, are certainly given, for æsthetic and fashionable reasons, to playing tricks with their diet, to eating irregularly, even if not insufficiently, and especially to the avoidance of what they are pleased to consider coarse feeding. It is not impossible that in their anxiety about their skins they may unwittingly starve their bones. It is not, however, necessary to detect error in what actually enters the stomachs of adolescent scoliotics. Nutrition being a very compound function, it may be said that not only is there many a slip 'twixt the cup and the lip, but there are many more between the lip and the blood. Now, a disordered nervous, especially a troubled vaso-motor, system is particularly likely to cause slips of the latter kind; that is to say, to prevent even the best of food from building up sound blood, bone, and other tissues. Puberty and the few years which precede and follow it constitute the time of all others when such nutritive disorders, such nervous troubles, are rife. They show themselves superficially in the form of cold extremities, of chilblains, of acne-covered faces and backs, of lustreless hair, of wet palms and soles, of chlorosis, and of some of the well-known signs of mental and spiritual discomfort characteristic of the hobbledehoy and of the bread-and-butter miss.

I am speaking of these as 'superficial' symptoms; but they are obviously significant of profounder changes. When the gums are chlorotic, the lungs are not less so. When the circulation in the feet swerves, at the slightest provocation, from the even tenor of its way, it may be just as irresolute in the liver or the kidneys.

All this points to the probability of disordered nutrition of the bones—the parts primarily affected in true scoliosis—being of the very essence of the disease.

But, having got so far, we are still far indeed from a complete knowledge. Why do only a limited number of wrongly fed infants get rickets? Why do only a small proportion of young people at or near puberty suffer from disordered nutrition of the bones?

The whole answer to these questions has yet to be worked out. Various guesses have been made, but mere guesses they still remain. It would be strange if masturbation, the universal scapegoat for the pathological errors of adolescence, had not been pitched upon. Accordingly, we find that one eminent surgeon has scarcely a doubt upon the point. In his eyes the knock-knee and the scoliotic back appearing about puberty are almost as pathognomonic as the shamefaced glance, the dull eye, the spiritless manner, and the other little signs that together make up a picture which, it cannot be denied, all who run may read. But when one comes to examine either this surgeon's argument or Dr. Moxon's paper, to which he refers us, we see that it is but guessing again, and that all the difficulties of a most difficult question are simply evaded. For instance, let each of my readers run over in his own mind the number of persons whom he *knows* to have been guilty of self-abuse, and then ask himself how many have lateral curvature or knock-knee. As I write this I pause and, without an effort, recall a number who have confessed to an excessive addiction to the practice throughout youth, and every one is straight in trunk and limb, excepting a case or two of slight kyphosis. But we believe that the vice in question is even more common among the poor than among the rich, and quite as common among young boys as among young girls. How do these facts and beliefs fall in with the proportionate liability of these classes to scoliosis? Nevertheless, the mere fact that a grave vice, well known to be capable of seriously impairing nutrition, is most common at the age at which the rickets of adolescents occurs, is to be well remembered in the study of the affection. A cause may be a true cause, and yet act only exceptionally. For instance, masturbation is an undoubted cause of insanity, but only in the case of a small proportion of offenders. On the other hand, lateral curvature is frequently seen commencing in young people with frank, innocent, bright looks, practically beyond suspicion. Many such are not more than eight, ten, or twelve years of age.

A considerable proportion of young patients with scoliosis show signs of chronic obstruction to respiration, especially of post-nasal obstruction, due to adenoid growths. The pigeon-breast and anterior transverse thoracic depression arising from such influences are well known, as well as the high shoulders and upper dorsal kyphosis which sometimes follow. It is perhaps the exception rather than the rule for upper dorsal kyphosis to be laterally symmetrical, except when arising from caries. And of course lateral asymmetry of a spinal curve means scoliosis.

Scoliosis complicating kyphosis means that one lateral half of the column of vertebral bodies has yielded more than the other. It is exactly analogous to what is seen (very often, in knock-knee, in-ankle, and flat-foot) when the knees, ankles, and feet of the two sides are not symmetrically deformed.

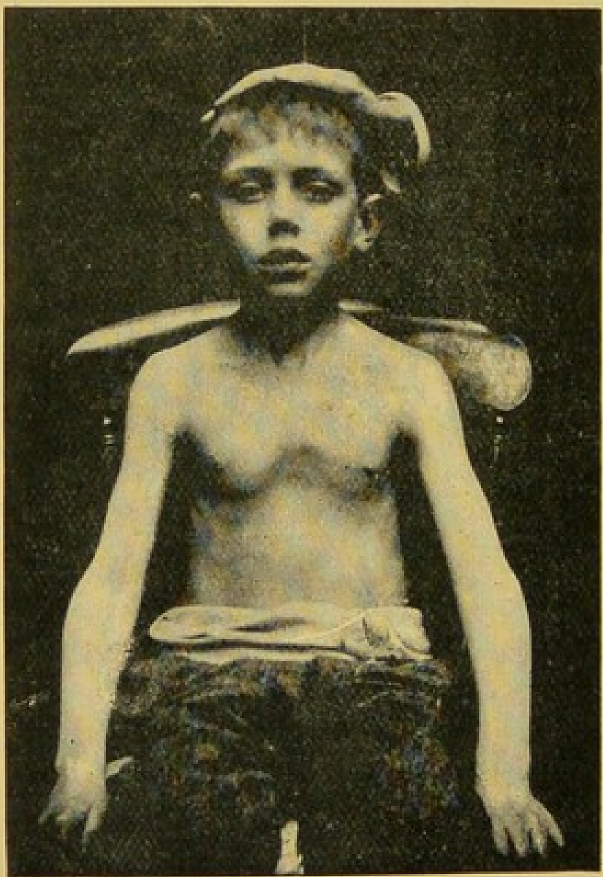


Fig. 194.—Chest Constriction secondary to Nasal Obstruction.

The frequency with which a certain degree of lateral curvature and high dorsal kyphosis is seen in conjunction with chlorosis and with signs of ulcer of the stomach in young women may also be noted.

To sum up, the essential nature and causes of scoliosis are not known with certainty, and invite inquiry. But facts point very strongly towards the probability of a disturbed nutrition of the ossifying cartilages and of the bones of the spine being a necessary factor in the production; and this disturbed nutrition is not secondary to any such coarse mechanical influence as, for example, a habit of sitting or standing with the spine arched sideways.

Next we have to ask ourselves, Do such mechanical influences as those I have just mentioned play any part in the etiology, and, if they do, *what* part ?

Once again let us try to realise how utterly unscientific is the practice of saying, 'So-and-so used to carry a heavy bag with one hand, or to regularly practise on the violin, and *consequently* he got a lateral curvature of the spine.' How surgeons can talk and write like this when any evening they may, if in London, go to a theatre and see a dozen straight-backed musicians, who have all fiddled away for their daily bread from their boyhood upwards, is really astonishing.

But this slipshod style of inference is not necessary to prove that statical forces do almost certainly play a part in the causation of scoliosis. In almost every instance of this deformity there is more than one curve in the spine. And *the successive curves alternate.* Now, if the affection were purely one of defective nutrition, or other form of tissue disease, it would be in the highest degree unlikely that the vertebræ most affected, most altered in shape, would always be found to occur in alternating sets, thinned first on the left side, then on the right, and so on. We seek in vain for any anatomical facts to explain the regular alternation ; and when it is remembered that the positions of the different curves vary almost infinitely in different cases, it is clear that such anatomical explanation is not very likely to be possible. On the other hand, the statics of the spine give a reason at once ready, satisfactory, and not inconsistent with what else is known about the matter. We shall return to this subject when writing of secondary or 'compensatory' curves.

Now comes the question, *What* part do statical forces play ? Do they deserve to rank with the rachitic affection itself ? Are they more important or quite subordinate ? This question has a distinct bearing on practice, as we shall see by-and-by.

I am scarcely inclined to go with Professor Busch, of Berlin, and other German surgeons, who write of the rachitis as a mere predisponent, and of the statical or 'pressure' forces as the causes ; the latter are so common—in fact they are universally existent in some degree—and yet it is so seldom that they produce scoliosis. On the other hand, does rachitis of the adolescent spine ever exist without causing scoliosis? That is a difficult question to answer in the negative, but it is enough for my argument that it is equally difficult to answer in the affirmative.

When an ill-made pudding goes to pieces we do not blame the universal force of gravity; we fix our attention on the faulty preparation of the pudding.

That statics play a part in determining the direction of each curve may be regarded as certain; that they play a part in fixing the position of the centre of each curve is almost equally certain; that they have a great deal to do with regulating the intensity of each curve is possible, but by no means certain.

Before passing to simple anatomical description a few other points should be noticed bearing on etiology. I have mentioned already the *ages* at which scoliosis usually supervenes, namely: (1) early childhood, first to fourth or fifth year; (2) eighth to fourteenth year or later; (3) after the fiftieth year. The last class of cases rarely actually originate in advanced life; but they may have been stationary throughout the prime of life, and in old age commence to get worse. Such cases are usually complicated with kyphosis, sometimes to a very marked degree.

With regard to *sex*, in early childhood the proportions are about equal. In adolescence the females greatly outnumber the males (five or six to one). This fact suggests a relationship of the cause of scoliosis to the sexual changes about this period, far more impressive in the female than in the male organism. On the other hand, it does *not* suggest a special connection between scoliosis and moral vice of a certain kind.

It is not uncommon to find more than one case of scoliosis in the same family. I occasionally see three sisters, all scoliotic, each with a considerable degree of kyphosis. There appears, therefore, to be at least an occasional hereditary, direct or indirect, tendency to scoliosis. By 'indirect' I mean, *e.g.*, a tendency which acts through the influence of post-nasal growths or chronic ulcer of the stomach.

Cases of scoliosis occur in which the *mechanical origin* is beyond doubt; but they are rare, and such as I have seen present marked differences from ordinary scoliosis. Among such mechanical causes are cicatricial bands, injuries to the spine, the pressure of tumours, and contraction of one side of the thorax consequent on empyema. I know personally of no case of lateral deformity of the spine due to any of these causes, except cicatricial contraction after burns of the neck and lateral curvature after empyema. Even when powerful mechanical influences, such as the above, act, the deformity only exceptionally assumes a form similar to that of true scoliosis.

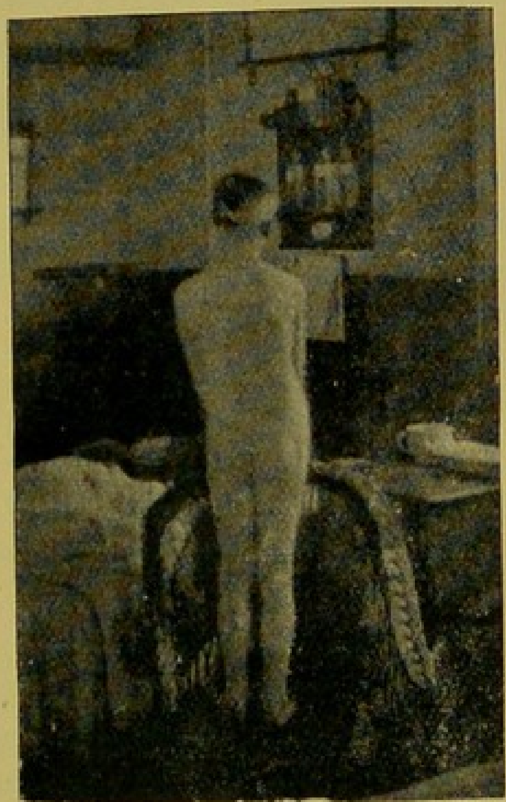


FIG. 195.—LATERAL INCLINATION OF SPINE Position retained for months by boy with incipient disease of left hip-joint. There was no shortening or ankylosis. or even roughness of the joint when moved.

Lateral inclination of the spine, starting at the point of disease, is not uncommon in cases of caries, especially lumbar caries.

The statical inclinations which play a certain though limited part in the etiology of scoliosis may be referred to two classes of influences, namely (A) those which disturb directly the equilibrium of the body above the pelvis, and (B) those which directly raise or lower one side of the pelvis above or below the other. Class A includes the loss of one arm, inequality of the arms, paralysis of one arm (causing it to hang like a dead weight), alteration in the size of one or more of the viscera, and development of a tumour laterally. Class B is for practical purposes confined to deformities, deficiencies, &c., of the lower limb or limbs. It includes amputations, dislocations, permanent flexions, ankyloses, arrested development, club-foot, paralyses, unsymmetrical rachitic curves, and the like.

Before leaving this subject I should like to mention that scoliosis occurs in animals, such as the horse, which walk on all-fours, and also in fishes. A scoliotic goldfish was to be seen swimming in a bowl for some years in 'Accident' Ward at the West London.

Cases have been recorded in which scoliosis appeared to have had a rheumatic origin.

Among *attitudes* and *actions* favourable to the development of scoliosis have been enumerated carrying weights always on one arm, working excessively with one arm or one leg, harp-playing, fiddling, embroidering and sewing with machines, writing and drawing. I hope that the appeal which I have already made to my reader's common sense will have prepared him to endorse what Bouvier and Bouland have to say about these occupations: 'The influence of these on young girls has been much exaggerated. It is only in particular cases, and when they have been pushed to extremes, that they appear to really concur in the production of scoliosis.' Mark the caution of the expression: 'they *appear* to really *concur* in the production,' not 'they produce.'

The Causes of Rotation in Scoliosis

The peculiar shape of the scoliotic spine is almost entirely the sum of changes in its component vertebræ. It is only in a small degree the result of changes in the ligaments and articulations. What are the changes in an individual vertebra? They are greatest in a certain very small number, chiefly those at or near the centre of each curve. They have been many times described; for example, by Bouvier, by Nicoladoni, and by Lorenz, the last two authorities having in their minds during the description each a special theory to account for the 'rotation.'

If we look at the front of a vertebra chosen from the centre of a curve with convexity to the right, we should expect to find the outline of its body wedge-shaped, with the apex towards the concavity of the spinal curve, and more or less marked with a horizontal groove on the left side, as if the force of growth, having been checked perpendicularly, had spread laterally, so as to form two lips. If the same vertebra be viewed from behind, it will probably be found that, although not strictly symmetrical, especially as regards the articular processes, the wedge shape is not at all pronounced, and may even be not discoverable except by measurement. If, now, a third view be taken of the vertebra—viz., from above—it will, if at all a typical case, be seen to be strangely 'slewed,' as it were, in such a manner that the posterior segment of the vertebra, including the pedicles, the transverse processes, the laminæ, and the spinous processes, appear to have struggled to retain their normal relations and positions in the particular human frame to which they belong, while the body of the vertebra has been equally determined to deviate to the right. 'Struggle' is, in one respect at least, a good word, because it suggests a certain amount of confusion, such as might produce the minor varieties in the pathological anatomy of such bones as I am describing. But the chief peculiarities are both orderly and almost uniform.

If it be granted that the prime cause of scoliosis is, in young children, ordinary rickets, and in older ones and in youths 'rachitis adolescentium,' it cannot be forgotten that in rickets it is at the so-called 'epiphysial' cartilages that the greatest abnormality of growth, leading to the major part of each rachitic deformity, takes place. Now the epiphysial cartilages of the vertebral body are placed above and below the main bony masses, but the cartilages of growth of the transverse processes and the spinous process, and in fact of the whole segment of the vertebra posterior to its body, are placed horizontally with regard to one another. Hence rachitic deformity would have a much greater tendency to produce lateral inclination in a vertebral body than in the more posterior constituents of the vertebra. Further, the external projection of the transverse and articular processes gives them an increased mechanical power, like that of buttresses and of cross-trees, to check a tendency to lateral inclination. On the other hand, the comparative thinness from side to side of the pedicles, arches, and spinous processes offers diminished resistance to horizontal 'slewing' of those parts. *Therefore, the fact that the layers of cartilage of* *growth or epiphysial cartilages above and below each vertebral body do not extend backwards to the posterior parts of the vertebra is the prime cause of torsion*, and the arrangements of the cartilage of growth of the pedicles, transverse and spinous processes, together with their shape, greatly contribute to the production of torsion by facilitating 'slewing' of these parts in a horizontal direction. Lorenz finds the cause of torsion in the existence of the cartilage of growth in each side of the posterior part of the vertebral body, near the base of the corresponding pedicle. I cannot see how it can possibly *cause* the torsion, although it may assist in permitting it by weakening the power of resistance in the bond between the anterior and posterior elements of each vertebra. It is, therefore, a noteworthy fact that near the junction of the anterior with the posterior segment of each vertebra there is a cartilage of growth which is, like others of its kind, no doubt specially sensitive to rachitic influences. But I maintain that unless the vertebral bodies had their principal cartilages of growth placed above and below them, they would have no more tendency to lateral curvature than the rest of the vertebræ, and therefore the action of the pedicle cartilage would not come into play.

The *etiology of congenital scoliosis* is quite special, and all the above remarks apply to it little, if at all. It is associated with other grave defects constituting a peculiar kind of monstrosity.

Symptomatology.—To accurately judge the nature and amount of any case of scoliosis, and to diagnose a doubtful case, the patient's back should be unclothed down to the level of the top of the sacrum, so that the hips and waist, as well as the shoulders and chest, may be clearly seen. The commonest of all the many different varieties of this deformity is that in which the dorsal region presents a curve with convexity to the right; and a well-marked instance of this variety may be chosen as a type. Upon referring to fig. 196 the line of spinous processes will be seen forming a marked dorsal curve with convexity to the right, a slighter lumbar or dorso-lumbar curve with left convexity, and a still slighter cervical or dorso-cervical curve, also with left convexity.

To the right of the dorsal curve the ribs bulge backwards to form the costal gibbosity. This descends lower than the curve of the line of dorsal spines, a circumstance which tends to obliterate the waist on that side.

On the left, just below the scapula, is a deep depression, where the thorax seems to, as it were, sink away from the

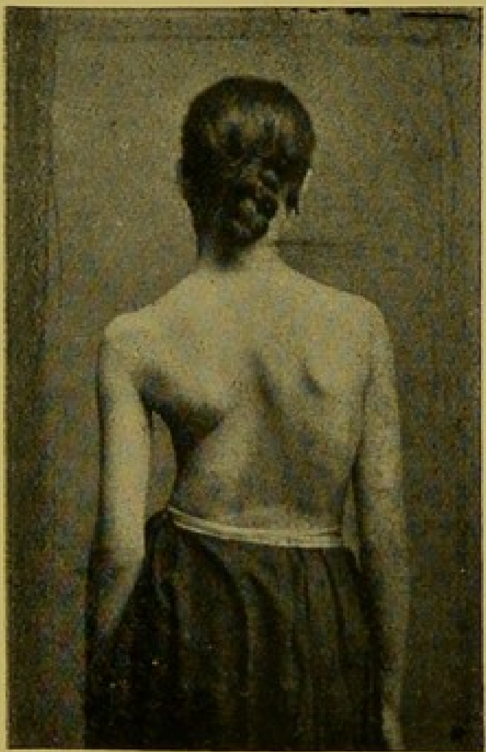


FIG. 196.—A VERY COMMON VARIETY OF SCOLIOSIS, having the dominant curve in the dorsal region, with its convexity to the right.

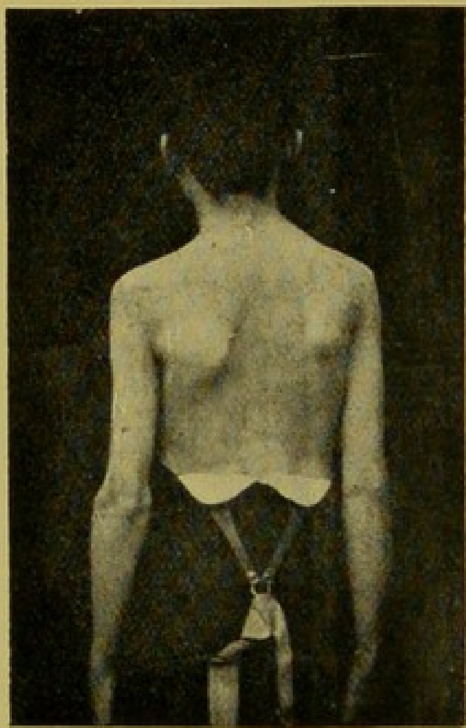


FIG. 197.—BOY WITH HIGH DORSAL DOMINANT CURVE.

arm and shoulder. It resembles somewhat an oblique groove descending downwards and forwards.

Below it there is a lumbar gibbosity corresponding to the convexity of the lumbar curve, but not nearly so prominent as the dorsal gibbosity on the opposite side, already described.

With regard to the two hips, the left is very prominent, owing to the depression above, while the right is just the opposite, owing to the dorsal gibbosity, which, as before said, descends low.

Consequently the waist, obliterated on the right side, is higher than normal on the left.

The shoulders are not at the same horizontal level; for the changes in the spine and ribs push the right one up and allow the left to droop. A general inclination to the left is seen at the dorso-cervical level.

A vertical from the right axilla falls even beyond the right hip, while one from the left falls well within the corresponding hip.

Upon looking at the patient in front, of course the same alterations in the general outline are visible as those seen from behind.

The left breast and the thoracic wall on the left side are prominent. The right nipple is farther than the left from the umbilicus, probably about half an inch, more or less. The rotation of the trunk is often very apparent, the transverse plane of one part not coinciding with that of another. This is best seen by looking down from above the patient's head.

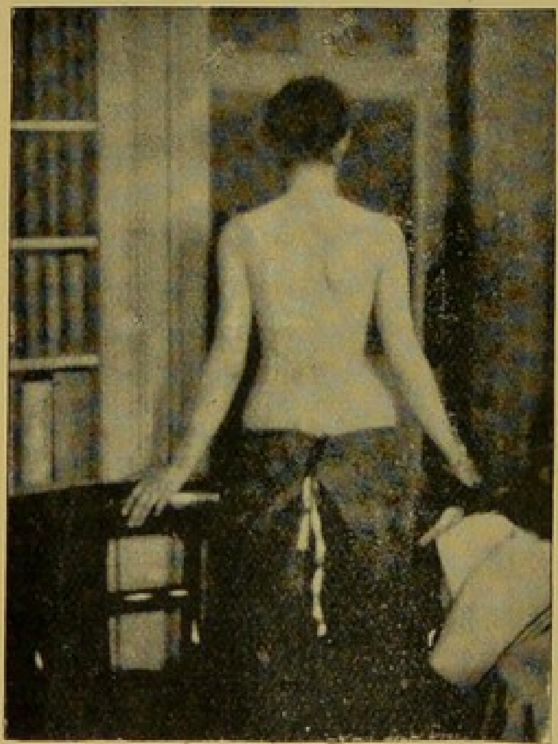


FIG. 198.—A VARIETY OF SCOLIOSIS in which the shoulders are practically at the same horizontal level, the back nearly flat, and the line of spinous processes not much curved, but the unsymmetrical outline of the flanks very noticeable. The curves are mainly in the lumbar and lower dorsal region, and compensate each other very correctly. A favourable case for treatment.

Such is a typical case of true lateral curvature of the spine, or scoliosis; and he must indeed be a novice who cannot recognise such a case at a glance. But in its incipient stage even this case might present difficulties in diagnosis.

In the *incipient stage* the line of spinous processes is straight, or nearly so, even when the line of the bodies of the vertebræ is decidedly curved. The reason of this has been explained under the head of Pathology, and it has also been shown how this disproportion between the degree of curvature of the lines of spines and bodies is necessarily accompanied by torsion, also above described. Now, *as soon as ever scoliosis can be diagnosed at all, the signs of this torsion, and consequently of curvature of the line of vertebral bodies, are recognisable.* One of the very first alterations visible, when the surgeon makes a careful inspection from behind, is a slight rise in the level of the waist on one side and a slight tendency towards obliteration on the other. An exceedingly small alteration of this kind can be recognised by the practised eye. Fig. 201 is a photograph from a case not quite incipient, but still with the line of vertebral spinous processes almost straight and the shoulders nearly square. Note how manifestly unsymmetrical are the outlines of the two flanks in the way I have just described, although the spinal line is all but quite straight.

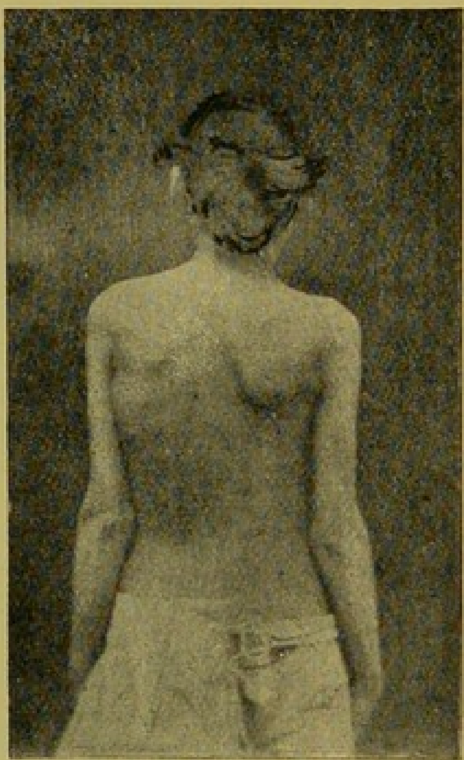


Fig. 199.—Scoliosis with Principal Curve Dorsal and to the Left (compare with the more usual variety, fig. 196).

Again, the scapulæ are seldom quite at the same level. Any straight article held perfectly horizontally across the back at the level of one inferior scapular angle will be either above or below the other. Usually the shoulder on the side on which the waist is heightened and the hip prominent is the lower.

What first attracts the attention of the patient's mother or friends is generally the rise of one shoulder or the increased prominence of one hip. Sometimes it is the comparative prominence of one breast, usually the left; also a sign of torsion, as already explained. More rarely it is the apparent projection away from the thorax of the inferior angle of the scapula, on the side on which the shoulder is low and the waist high.

Only the initiated have even a suspicion that the spine is deformed.

Contrast this with the appearance of a so-called case of 'severe lateral curvature' in which osseous deformity has not yet commenced to show itself. I find it difficult to write with patience about the inexcusable error of describing such a sham case as one in the first stage of true lateral curvature, or scoliosis. When I hear of 'a case of lateral curvature, severe

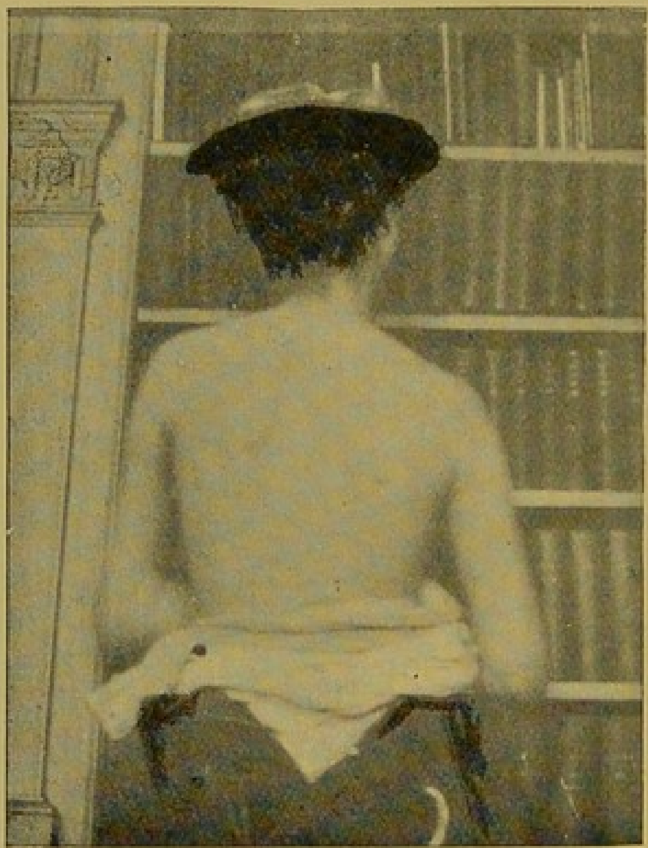


Fig. 200.—Similar to the last figure, but the subject is older and better nourished. Although the dominant curve is in these cases dorsal and to the left, this curve differs by its great length from what is seen in the scoliosis usual in young rachitic children.

but without osseous deformity,' being cured, I am reminded of the bones 'out of joint' which the bone-setters reduce with a click.

Combined with the curvation due to the anatomical changes in the spine there is, in each case of scoliosis, excepting those advanced ones in which ankylosis has taken place, an element of simple flexion, due to gravity, which, when the patient is erect, of course tends to aggravate the curves. This element of flexion disappears when the patient is horizontal, and it is also removed by the patient's bowing forward as far as possible, with the knees straight, and when the patient is partially suspended by the head, as in applying a Sayre's jacket. But the bent forward posture, while it will

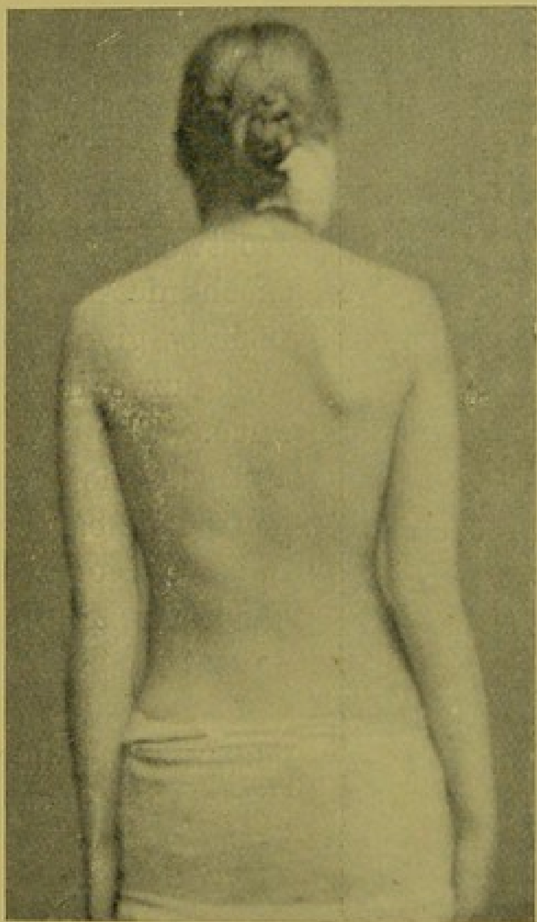


FIG. 201.—SLIGHT SCOLIOSIS. This is a typical example of the changes commonly seen in an early stage of scoliosis. The line of spinous processes is nearly straight. It is not well shown in the illustration. But evidence that the line of vertebral bodies is more curved is supplied by the signs of rotation, viz.: (1) the unsymmetrical flanks, (2) the lower dorsal or dorso-lumbar boss on the left side, (3) the upper dorsal boss, beneath the scapula, on the right side.

undo most spurious flexions, especially if the patient be resolutely and skilfully managed by the surgeon, will sometimes add to a genuine curvature a further flexion not existent even in the erect posture. And partial suspension not only undoes the flexion caused by gravity, but hides much of the actual osseous deformity, by producing in each intervertebral ligament a tension on the side of the concavity of the curve.

But, as a rule, the greater the alteration produced by a change from the ordinary erect position to a horizontal one, or to a position of suspension, the greater is the element of flexion in the case, as distinguished from curvature due directly to osseous changes.

With regard to the question of which curve is the first to appear, the dorsal or the lumbar, there has been much difference of opinion, a good deal of bold assertion, and very little trustworthy observation. The mechanico-muscular theorists usually give the lumbar as the first curve in order of appearance. The whole affair is so simple—one leg shorter than the other, lumbar curve to preserve balance, dorsal curve to bring shoulders, &c., into position, and so on!

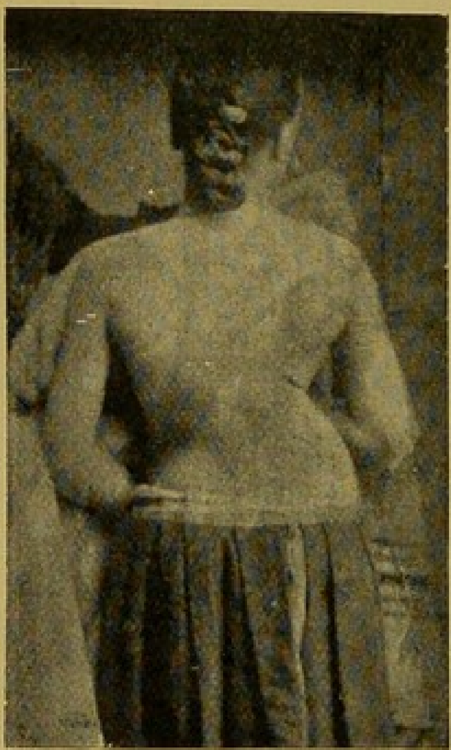


Fig. 202.—A very Severe Case of the same type of Scoliosis as the last figure.

Now, it is the rarest thing in the world to be able to trace the addition of a second curve in a case in which a first curve has been already observed to exist alone. Probably one does follow the other in most cases; but it is in very quick sequence indeed.

The dorsal curve is generally more marked than the lumbar, even in the earlier stage of scoliosis, and this suggests that it is likely to have commenced earlier in such cases. When, on the other hand, the lumbar curve predominates (as regards intensity), in other words is the 'dominant' one, the chances are in favour of the lumbar curve having appeared first.

The narrowness of the bodies of the dorsal vertebræ predisposes them to yield to the causes of scoliosis; and the ribs do not protect them at all as might possibly be imagined, for, within certain limits, the ribs move up and down freely. They therefore offer no obstacle whatever to the *commencement* of a dorsal scoliotic curve; and when such a curve has progressed, whatever obstacle they may oppose to its further

FIG. 203.—The principal curves in this figure are lumbar and lumbo-dorsal, the shoulders nearly level, and the back nearly flat.

advance is overcome in such a way as to produce the gibbosity.

On the other hand, the lumbar vertebræ, comparatively mobile as regards *extent* of lateral movement, oppose by reason of their breadth a certain resistance to the quick action of rachitis, either of childhood or adolescence.

An almost endless number of different varieties of scoliosis could be made out, all, however, gliding into one another, so as to interfere greatly with the definition of the said varieties. But a few of the chief kinds deserve special notice.

The *left dorsal principal—i.e.* scoliosis with the principal curve in the dorsal region and the convexity of that curve towards the patient's left—is most common in early childhood, and has been noticed under the head of rickety scoliosis. It occurs also in a small proportion of cases which have commenced at the period of adolescence.

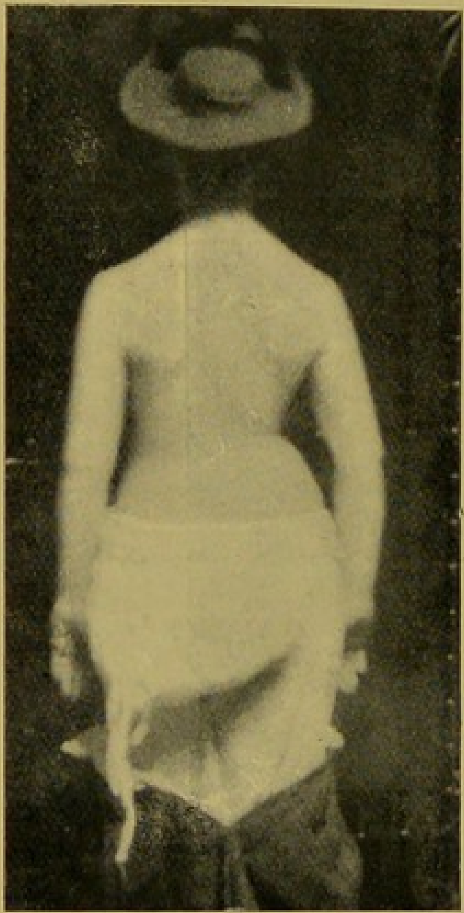


Fig. 204.—Left Lumbo-dorsal Principal Curve, but with a well-marked right upper dorsal curve, with great lumbar lordosis and considerable dorsal kyphosis.

The *left lumbar principal* has a predominant lumbar curve. This curve has its convexity to the left, as in the commonest variety of scoliosis. But in the latter the dorsal curve is dominant, and in the former the lumbar. Compare together figs. 203 and 196.

Occasionally, when the dorsal curve has a left convexity, the lumbar curve (with a right convexity) is dominant. Sometimes, indeed frequently in slight cases of scoliosis, the dorsal and lumbar curves are about equal.

As lumbar curves become large and dominant they encroach more and more upon the lower dorsal region.

Subjective and Functional Symptoms.—These vary with the stage of the disease.

The commencement of the affection is often quite insidious; but it is frequently attended by pain in the back, not necessarily in the spine, sometimes near one shoulder-blade. It is not at all clear what is the connection between the pain and the scoliosis. Similar pains are occasionally felt at the commencement of a genu valgum.

Frequently an incipient scoliosis is associated with disturbances in the genito-urinary system, such as disordered menstruation. According to Clement Lucas, the urine is frequently albuminous in such cases.

Scolioses of extreme severity may interfere seriously with many of the chief organs and functions—respiration, circulation, digestion, innervation, and probably even the intellect and character.

Respiration is disturbed in consequence of the cavity of the thorax being diminished in size and altered in shape, while the natural mobility of the ribs and diaphragm is impaired by the anatomical alterations. There is shortness of breath, readily noticed in very severe cases, and a disposition to bronchial and pulmonary congestions, but not to tuberculosis. But such symptoms in scoliotics are far more commonly due to post-nasal growths, or even to asthma, than to the spinal curvature.

The presence of the bodies of the vertebræ close beneath the ribs on the side of the convexity of a severe dorsal curve may be detected by their causing dulness on heavy percussion. The respiratory murmur gets weak or even disappears altogether in the gibbosity, but is normal on the opposite side of the thorax and in front.

Circulation is affected, probably rather indirectly through the disturbed respiration than through any direct mechanical interference with or pressure upon the heart. There are palpitations, irregularities of the pulse, and sometimes liability to faint.

The heart impulse is usually more superficial and extensive than normal.

Digestive troubles are frequent both in the first and last stages of scoliosis, though probably from different causes. Those of the first stage may be connected with the actual origin of the malady; those of the last stage secondary to the circulatory and respiratory troubles. Chlorosis and ulcer of the stomach have already been mentioned as possible factors in the causation of certain cases of scoliosis.

Nutrition is impaired in advanced cases.

With regard to the nervous system, the spinal cord seems generally, if not always, to escape from any direct interference or pressure. But cases have been recorded of more or less paralysis, apparently due to the spinal deformity.

Pains, usually described as neuralgic, are frequent. They may possibly be caused by compression of the intercostal nerves as they leave the spinal canal. Sometimes they seem clearly connected with the pressure of the lower ribs down inside the crests of the ilia, and are relieved by measures to take off that pressure.

With regard to the intellect, scoliosis, like many of the disabling affections of youth, predisposes to the society of books and people older than the sufferers themselves, and is hence sometimes favourable to mental development.

Upon the character, deformity has, in all ages, been known to leave its mark. What that mark may be—whether one of sadness, or of malignity, or cheerful endurance, or otherwise—depends upon the original disposition, upon the treatment and consideration shown to the sufferer by the people among whom he lives and moves, and, doubtless, upon the other various influences which collectively mould each human being into what he is.

The voice is usually more or less weak.

Gestation and labour may be interfered with to a serious or even fatal degree when the mother suffers from rachitic scoliosis, which is so frequently complicated with deformed pelvis. But it is very rare indeed for lateral curvature commencing at a later period to cause any such troubles, even though the lumbar spine may be badly deformed.

Diagnosis.—True lateral curvature of the spine, or scoliosis, has to be distinguished from (1) mere flexions simulating it, and (2) Pott's curvature. The bosses, &c., produced by the affection have also been occasionally mistaken by the careless or the inexperienced for tumours or local hypertrophies.

Diagnosis from *mere flexions simulating scoliosis.*—There are three distinct varieties of these, namely (1) flexions compensatory to obliquity of the pelvis, caused by a short leg or some similar influence; (2) reflex flexions; (3) flexions caused by wilful and conscious malingering. The so-called 'hysterical' or 'neuromimetic' cases are probably mixtures, in varying proportions, of the last two elements.

There are three points in which flexions in general tend to contrast with the curves of a scoliosis. In the first place, the favourite centre of mere flexions is the point of union of the dorsal and lumbar regions, a somewhat unusual centre for a scoliotic curve. In the second place, mere flexions are usually much longer, involving more vertebræ than an individual curve of a scoliosis. In the third place, flexions, unless very slight, produce more marked folds of skin in the concavity, scoliosis as a rule not being attended with such folds. Though these distinctions are not individually absolute, they go collectively for a great deal.

(1) Flexions compensatory to obliquity of the pelvis disappear as soon as the pelvis is made horizontal by, *e.g.*, placing books of a proper height beneath the sole of a short leg. In some cases such flexions lead to a certain amount of osseous deformity, which persists; but this is quite exceptional. The observer must not confound the want of symmetry in muscular and osseous development which may exist, even in the loins of a patient suffering from a weak and short leg, possibly ankylosed at the hip or knee, with the asymmetry of scoliosis.

There are also old cases of paralysis and of hip disease in which it is quite impossible by raising one heel or by anything short of a surgical operation to get the pelvis into a normal position. But in such cases the pelvis can be got into various positions which, if not quite normal, are yet sufficient to make the spine demonstrate by its alterations of position and apparent shape that it is not scoliotic. If such a patient be made to lie flat on his belly and chest on a couch, with his thigh over the edge, should a hip be contracted or ankylosed, the spine can be placed by the surgeon in a normal position. It must be remembered that the buttock and even os innominatum of the lame side may be more or less atrophied.

(2) Reflex flexions.—Unquestionable cases of this kind are not common. They are marked by the obvious presence of an exciting cause, *e.g.* severe rheumatic pain in one loin. They can be relieved by removing the cause, and are usually

comparatively severe flexions which have come on more or less suddenly. *One form* is that which sometimes complicates *sciatica*.

(3) Sham flexions—Malingering.—A genuine scoliotic, unless also hysterical or having a short leg, can usually, without difficulty, be got to stand with both knees straight. A malingerer wilfully bends one knee, and finds it difficult to preserve the character and extent of his or her spinal flexion when compelled to straighten both knees and keep both heels flat on the ground. The characteristic differences between true scoliotic curves and flexions in general, given above, are present. When the patient is laid flat on the face, and persevering attempts are made to straighten the back, wilful attempts to reproduce it can often be detected. The signs of torsion are absent. A probable motive can sometimes be discovered.

Neuromimetic cases present the signs of sham flexions above noticed, and may be diagnosed much in the same way. Though they may persist for years, they usually commence in young women at an older age than that at which true scoliosis commonly begins. The amount of apparent deformity is usually out of all proportion to the duration of the case, if it is seen early, and contrasts strongly with the absence of signs of torsion. Many of the sufferers have a characteristic look—a kind of languishing, woe-begone appearance.

Whether malingering or neuromimesis be suspected, the patient's spine and figure should be carefully examined as he or she bends well forward with the knees straight and the heels together.

Diagnosis *from Pott's curvature.*—Ordinary cases can present no difficulty; but there are (1) severe cases of scoliosis with a more or less sharp angular curve in one spot; (2) cases of slight scoliosis with one or two unusually prominent spinous processes; (3) cases of caries of the spine accompanied by a lateral flexion; (4) cases of lateral curvature actually coexistent with caries of the spine.

The first class of cases, being severe, present the characteristic features of scoliosis in a marked manner—the gibbosity, the unsymmetrical waist, &c. Such cases as I have seen have usually had the spurious Pott's curvature high up in the dorsal region. On the other hand, there is a total want of the ordinary collateral symptoms, some of which would certainly be present in a true case of caries of such severity.

The cases of slight scoliosis with one or two prominent vertebræ may present some difficulty. But the spine has lost none of its normal mobility at the suspicious-looking locality, nor can tenderness or local pain be elicited at the spot by either direct or indirect percussion, unless the case is neuromimetic, a rather unlikely combination of things. I have met with it once, and been much puzzled, especially as the prominent vertebra in this case was at the very centre of the scoliotic (?) curve. The inconsistencies of this case led me to diagnose a genuine slight case of scoliosis, associated with a neuromimetic imitation of caries at one point.

It often happens that caries, especially of the lumbar vertebræ, is accompanied by lateral inclination of the trunk above the point of disease. But this inclination usually disappears in the prone posture; and the signs of caries are almost invariably well marked in these cases. Not that there is always a prominent boss. As is well known, the lumbar region, being naturally concave behind, is slow to develop a marked posterior angular curvature. But an obliteration of the concavity can usually be detected and a thickening felt; while there are the characteristic local weakness and stiffness, as well as peculiar gait, and sometimes abscess. But see also the chapter on 'Pott's Disease.'

Scoliosis and caries are not antagonistic, and therefore do occasionally exist in the same subject. Such cases sometimes require very careful study in order to recognise what symptoms and effects are due to each disease, or even to avoid leaving one altogether undiscovered. But they are so rare that the surgeon should not bear them too acutely in mind, or he will discover mare's nests.

The gibbosity on the side of the convexity of the lumbar curve has been occasionally mistaken for a tumour, and is frequently supposed to represent a unilateral muscular hypertrophy. The costal gibbosity also sometimes gives rise to a suspicion of intra-thoracic disease, bulging out the chest wall, especially in rachitic cases, wherein the said gibbosity is apt to be more circumscribed. Similar errors also occasionally result from the antero-lateral thoracic prominence beneath or near one breast.

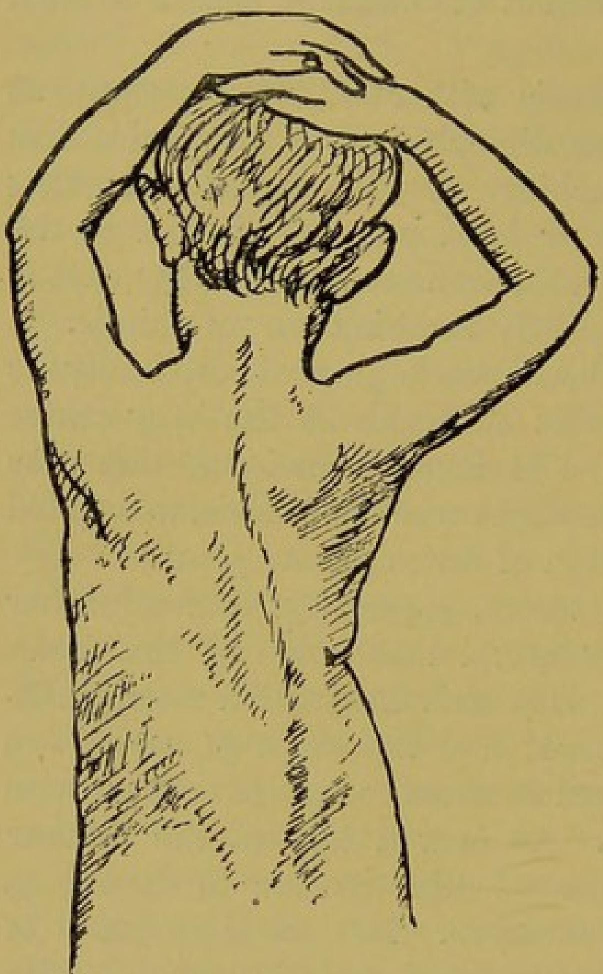


Fig. 205.—Spinal Curvature secondary to an Empyema which had been treated by an extensive Resection of Ribs. (Helferich, 'Langenbeck's Archives,' 1892, Bd. xliii. p. 208.)

These errors are sometimes the result of a very imperfect and partial examination of the patient's trunk.

Prognosis.—Although much can be done to relieve and disguise the amount of deformity, and to prevent increase, the sad truth remains that scoliosis, or true lateral curvature, is, in the present state of science, incurable. Into almost every case of the affection two elements enter—one, the prime and essential deformity of the vertebræ; the other, an aggravation in the appearance, due to the action of gravity, and termed flexion. When the latter is considerable, much can be done for the patient's appearance. All such phrases as that 'in severe cases of lateral curvature the deformity of the bones can never be perfectly removed,' and the like, are delusive; for they imply that slighter cases may be entirely cured. Cures have been claimed for one system of treatment after another; cures are still claimed for almost every system of treatment by different people; but, speaking for myself, I have made a careful study of the evidence in favour of these claims, and only feel assured that they are unfounded.

With regard to the natural tendencies of the disease when left alone, much depends upon the stage of the disease, upon its causes, and upon the patient's age, sex, occupation, habits, and mode of life.

The slighter the case, the less likely is it to progress. When the most advanced stage has been reached—namely, that in which the vertebræ are ankylosed together—it is in the highest degree probable that increase will not take place. When a curve is well marked the influence of gravity and flexion tell more unfavourably upon it than upon a faint curve.

With respect to the causes, they are, alas! only too often more or less obscure. But cases arising from rickets in early life may be stationary for a considerable time, and then increase again during adolescence. And many cases, especially such as those due to pleurisy or cicatricial contraction, reach a certain degree, and there spontaneously stop.

It is during the period of growth and development on the one hand, and of approaching old age on the other, that scolioses are most liable to increase.

Female scoliotics are liable to a special increase during and after pregnancy; and in that period the constantly changing shape interferes with wearing appliances. Occupations which involve long persistence in the upright position, or carrying weights on the arms or shoulders, have an evil influence. Unhealthy sedentary occupations and habits are unfavourable.

The persistence of any obstruction to respiration, or of chlorosis, is very unfavourable. As a matter of fact, the surgeon should not permit the continuance of such conditions.

Double deviations, in which the lumbar and dorsal curves are pretty equal, progress, as a rule, slowly, compared with those in which one curve is very predominant, especially if that dominant curve be dorsal or dorso-lumbar.

Scoliosis, whether rachitic or otherwise, is never cured spontaneously.

Treatment.—Although genuine cure is not to be expected, there is yet plenty of room for treatment; in fact, treatment is, in most instances, an absolute necessity to prevent increase of the deformity, and it generally offers hope at least of an *apparent* improvement, which in some cases is very considerable.

The indications are to prevent increase of the deformity; to try to remove the element of flexion increasing the apparent curve; to strengthen the muscles of the trunk, and to teach them to support the spine in as straight and good-looking a position as possible; also to take pressure off the vertebræ on the side of the concavity of each curve, to increase the pressure

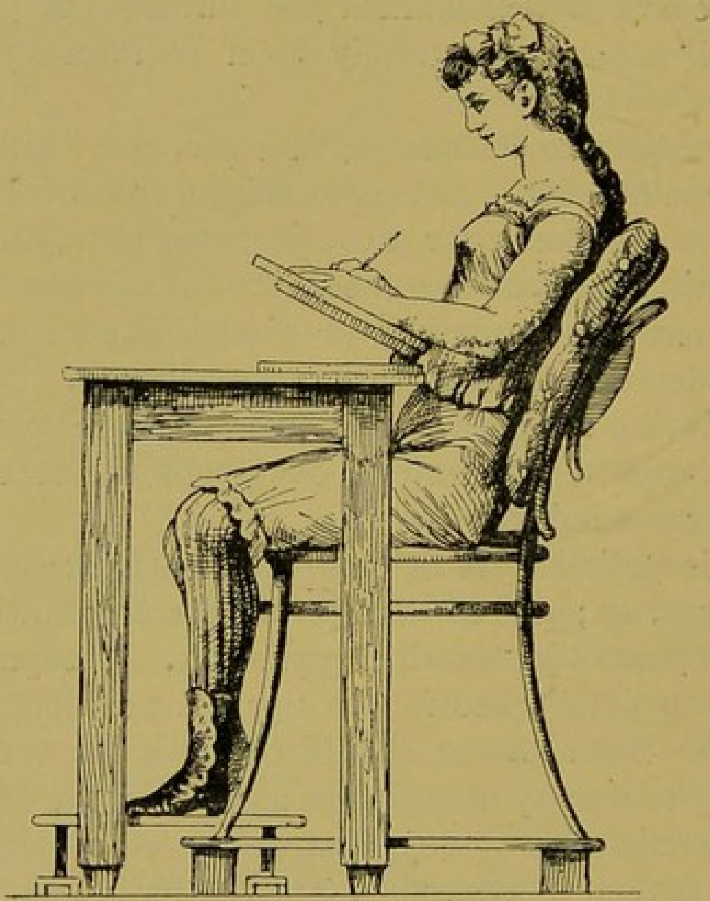


Fig. 206.—A Rational School Desk and Seat. (From Hoffa, after Lorenz (?).)

on the side of the convexity, to exercise gentle pressure on the gibbosity or gibbosities, and *to develop the chest and breathing capacity as much as possible.*

As a preliminary, all obstructions to free respiration, whether mechanical, *e.g.* nasal obstruction—or physiological, *e.g.* chlorosis—or mechanico-physiological, *e.g.* the practice of wearing tight stays, should be dealt with. Moreover, great attention must be paid to the nutrition generally, and to that of the bones in particular.

The means adopted in order to follow out these indications may be classified as: (1) appliances, (2) exercises, (3) medicaments, (4) surgical procedures, (5) hygienic measures other than exercises. To these may be added (6) simple horizontal rest.

Appliances, again, may be divided into (1) portable—those which the patient wears and carries about; and (2) those which he does not.

The prototype of these portable apparatus was what the Germans call 'Heister's Cross,' a simple upright wooden backboard with a shoulder-board at right angles to the upright; a circlet for the head; and three straps, one for the waist and one for each axilla. The principle of this appears to have been simply that of fixation with a back splint. A step in advance was to convert the pelvic strap into a pelvic girdle of padded steel. The same metal came also to be used for the posterior upright; and it was sometimes made double, so that there might be no pressure on the spinous processes of the vertebræ.

Another form of 'spinal support,' as these apparatus are called, has two lateral uprights rising from the pelvic girdle, and bearing each a crutch in the corresponding axilla.

The girdle is either completely of steel, or may be of steel behind and at the sides, but of leather anteriorly. In position it rests on the sacrum behind and, passing laterally between the great trochanter and the anterior iliac spine, lies in front a little higher than the os pubis.

The axillary crutches are, in some supports, fixed to the posterior upright, from which they curve, first outwards, and then forwards, like the horns of an ox (fig. 207). The pelvic girdle is frequently supplemented by two strips of padded metal in the position of A, A′, fig. 208.

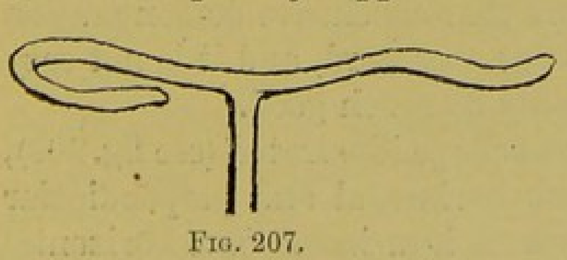


Fig. 207.

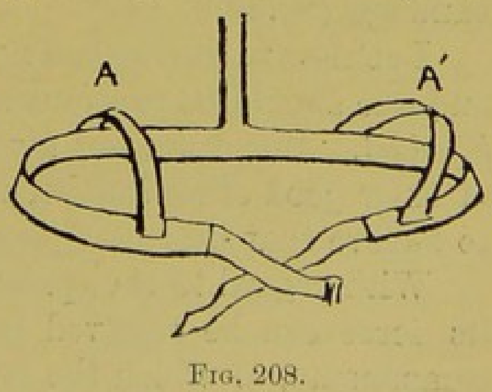


Fig. 208.

In order to change their character from that of mere supports to that of actively working instruments, parts of the apparatus were made movable on the rest by a ratchet-and-key arrangement. At first the posterior upright was joined to the pelvic girdle in this way, and by working it laterally it was sought to bend over the body from the side towards which the spinal curvature inclined it. Such was the principle of Hossard's 'ceinture à inclinaison.'

The immediate application of the pressure produced by ratchet and key was in some cases effected by webbing bands, in others by padded steel plates. These steel plates were usually connected to the posterior upright, sometimes to the axillary upright, and sometimes, by means of levers, to the pelvic girdle. In almost all cases a broad abdominal band of webbing. and often a thoracic one also, or a complete waistcoat, so to speak, was attached to the metal part of the apparatus.

These alterations or additions were made gradually, and in some form or other they all survive in different instruments.

Another variety of portable apparatus is formed by the simple shoulder-straps. These can, of course, have no action on the spine at all, except that, by holding the shoulders and arms back, they remove the weight of those parts to a posterior position, in which there will be less leverage for them to use to bend the dorsal spine forwards.

Still other forms of portable apparatus are those by which Barwell has attempted to apply elastic force on principles similar to those according to which it is used for cases of club-foot, &c. See the annexed diagram of Barwell's spiral bandage (fig. 209).

I confess to having had no experience of these contrivances, and one should be cautious about condemning any apparatus *à priori*. But I am not aware that conclusive demonstration of their good effect has been put on record, and it is not easy to believe that they can possibly do much good.

With regard to the spiral bandage illustrated (see fig. 209), its force can be resolved into horizontal and perpendicular components, of which the latter is injurious. The horizontal component tends partly to compress the abdomen and thorax where the bandage lies, and partly to draw back the left shoulder, an effect of questionable value. For the reasons above given I have not felt justified in trying it.

A different class of spinal supports is composed of stiff corsets made of leather, of prepared felt, or of bandages stiffened with plaster of Paris or with water-glass. It is doubtful whether one should class with these or with the steel supports corsets made of canvas or linen stiffened with rods of whalebone. Whalebone corsets are used only for slight or perfectly stationary cases, or for cases believed to be improving under the influence of treatment. They have very little action, even when new and skilfully made, and none when old or badly made.

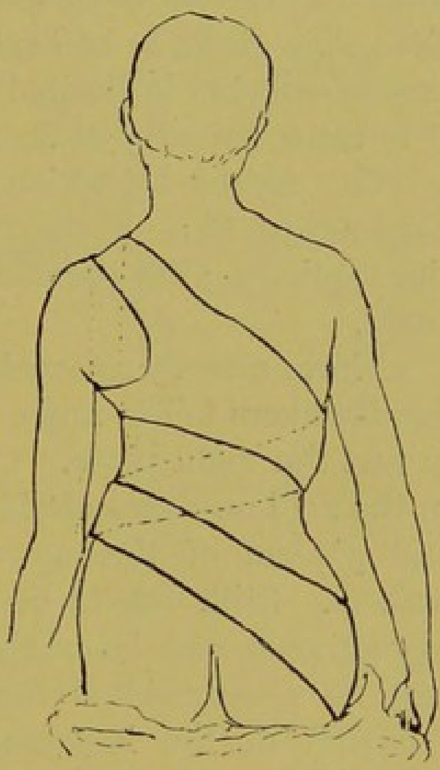


Fig. 209.—Barwell's Spiral Bandage.

With regard to poroplastic felt and plaster-of-Paris corsets or jackets, I have thought it judicious, from their extensive use and usefulness, to give a long, detailed, and, I hope, thoroughly practical account of them in a separate chapter.

Points bearing on the relative value and effectiveness of the different forms of portable apparatus, especially spinal supports of steel, leather, felt, and plaster of Paris.—The chief indications which they have to fulfil are—(1) to take the perpendicular pressure off the vertebræ on the side of the concavity of each curve; (2) to increase the perpendicular pressure on the side of the convexity; (3) to exercise gentle pressure on the gibbosity or gibbosities; (4) *not* to press upon certain parts, *e.g.* the female mammæ; (5) to interfere as little as possible with the movements of the respiratory and digestive organs; (6) to be removable; (7) to be strong, but reasonably light.

The prime essential in the different kinds of stays and corsets is a satisfactory base. This must be sought in that part of the instrument which clasps the pelvis.

It is, no doubt, easy to make a pelvic girdle which, if it only keep in position, will sustain any amount of force transmitted to it from other parts of the appliance. Not only has the pelvic girdle to be kept in position, but its usefulness as a base of support is limited by the tendency of the pressure of it to cause soreness of the soft parts beneath.

The means by which it is kept in position are—(1) its accuracy of fit; (2) the reaction of the other components of the appliance ; (3) the addition of certain parts to the instrument.

I have already referred to the frequency with which instrument-makers fail to make a pelvic girdle fit accurately and lie in just the right place. Of course there are great differences in the skill and care of different workmen, and in the amount and wisdom of the superintendence of master instrument-makers. Still, defects of the kind are so commonly seen by any surgeon who takes the trouble to look for them, that it may be plainly stated that, with ordinary care and skill on the part of the instrument maker, they still remain unavoidable.

Now a tyro can soon learn to make a plaster-of-Paris, or even a poroplastic felt jacket, fit the pelvis like a glove.

If a movable pelvic girdle does not fit well, the patient's feeling of discomfort will make him actively shift it out of position.

By the reaction of the other component parts of the appliance I mean, for example, the effect of axillary crutches in keeping the girdle from shifting upwards, and of the abdominal band and shoulder-straps in preventing any tilting out of the horizontal.

Still, it has been found necessary to make special additions to effect the object under review. One plan is that of carrying a steel rod down to a girdle clasping one thigh. This is used when, either from the peculiarity of the patient or from the action of the instrument, there is a tendency for the girdle to tilt upwards on the side where it is, by this contrivance, fixed down to the thigh. However skilfully such an appliance is made, it is scarcely likely to act equally well in both the sitting and standing positions and during free movements of different kinds.

With regard to the axillary crutches, they fail to effectively extend the spine on account of the great mobility of the scapulæ. They, however, can certainly be so used as to more or less relieve the spine of part of the weight of the upper extremities; but, as I have already mentioned, this action cannot be continuous, because of the injurious pressure which thereby results on the axillary vessels and nerves. The crutches are made of soft metal so that the surgeon can bend them out of any shape that may be found to cause discomfort. They should be long enough anteriorly to curve well round in front of the pectoral folds.

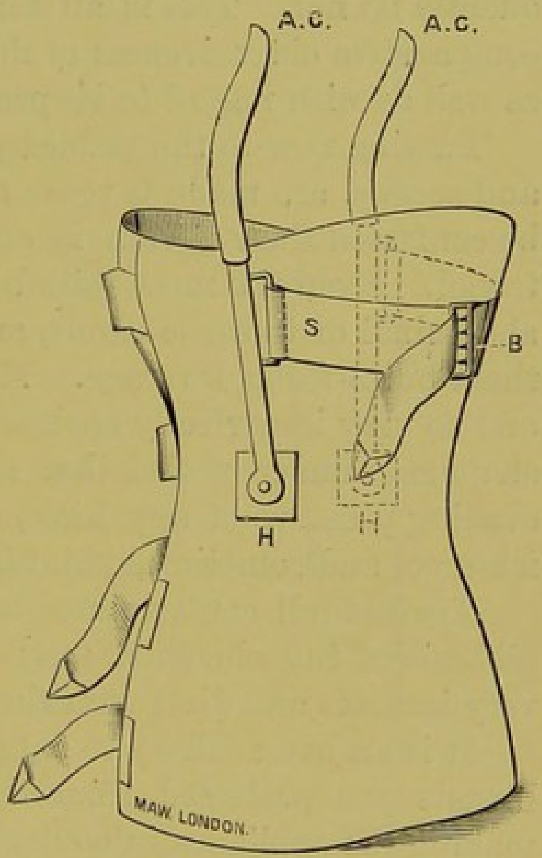


FIG. 210.—POROPLASTIC JACKET WITH ANTERIOR CRUTCHES, USED BOTH IN SCOLIOSIS AND KYPHOSIS. The two anterior crutches are united behind by a strap of elastic webbing. The *whole* strap should be elastic. I have seen many of these appliances spoilt by placing elastic at only one end of the strap.

Whether a steel support have axillary crutches or not, it is almost invariably fitted with straps passing over the shoulders. Sayre inveighs against these as positively holding the upper part of the spine down, and thus counteracting whatever forces may be in action to straighten out the curves of a scoliotic spine. There can be no doubt but that they have this tendency.

The practice of carrying up a plaster-of-Paris or felt jacket to the top of the axillæ, in order to imitate and aim at the effect of the crutches, can only be stigmatised as ridiculous and calculated to cause cruel discomfort. It has, however, been advocated. Of course, no patient could possibly endure that any weight should lie on the sharp upper edge of a plaster or felt jacket.

The surgeon must take care that both the axillary and dorsal uprights fit well to the patient's body. They frequently do not. This is an important point as regards the comparative obtrusiveness of the jacket beneath the clothing, as well as with regard to its practical efficacy.

Passing now to the padded plates which, by means of keys and screws, are made to press against the gibbosities, it must be confessed their action is often *nil*, and never more than trivial. Even the most skilful arrangement of pelvic girdle, abdominal or thoracic bands, and perpendicular metals gives them but a feeble leverage. Moreover, the trunk is so mobile and so very imperfectly enclosed and fixed by the class of instruments under notice that the patient learns the trick of evading pressure of any force, especially as such pressure is irksome, and sometimes painful.

Against all contrivances for exercising pressure on the gibbosities the objection may be urged that their action is very indirect and distant on the spinal curvature itself.

It is an utter fallacy to suppose that parts like the female breasts are protected from the ill effects of pressure by making the appliance in contact with them of a soft material. The most disfiguring absorption is often caused by webbing bands or by felt jackets carefully softened over the mammæ. Such soft appliances only leave the breasts uninjured when they do not press upon them at all—in other words, when they do not act at all, and might as well be absent altogether. On the other hand, a *firm* corset can be so shaped as to exercise no pressure on the mammæ.

All webbing or other soft belts are open to the objection that, owing to their mobility and the capacity of the abdomen, and even of the thorax, for changing shape, they cannot perfectly fix any part of the lumbo-dorsal spine backwards. If they are unduly tightened, the functions of the respiratory and digestive organs are interfered with, which is directly contrary to one of the most important indications for treatment.

All spinal supports used for scoliosis are removable. Sayre's jacket is commonly imagined to be an exception, and as formerly used it was so. But it is so no longer. The way in which the plaster-of-Paris jacket is made into a removable appliance is described elsewhere.

Let us consider now how far corsets of plaster of Paris or other stiff material—*e.g.* 'poroplastic felt'—fulfil the indications enumerated at p. 364.

As extension opens out the curves of the scoliotic spine, it necessarily satisfies indications 1 and 2; *i.e.* it increases the perpendicular pressure on the side of the convexity of each curve and decreases it on the side of the concavity. The question, therefore, becomes simply this: To what extent and how long does the plaster jacket keep up the spinal extension obtained by self-suspension with the collar and pulleys?

FIG. 211.—The curved line A B′ is the same length as the straight line A B. So slight an extension as that of the point B′ to B has sufficed to straighten so marked a curve.

I have made many measurements, and can say positively that an extension of five-eighths of an inch can frequently be kept up for a month, or even much longer, with an ordinary Sayre's jacket, and nearly as much with a poroplastic felt one. This contrasts very favourably with the figure got on measuring a patient wearing a steel instrument. I have frequently found such a patient shorter with the 'spinal support' on than with it off, and that even to a difference of more than an inch, especially if the instrument were old. But I have observed it in the case of brand-new steel supports and stays. In the case of plaster or felt jackets I have only once found this shortening and then the jacket was very old indeed.

A quarter of an inch is a very respectable amount of extension for a steel appliance to keep up.

In making the measurement the surgeon must beware of being deceived or tricked by the patient. The latter should be perfectly passive, beyond simply doing his best to stand upright.

The third indication was, it will be remembered, 'to exercise gentle pressure on the gibbosity or gibbosities.' By 'gentle' is meant such pressure as can be comfortably borne.

Now, when a young scoliotic patient is suspended, the gibbosities are seen to become less prominent—sometimes much less. If, then, a rigid case is moulded and set on the figure thus suspended, as soon as the suspending gear is relaxed the patient sinks, as it were, into her jacket, and the gibbosities, attempting to bulge out again as they did before suspension, press against the wall of plaster, and receive from it a *counter-pressure*, compared with which the action of the plates worked by screws and keys on a steel instrument is but as that of a toy.

Thus do the rigid jackets fulfil the third indication.

With regard to the fourth indication—'*not* to press upon certain parts, *e.g.* the female mammæ'—I have already mentioned the injurious effects of bands or belts of any kind which press upon those glands. In the case of plaster and felt jackets great care must be taken to mould them into half cups or pockets of appropriate size and shape opposite the breasts; while the secret of preventing undue pressure on bony prominences is to secure a perfect *fit*.

The fifth requirement is that the movements of the respiratory and digestive organs shall be interfered with as little as possible. It is a matter of experience that properly applied plaster-of-Paris and felt jackets satisfy even this requirement. The statements to the contrary are libellous, and have for their parentage rashness of statement and ignorance of fact; in other words, they have for their brothers and sisters the large family of falsehoods which have been brought forth with reference to the plaster-of-Paris corset. A plaster or felt corset which interferes with either ordinary respiration or ordinary digestion is either tighter than there is any necessity whatever to make it, or else is of a wrong shape. If the directions presently to be given be accurately followed, the error in question will be easily avoided.

Even the plaster-of-Paris jacket, when used for scoliosis, can be, and should be, made removable and replaceable.

With regard to the weights of plaster and of felt jackets, they do not compare unfavourably with those of steel supports.

Before leaving this subject I will stay to deal with the falsehoods and exaggeration concerning the plaster-of-Paris jacket to which I have just referred. The language in which its alleged dirtiness has been described will be more appropriately dealt with when describing its employment for spinal caries, for which an irremovable jacket will be recommended. The same remark applies to the accusation that the plaster jacket hides the formation of pressure sores, the increase of deformity, &c. For, I repeat, the plaster-of-Paris jacket, when used in the treatment of scoliosis, may be, and generally ought to be, cut down the middle in front, made to lace and unlace, and removed frequently.

But the plaster jacket has been alleged to be harsh as mortar, and necessarily very uncomfortable. Its surface, when skilfully made, has about as much resemblance to that of mortar as the surface of a smooth tile has to that of a common brick, and it causes no more necessary discomfort than does a well-fitting boot or hat. It has been described as being excessively heavy. In the scales it is not heavier than a 'spinal support,' and on the patient's body the weight is not felt nearly so much, because it is more evenly distributed. Lastly, it has been reviled as a 'pauper' splint. Would that it were so; but it is, alas! rather expensive of skilled labour and of the surgeon's time, and it gives opportunity for the exercise of a little artistic or modelling talent, if he have any. The person who can think seriously of expensiveness of material in a surgical appliance, and lightly of expensiveness of the surgeon's time, reminds one of the rustic who, gazing at a fine Millais, said, 'They tell me that the paint on that pictur cost ten shillin', let aloän the trouble o' layin' it on!'

Then there are the equally exaggerated misstatements about suspension. During the application, we learn that 'the subject is in a state of trying suspense;' it shocks nervous sensibilities, because of its resemblance to capital punishment; the arms become blue, cold, and numb; 'the muscles of the entire body' are, 'after a minute or two, rendered powerless, and the patient relapses into a state of pendent and distressing helplessness;' 'retching and vomiting are not unfrequent;' fainting occurs sometimes; in one or more instances fatal results have followed; 'traction does not restore natural curves to the spine'—and so on, are the accidental complications that have been known or imagined to occur in connection with the hundreds of thousands of suspensions done of late years, being scraped together and related as if they were of frequent occurrence in the hands of skilled persons. In order to make any of the above troubles excessively rare, and the more serious of them out of the question, all that the operator has to do is to prepare for and initiate the suspension with cheerfulness, gentleness, and a little tact, and then, supposing him to be applying a plaster or a felt jacket, to do the work with smartness and expedition. Of course, a surgeon who dawdles or deliberates, as if he were treating a lay figure or dummy, may expect now and then to have a patient who cannot stand such treatment.

In cases of cervico-dorsal curve, and even in very severe cases with the dominant curve at a lower level, the jury-mast may be used for scoliosis. Great care has to be taken to fix it so that it shall project in the right position, over the vertex of the head.

Exercises or Gymnastics in the Treatment of Scoliosis.—Exercises of a suitable kind, carefully superintended and directed, are among the most valuable means at the disposal of the surgeon treating deformities. But it is important to understand what may really and justly be expected of them in each class of case.

Now, no mere gymnastics of any kind, Swedish, German, American, or English, will *cure* a genuine case of scoliosis. If there be ever so slight a gibbosity or other indubitable indication of rotation, there is an osseous deformity which no surgeon or gymnast can expect to remove. It is, however, quite otherwise with the element of mere *attitude* in cases either of genuine scoliosis or of neuromimesis. Upon that, gymnastics, with training in deportment, are competent to work wonders, and they further act to straighten out the spine by developing and expanding the chest. But I have never, in a single instance, seen them actually remove the scoliosis.

Before describing exercises in detail there are certain general principles to dwell upon.

First, let me condemn all attempts to directly ' untwist ' the distorted spine as vain, wasteful of time, and very likely positively injurious. The scoliotic torsion is actually *in* the vertebræ; it is the sum of a number of torsions, each to be plainly seen in a single individual of the vertebræ affected. But the torsion produced by the gymnast is a motion between the vertebræ, and, if it have any powerful effect at all, has that of tightening the ligaments and muscles which unite the vertebræ, and of thus crowding the vertebræ down upon one another. If we consider also how various are the positions and extents of the individual curves in different cases of scoliosis, we shall feel how difficult it would be to adapt to each a set of exercises fitted to undo the torsions of its particular curves. But we need not to attempt it. *If* we can undo the scoliotic curve, the torsion will necessarily disappear with it; because the scoliotic curve in the vast majority of cases exists mainly in the line of vertebral bodies, and exercises capable of straightening that are not at all likely to over-curve the line of spinous processes in the opposite direction. Now, given a straight line of bodies and a straight line of spinous processes, and there can coexist no torsion.

Secondly, exercises which bend the spine forcibly forwards, as in bowing, are not good. They tend to shorten the line of vertebral bodies, because the line of spines and interspinous ligaments has a certain limit of extensibility. And whatever shortens the line of vertebral bodies increases any pre-existing curves in it; all the more so when, as often is the case, a dominant dorsal curve has a postero-lateral convexity, or, in other words, is complicated with a kind of kyphosis.

Thirdly, for reasons the exact converse of those detailed in the last paragraph, exercises which bend the whole spine backwards are, as a rule, good; they stretch out and undo the curves.

It is to be borne in mind that some persons are, by reason of bodily imperfections, such as herniæ and heart disease, to be exercised either with great caution or not at all.

Scoliotics should at first go through their chief exercises under the regular and constant superintendence of a skilled person. There are, however, certain simple exercises which the patient, when properly drilled in them and occasionally supervised, may go through alone and without constant superintendence.

The exercises should be adapted to the age, sex, and strength of the patient.

They should be kept up with great perseverance and for a long time. In the intervals the improvement should be as far as possible maintained, either by rest in the horizontal position, or by a suitable portable appliance, such as a plaster or felt jacket.

The lower extremities should be mostly passive in the majority of the exercises, especially in those of suspension, wherein they are to act mainly by their dead weight. Fatigue and weariness are to be avoided.

Variety in exercises is of great value. To do any good great perseverance is essential, and the less monotony there is, the easier will perseverance be.

With regard to apparatus, dumb-bells and Indian clubs, and a ladder and a firm hard couch or bed, are within the reach of almost every one. Not much more unattainable in most private cases are a horizontal bar, 'rings,' parallel bars, ropes for climbing, and a pair of upright parallel poles. And there are also the patent exercises, consisting of handles and stirrups attached to ropes, weights, and elastic bands working in pulleys screwed to the wall.

A few special exercises may be described merely as *examples*.

Exercise 1.—*Position*.—The patient lies prone on a firm table or couch, but with the trunk projecting beyond one end. The legs are kept down by pressure. This pressure is supplied either by the weight of some one sitting on the legs, or by a broad leather strap passed round both legs and couch.

Action.—The patient slowly raises his head and trunk. He will usually at first require the assistance of his attendant in order to do this. The exercise should be repeated again and again, stopping just short of absolute fatigue. If headache be produced, the range of motion should be limited; and especially the patient should be so supported by the attendant that his head shall not descend below the level of the couch.

Sayre places the patient simply prone on the couch, not projecting beyond it, arms outstretched. Then the patient endeavours to raise his chest from the couch, at the same time pressing his arms backwards—*i.e.* away from the couch. Sayre adds to this an exercise meant to untwist the rotated spine. I have already said what I think of such exercises.

Exercise 2.—Patient lies half on the couch, as in Exercise 1. It is thus described by Busch: [1]

'The gymnast buckles round his waist a firm leather girdle which carries a movable loop at the back. He now places himself on the left side of the patient, who steadies himself with his left hand in the loop of the girdle. The outstretched right arm of the patient is firmly grasped, above the wrist, by the gymnast's left hand. The latter places his right hand on the prominent ribs of the right dorsal gibbosity. While he exercises firm pressure against the ribs with this hand, he bends the patient's back over towards that side, and thereby, as it were, forces open the dorsal curvature. The gymnast has in this exercise, since he can throw his own weight into the scale, a very considerable force, and can, if he be a tolerably powerful man, unbend even strongly marked dorsal curvatures. Indeed, he must be careful not to use too much strength, or he may break the continuity of the spine.'

I am not aware whether any such accident has ever happened.

Exercise 3 (Description from Busch, *op. cit.*).—'The patient remains in the same position. The gymnast stands

[1] *Allgemeine Orthopädie, Gymnastik und Massage.* Leipzig, 1882. An English translation, by Noble Smith, has been published.

at the right side of the patient's head. The patient fixes his right hand in the loop of the girdle and stretches out his left arm alongside his head. The gymnast grasps this arm firmly close to the wrist-joint, and places his left hand on the patient's left flank, opposite the lumbar curvature. After this the body is bent over towards the left, while the left hand of the gymnast exercises a counter-pressure on the lumbar spine.' Busch adds that the effect of this is not so great as that of the last-described exercise, since there are no ribs to communicate pressure to the lumbar vertebræ.

I give the last two exercises for what they are worth. They are examples of a school in which I myself do not believe.

Use of the Ladder.—Exercise 1 (with the ladder placed obliquely).—The patient seizes, not the rundles, but the sides of the ladder, and swings himself, slowly and gradually, higher and higher. Each time that he advances one hand a little higher he swings his body from side to side, making the centre of motion at the loins rather than at the shoulders. Afterwards he descends in the same way. All hurry, jerking, and over-exertion are to be avoided. The patient must not ascend too high up the ladder, and throughout the exercise the legs should stretch out stiffly side by side and simply act as dead-weight. By this exercise the loins, back, and shoulders are strengthened, and the pressure on the segments of the spine becomes, for the time being, a negative one.

Exercise 2 (on the ladder horizontal above the patient's head).—This is identical with the last-named exercise, except that the patient proceeds backwards and forwards instead of up and down. It is also less fatiguing, can therefore be kept up longer, and is therefore preferable, as the object of the exercise is to develop not the arms, but the thorax.

Exercises with 'the Rings.'—These are rings attached to two ropes which swing from a considerable height—the higher the better. The patient grasps the rings firmly, one in each hand, and starts himself off with a smart run. The elementary exercises on the rings done in ordinary gymnasia are suitable for scoliotics, excepting only those that are too violent. Even the bending the knees up towards the chin, used during one part of the swing, is scarcely counter-indicated; for the weight of the hips and lower extremities, greatly increased by the centrifugal force exercised by this apparatus, will be sufficient to prevent harm resulting.

In *climbing ropes* the legs should not be much used.

Exercises in the Sitting Position.—These are scarcely so powerful as the above-described; but they have the advantage of requiring little or no apparatus. On the other hand, they specially demand the skilled assistance of a gymnast or surgeon.

As examples we give the following, our descriptions being translated from those of Bouvier and Bouland.

Exercise 1 (Eulenburg of Berlin), for a dorsal curve with right convexity:

Position.—Patient seated, his thighs fixed either by an assistant or otherwise, his hips square. His right arm raised and extended, with the palm of the hand turned outwards; the left arm is less raised, and is flexed in such a way that the palm of the hand is placed behind the neck.

Movement.—The surgeon or the gymnast, standing to the patient's left, places his (the surgeon's) left hand on the outer side of the right fore arm of the patient, opposite the summit of the dorsal curve. The patient then gradually makes every effort to straighten out or even to reverse the curvature by contracting the 'lateral flexors' of the right side, and at the same time the surgeon offers more and more resistance to this contraction with his right hand, which he employs, as it were, to draw the patient's body towards himself. At the end of the movement he points out to the patient with his hand the situation of the summit of the curvature, where he ought to concentrate his muscular efforts.

This movement is repeated three times in succession, with a rest of five seconds and a deep breath after each movement. Afterwards the patient receives five minutes' freedom before the exercise is resumed.

This exercise has a superficial resemblance to Exercises 2 and 3 on the couch, described above, but there is this essential difference: in the latter the force supplied by the gymnast is active and the patient passive, while in the former the patient is active and the gymnast, though not passive, is yet little more than simply counter-resistent and controlling. The exercise in which the patient is made to attempt to straighten the curve by his own muscular force is typical of a whole class of exercises—a class which has attracted more attention than perhaps it really deserves, and which was originally based on a false theory of scoliosis. The exercises are, however, of great value in neuromimetic or sham cases, and in real cases they teach the patient to *carry* himself better.

Exercise 2 *in the Sitting Position* (Berend of Berlin), for two curves, one right dorsal, the other left lumbar.—The patient is seated with the left arm raised obliquely, the right extended from the side and horizontal, the lower extremities fixed. The gymnast, standing behind him, places one hand opposite the dorsal convexity and the other at the level of the lumbar convexity. He pushes with the first the upper part of the trunk from right towards left; at the same time the patient resists, and he himself, with the other hand, leans strongly upon the lumbar convexity. This proceeding is repeated from four to six consecutive times, with intervals of rest.

Exercise in the Standing Position (Bouland), for an ordinary right dorsal principal curve.—The patient endeavours to lift the upper part of his body upwards and a little towards the left, as if he wished to make himself taller, and at the same time directs his hips a little to the right. He ought to avoid in this movement hollowing his loins, lowering his left shoulder, and bending one knee. In going through this exercise he puts himself in the straightest position that the conformation of his spine will permit, and consequently effects a momentary effacement of the *flexions* (as distinguished from the osseous changes), and especially that which produces or increases the dorso-lumbar inclination.

The patient may find assistance in doing this exercise, and indeed many other exercises, correctly by *using a looking-glass.*

The above are fair examples of exercises, the variety of which may be multiplied without limit; only, in devising any original form of exercise let the general principles and cautions enunciated at the commencement of this section not be forgotten (see p. 375).

Swimming deserves special mention and high praise as an exercise for scoliotics. It takes weight off the vertebræ, tends to open out the line of vertebral bodies (as the trunk has to be arched back), develops the lungs and chest, and promotes the general strength and well-being.

Electricity has been employed to strengthen the muscles which, when in action, would tend to straighten out the curvatures, but its effect, if any, is trivial when compared with that of gymnastics ; it is moreover troublesome, and in some cases expensive, and its use was originally based on a false theory of scoliosis.

Extension.—Extension is effected either in (1) the upright position, (2) the horizontal, or (3) the inclined.

The practice of extension in the upright position, excepting in so far as it was supposed to be effected by spinal stays and corsets, had fallen into entire disuse for more than half a century until, a few years ago, it was revived by Sayre in connection with the use of plaster-of-Paris jackets. But it was originally devised and employed by the illustrious Glisson, 230 years ago, and also by Nück forty years later. The method by which they obtained their vertical extension was practically the same as the plan of suspension which we now employ in applying a plaster jacket. Nück used a collar very similar to that of a set of ordinary modern suspension gear. About 130 years ago Levacher de la Feutrie, in the Memoirs of the French Academy of Surgery, described, with excellent drawings, a kind of 'stays' bearing what we should now call a jury-mast, which took off the weight of the head by means of a chin and head strap.

The practical use of suspension gear is described in the chapter on the plaster-of-Paris and felt jackets ; it remains only to say a few words on their action. That they open out the scoliotic curves, excepting where there is bony ankylosis, is indubitable. In some young and supple patients the effect is almost wonderful ; the momentary increase in the perpendicular length of the spine, *i.e.* in the distance between the atlas and the base of the sacrum, can be measured in inches ; and when we remember how short the spine really is, it will be felt how much it must be straightened when the distance between the two points just mentioned is increased by an inch and a half. So long as the suspension is kept up there must be an increased pressure on the convex border of each curve—in other words, on the side towards which the individual vertebræ are thickened—whilst there must be a negative pressure on the other side. It has been urged, with some truth, that the extension may tend to stretch and weaken the ligaments uniting the vertebræ. This is, of course, analogous to one of the chief objections to the instrumental treatment of knock-knee. It does not, however, carry nearly the same weight in the case of the spine; because, compared with apparent straightness, strength and mobility are not of such importance in the spine as in the knees. Moreover, the objection is, so far as I know, a merely *à priori* one, and it comes from a work disfigured by other statements about Sayre's treatment which my own experience tells me to be most erroneous. *A priori* arguments can be produced on the other side. For instance, we do not find that performers on the trapeze and horizontal bar weaken the ligaments of their spines. As a matter of *fact*, I have not found self-suspension weaken the spinal ligaments.

The self-suspension should be gone through twice daily. Each occasion should last from five to ten minutes, more or less, according to the strength. The patient does not raise the toes from the ground, but merely the heels. Immediately after the exercise the horizontal position should be assumed, and not left until the patient's corset has been reapplied and tightened (supposing it to have been removed). If it should be inconvenient or impossible to get half an hour's horizontal rest after each turn of self-suspension, the corset should not be removed at all.

Horizontal Extension.—This is undoubtedly a very powerful means of acting on the spine, and one which can be kept in vigorous action for many hours out of every twenty-four. It was formerly extremely popular, especially in Continental orthopædic institutions. Indeed, it is a method specially adapted for use under circumstances where the patient can devote all his time to treatment and be under constant skilled superintendence. There can be no doubt about its competence to produce improvement in suitable cases; that is to say, in patients who are not too old and have not been scoliotic too long. The great objections to the treatment as generally practised are that, being kept up, as a rule, eighteen hours out of the twenty-four, it is inconsistent with proper participation in ordinary social and educational life. But few surgeons, therefore, would think of employing it for slight cases, and none would use it for old and confirmed cases.

The appliances for horizontal extension consist of a flat couch or bed, with a collar or chin and occiput strap, similar to those used for suspension, but carefully padded, and also a well-padded, well-fitting pelvic girdle of leather. Axillary loops are also often used. The head and axilla gear are merely fixed to the head of the bed. The extending force is connected with the pelvic girdle by two leather straps which pass downwards, one along the outside of each leg, and are united by a crossbar below the feet. The force itself may be applied by means of a screw, but it is much better to use a weight and pulleys. The amount of weight cannot be arbitrarily fixed. It is to be determined by observing the effect on the patient's spine, and must, of course, stop short of causing pain or discomfort.

If the *inclined plane* be used instead of the horizontal, the weight may be dispensed with. The extension is produced by gravity acting on the patient's pelvis and lower extremities.

Certain points must be carefully attended to in the use of extension on the horizontal couch or inclined plane. The patient must be first of all accustomed to wear the head and pelvic straps, &c., before any weight is applied. Afterwards the weight must be applied very gradually, commencing with a very light pull indeed. Similarly, the time during which the pull is kept up should be gradually increased until a maximum is reached. Less weight should be on during the night.

Attention should be paid to the height of the pillow and to the amount of the slope of the inclined plane. Otherwise inconvenient, not to say injurious, congestions of the head or of the pelvis may ensue.

Half a century ago it was the common custom to keep scoliotics *continually* in the horizontal position for months, or even years, much to their general detriment. Now I know of no one who would prescribe its use for more than eighteen hours out of the twenty-four. In the remaining six the greatest care must be taken to preserve whatever good effect may have accrued from the horizontal extension. Part of the time—that is, as much as the patient's strength will permit—should be devoted to gymnastics and massage; in the remainder he should wear a suitable corset, preferably one of plaster of Paris or strong poroplastic felt.

In the orthopædic institutions of France the patients under this treatment, when not lying down, used to spend much of their time in moving about on high crutches which raised them nearly on tiptoe.

The employment of the inclined plane in the treatment of scoliosis was originally due to Erasmus Darwin, the grandfather of the investigator of the origin of man.

Mere horizontal rest is of great value in the intervals of the employment of active means of treating lateral curvature of the spine.

Compression in the Horizontal Position.—There are at least three ways in which this is applied: (1) by screw force; (2) by elastic force; and (3) the weight of the body is itself made to supply the compression. Any one of these may be combined with horizontal extension.

Principles 1 and 2 can be effectively applied only by means of special apparatus. As may be imagined, there are many different ways of fixing and arranging the requisite screws, springs, padded plates, and girdles. Of course the pressure is, as a rule, applied to the convexities, *e.g.* to the dorsal gibbosity, and the counter-pressure above and below, *e.g.* in the axilla and against the loin of the opposite side. It is necessary also to so fix the patient that he may not easily, by movement during sleep, evade the action of the machine. This is a requirement more easily stated than satisfied. It is most important to superintend the action of these machines with great care, and to use them gently, or grave injuries may result, as they have done before now.

The best mode of carrying out the third principle, namely, that of utilising the weight of the trunk itself as a means of compression, is said to be found in a transverse sling about 4 or 5 inches wide, extended across the bed between upright supports. The patient lies on and in this in such a way that it clasps and presses on the dorsal gibbosity. This apparatus is recommended by Barwell, Volkmann, and Busch.

Operative Treatment of Scoliosis.—By this is generally understood merely the use of myotomy. It is a method of which I have had no personal experience whatever. I am not aware of its having been practised in London for years, if, indeed, ever at any time. The most contradictory assertions have been made about it. Guérin and Sayre have made very positive claims to the attainment by its means of striking results. A careful study of the case described by Sayre in the last edition of his 'Lectures on Orthopædic Surgery' fills me with distrust of the accuracy of his observations. Soon after Guérin first introduced the operation the cases which he had described as being so successful were carefully investigated by Malgaigne, who gave an account of them very different from that of Guérin. None were cured; some were made worse. Much excited discussion followed. Ultimately the Academy of Medicine thanked Malgaigne for his investigations. Spinal myotomy seemed to have perished. As, however, I have already said, it was revived in America.

In the performance of spinal myotomy there is no particular muscle to divide or place of division. The patient is extended, and whatever muscular or aponeurotic structures are felt tense in the concavity of the principal curve are divided subcutaneously through as many openings as may be found necessary.

Osteotomy for scoliosis would not be a difficult operation to a surgeon accustomed to osteotomy, and acquainted by dissection with the anatomy of the parts; and it would be by far the most effective and speedy mode of straightening the spine; but it is not practised, doubtless for the following reasons: (1) The risk of crushing or lacerating such structures as the cord, the aorta, and the visceral nerves; (2) the fact that straightening the spine in this manner would not undo all, or perhaps even any, of the effects of torsion. The same remarks apply to the question of osteoclasis.

The above considerations are, of course, intensified by the fact that the curves are multiple.

The practice of forcibly rectifying angular curvature must tend to reopen this question. In lateral curvatures, operative straightening would at least be free from the risk of re-awakening dormant tuberculosis.

The treatment of mechanical and other obstructions to free breathing, which has already been mentioned as a prime indication, will often require the removal of adenoids and enlarged tonsils, the treatment of asthma, and the substitution of a well-fitting poroplastic jacket with anterior crutches for tight stays.

General Treatment.—The effect of the measures already described may be very considerable on the health and condition. The regular and sufficient rest, alternating with appropriate and varied exercise, the resulting expansion of the chest and increased appetite, are almost certain to produce some amelioration, and sometimes work wonders in the appearance, spirits, and vigour. It may be taken for granted that fresh air, change of air, plenty of light, good food, sufficient clothing, and cheerful occupation are as valuable here as in most other diseases. And it should never be forgotten that when a scoliosis is progressive we almost certainly have to deal with a disease of the nutrition of the bones and their epiphysial cartilages. In earliest life this is rickets; in later childhood and in adolescence it is an analogous affection. The treatment of rickets has already been considered. That of rachitis adolescentium demands a few words. 'Parrish's chemical food,' or the Syrupus Ferri Phosphatis Co. (B.P.), should be given, as well as cod-liver oil. And although, as I have already said, I am not disposed to go far in regarding masturbation as a cause of rickets of adolescents, yet the commonness of that bad habit and its evil influence on the 'vis naturæ medicatrix' are to be borne in mind. The menstrual functions, if, as is usually the case, the patient be a female, should be inquired into. Mere delayed menstruation, or even amenorrhœa, in young girls is not necessarily of any import, especially if they are undergoing a course of gymnastics alternating with continuous extension. The food should in *all* cases be carefully inquired into, and care be taken that it shall be sufficient (though not too bulky), and be rich in flesh- and bone-forming elements. The digestive functions must not be neglected. But drugs should not be too eagerly resorted to; a fair chance should always be given to the regulated exercises, to rubbing, and general hygiene.

When there is really any inequality in the two lower extremities, adjustment should be effected by means of a raised boot, or by surgical means.

Spinal Curvature with Sciatica and with Lumbago

Certain cases of sciatica develop a natural inclination of the whole spine and trunk away from the side of the painful limb. They are rare; but I have myself met with at least three striking examples, and Gussenbauer, in 1890, had observed no less than nine.

In the first observed of my own cases, a middle-aged man, the pain was principally in the lumbo-sacral region. In fact it did not differ in the least from the pain of ordinary lumbar rheumatism, and was, strictly speaking, an example of *lateral inclination of the spine caused by lumbago*. The appearances were precisely those about to be described as occurring with sciatica.

I do not myself think the precise branch or branches of the lumbar or sacral plexus which are the seats of pain have much to do with producing the deformity. Even in a single attack of common sciatica the pain will range from the loin to the ankle. The 'painful point' between the last lumbar vertebra and the posterior iliac spine, to which Nicoladoni attaches importance, is sometimes present in ordinary sciatica without spinal curvature, and sometimes absent in 'ischias scoliotica,' or 'nervo-muscular scoliosis,' the two names commonly given on the Continent to the affection under consideration.

The first explanation of this disease which naturally suggests itself is, that the position is an attitude taken instinctively to relieve the pain. It is noteworthy, and was first observed by Gussenbauer, that when the patient is suspended, either by himself or others, the spinal deflection diminishes or disappears, whereas any attempt to forcibly remove the bend while the patient simply stands, aggravates the pain. Nicoladoni, in describing two cases in 1886, shortly after Albert had published three others, attributed the spinal affection to inflammatory swelling of the nerve-cords and perineurium of the sacral plexus, ascending as high as the corresponding side of the cauda equina. He supposed then that the bending of the trunk over to the opposite side gave more room in the spinal canal for the swollen part of the cauda equina. Schüdel, from an anatomical study of the parts (Langenbeck's 'Archiv,' 1889, p. 1), opposed this view. He discovered a branch from the sacral nerves to the sacro-lumbalis. Through paralysis of this, caused by sciatica, and contraction of the muscle of the opposite side, Schüdel thinks the complication arises.

Neither of the above theories seems to me very convincing. Even in ordinary uncomplicated sciatica, common as it is, it seems to me that it is not yet demonstrated what part in causing the pain is played by swelling of the nerve, swelling of its sheath, inflammation or irritation of the muscles which the nerve supplies, or of the fascia over them, or even of the periosteum beneath.

In the young lad shown in fig. 195 the attitude was very like that of 'ischias scoliotica,' and examination under chloroform, twice repeated at intervals, discovered no roughness of the hip-joint. The combination of spinal flexion and pains in the hip and thigh persisted, and at a third examination under chloroform I discovered a distinct, though limited, roughness in the hip-joint. Leaving town at that time, I transferred him to a colleague, who informed me that he cut down upon and found superficial disease of the head of the femur. Of course a case like this is consistent with any hypothesis. It shows, however, that, as in ordinary sciatica, we should not be in too great a hurry to give a positive verdict of absence of serious organic disease.

The subjects of 'neuro-muscular lateral curvature' are nearly all men in early-middle life—*e.g.* about thirty; the curvature comes on either slowly or suddenly, and at any period of the sciatica, from a few days after its commencement up to when it has persisted for months or years. The whole trunk is inclined away from the side of the painful limb, the curve being a low lumbar or even lumbo-sacral one. No true rotation and very little compensatory curvation occurred in such cases as I have seen. I have not had the good fortune to see complete recovery take place, only, I hope, because I had not the cases long enough under observation. But complete recovery does occur, for which and for other reasons it is probable that osseous changes are slow to supervene. However, treatment is very tedious. It should be addressed to the sciatica and to the lumbago, if present. The treatment of sciatica is to be found in treatises on medicine. I will only add that one should not forget the high value of brisk, but not too prolonged, exercise on the bicycle, tricycle, or 'home-trainer,' and caution the surgeon to search repeatedly for signs of some definite lesion of the rectal or urinary organs, of the pelvic organs in females, of the joints in adolescents, and for signs of gout, or syphilis, or gonorrhœa, or of alcoholism, in persons at all likely to suffer from those troubles.

In addition to the excellent papers of Nicoladoni and of Schüdel, whose observations were made under Kocher at Berne, the reader may refer to Albert ('Wiener med. Presse,' 1886, 1 and 3), to Babinski ('Archives de Neurologie,' January 1888), and to Gussenbauer ('Prager med. Wochenschrift,' April 23 and 30, 1890).

Antero-posterior Projections and Curvations (excepting those due to Caries).

I propose to first of all deal with kyphosis, as being a more positive affection than lordosis, which is usually symptomatic or compensatory, and often, therefore, merely temporary.

Although kyphosis almost always has its seat in the upper dorsal or the cervico-dorsal region, there are yet many varieties of this deformity. It varies with its origin and with the age of the person attacked.

In *infancy* occurs *rachitic kyphosis.* There are two essentially distinct varieties of this. One, scarcely worthy of the name, is due to the muscular weakness often associated with rickets. The dorsal muscles have not strength to hold erect the child's back, which then, whenever the child is placed in the sitting position, arches helplessly forward.

The length of the curve, comprehending the whole spine from the lumbo-sacral joint upwards, the complete mobility, the absence of any angular projection suggestive of Pott's disease, the usual freedom from pain and tenderness, the other co-existing signs of rickets, and the ease with which the spine can be straightened or even bent backwards, establish the diagnosis.

In the second or true form of rachitic kyphosis a curve exists, usually in the dorsal or dorso-lumbar region, and of limited extent, due to actual anatomical changes.

In this form either the kyphotic curve does not open at all when the child is laid supine, or else it only does so when the spine above it has been bent into a state of lordosis.

In children beyond the age of infancy it is frequently coexistent with scoliosis, and almost always with unmistakable signs of rickets in various parts of the person.

Its diagnosis from Pott's disease will be given under the heading of 'Spinal Caries.'

The treatment of rachitic kyphosis is practically identical with that of rachitic scoliosis.

Both boys and girls, from the age of about eight upwards, frequently grow what is called 'round-shouldered.' Often this is merely a trick of posture, the result of laziness and lassitude. For its cure perseverance in drilling and educating into a correct carriage should be combined with a careful and observant inquiry directed to finding out any possible cause of ill-health, muscular weakness, or want of dash and style. The condition of the nose, the naso-pharynx, and the chest should be particularly inquired into, the habits and tastes examined. Often children thus affected are very fond of books and disinclined to stir out of doors. Sometimes residence in town or want of suitable companionship will account for this. It is always a difficult and wearisome task to *drive* children out of doors. If they can be taught to excel in any particular outdoor game, and have opportunities of playing it, they will generally take them. As at a very early age girls develop pride in personal appearance and boys in physical strength, these two motives should be judiciously called into play.

The ridiculous idea that a round-shouldered boy or girl can be effectually straightened by 'shoulder-straps,' backboards, and suchlike contrivances had better at once be dismissed from any mind wherein it has found place. If any appliance is used, it should be on the principle of the anterior crutches attached to a support reaching down to the pelvis illustrated at p. 369.

At the adolescent age of which I am now speaking kyphosis is sometimes combined with a degree (usually small) of scoliosis. The treatment is included in that of the scoliosis. Gymnastics are here especially useful.

In early adult life and in middle age kyphosis may be—

(1) The persistence of habits of carriage contracted during adolescence.

(2) Due to causes similar to the 'round shoulders' of adolescence; *e.g.* habits of poring for long periods over books, and chronic illness, especially of the respiratory passages.

(3) Due to occupations causing long hours of fatigue; *e.g.* that of the agricultural labourer.

(4) Scoliotic.

(5) Rheumatic.

(6) Due to what is called 'spondylitis deformans.'

(7) Due to osteitis deformans.

(8) Caused by paralysis.

(9) Associated with albumosuria.

When habits of carriage cause a dorsal kyphosis to persist for years, osseous changes are likely to occur and partially fix the deformity. But, though likely, they are by no means certain, especially during early manhood; otherwise the slouching rustic would not so easily and so often be transformed into the erect soldier.

When kyphosis is associated with scoliosis there is usually a predominant upper dorsal or cervico-dorsal curve. The treatment is simply that of scoliosis (*q.v.*) plus the use of 'anterior crutches' (see fig. 210, p. 369).

Rheumatic kyphosis can scarcely be separated from what has been called 'spondylitis deformans.' Kyphosis due to muscular rheumatism is not so much a deformity as an attitude assumed to relieve pain, and in the intermissions of the disease disappears. The surgeon finds that temporary alteration of the attitude is rather easy, though perhaps very painful.

But kyphosis may be a permanent osseous deformity, due to chronic rheumatoid arthritis; and well-marked cases of this kind are usually described by the name of *spondylitis deformans.*

This disease usually affects the middle-aged and old, but it has been observed as early as even the twelfth year. The subjects are sometimes, but not always, 'rheumatic,' occasionally with a rheumatic family history. At first the sufferer notices only pains in the back, accompanied by stiffness. The pain continues—sometimes worse, sometimes better—for years, the stiffness increasing, and a permanent curvature, with the convexity backwards, of nearly the whole spine—in fact a general kyphosis—coming on and steadily increasing. In the advanced stage a perpendicular let fall from the most posterior point of the kyphotic spinal arc usually falls behind the buttocks, the patient cannot bring his chin down to his sternum, and has a limited range of active stooping, although his passive stoop is marked. As the odontoid process of the axis is often affected, he may be unable to rotate his head. The costo-vertebral articulations may be attacked, and then thoracic respiration becomes greatly interfered with, or even almost annihilated. Changes of position and careful examination go to confirm the diagnosis of a spine whose segments are at least locked together, and sometimes ankylosed by rheumatic changes, including fibrous degeneration of articular cartilage and osteophytic growths. For the pathological changes resemble, if they are not identical with, those of chronic rheumatoid arthritis.

Cases of this disease are fully described in the Clinical Society's 'Transactions,' vol. xii. p. 204 (Dr. Allan Sturge), and in the 'Pathological Transactions for 1877' (Dr. Hilton Fagge). The *post-mortem* changes were originally described by Professor R. W. Smith, of Dublin. There is also a paper on the subject, by Dr. von Thaden, in v. Langenbeck's 'Archives,' vol. iv.

The treatment is that of chronic rheumatoid arthritis; that is to say, it is not a very hopeful or brilliant one. It can be best carried out at such places as Buxton and Bath.

Possibly the rare cases in which not only is the spine rigid, but osseous buttresses extend from rib to rib, are related to the disease under notice. Mr. Stephen Paget recently showed a boy so affected at the West London Medico-Chirurgical Society.

The Kyphosis of Osteitis Deformans.—The chief points in connection with this rare disease are thus given in my 'Index of Surgery,' second edition, p. 62: 'General enlargement of the bones, with sufficient softening to permit loss of height (several inches), through arching of the long bones of the lower extremities and bending forward of the head on the breast; ribs also thick and immovable; skull thickened; cranial sutures obliterated; compact substance greatly increased. According to Butlin, the microscopic changes indicate that the disease is an inflammation rather than a new growth. In this view Paget concurs; hence the name "osteitis." But the frequent coincidence of sarcoma or carcinoma with this affection is most remarkable. Little or no pain usually; only clumsiness. Disease lasts for years, and death has often occurred from the intercurrence of the above-mentioned malignant tumours. The usual remedies for other forms of osteitis appear to be of no avail.'

This disease was originally studied by Sir James Paget, and described by him in the 'Roy. Med. and Chir. Trans.' for 1877. A special number of the 'Illustrated Med. News' for February 23, 1889, was given to it, with many photographs, articles by Sir James Paget and Mr. Jonathan Hutchinson, and cases by Messrs. John R. Lunn, Edmunds, Bowlby, Stephen Mackenzie, and Tom Robinson.

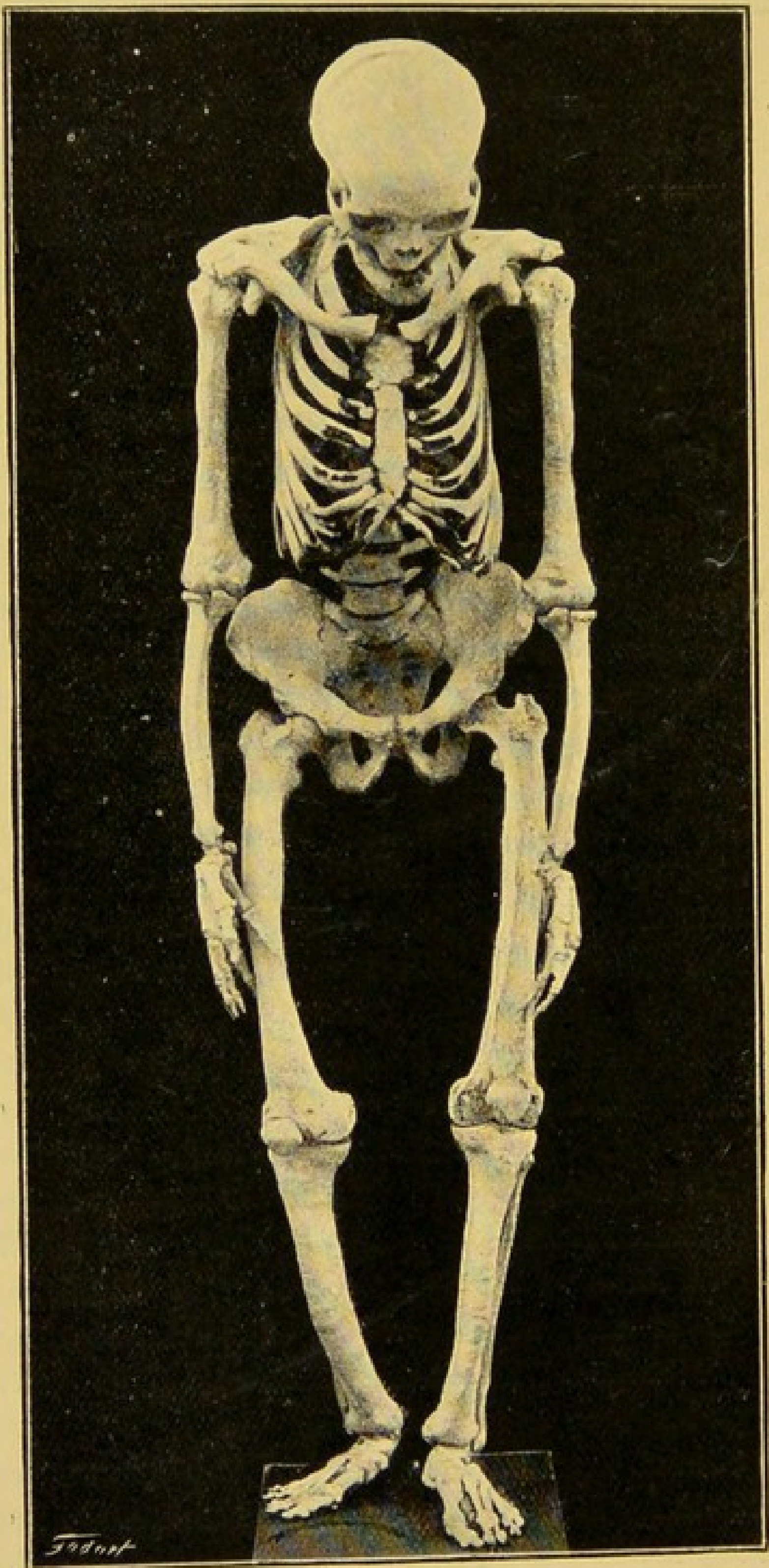


Fig. 212.—From one of Mr. Lunn's cases. The specimen is in St. Thomas's Hospital Museum.

Osteitis deformans commences in middle life, three times as often in men as in women, and progresses slowly, the patients often enjoying good general health. Many die ultimately of malignant disease. The appearance, postures, and movements of the patients are characteristic. The hands, when hanging down, reach lower than normally, owing to the curved back and consequent loss of height. The patient stoops, with shoulders rounded and head far forward, and the chin more or less raised. The chest is 'sunken towards the pelvis, the abdomen pendulous; the curved lower limbs are held apart, and usually with one advanced in front of the other; the ankles are overhung by the legs and the toes turned out. The enlarged cranium, square-looking or bossed, may add distinctiveness to these characters, and they are completed in the slow and awkward gait of the patient, and in the shallow costal breathing, compensated by wide movements of the diaphragm and abdominal wall, and in deep breathing by the uplifted shoulders.' There is generally, but not always, a tendency to symmetry. Occasionally there are signs of rheumatoid arthritis. The bones affected are greatly thickened, as if by chronic inflammation.

Osteitis Deformans affecting a Single Bone.—Cases have been observed by Walter Edmunds, by Bowlby, and by myself. My own patient was a woman past middle age; the bone affected, the right tibia. Some years after the deformity appeared she fell and broke the limb. The final result of this accident was considerable improvement in the shape of the limb. In Edmunds's case the right tibia was the bone affected, in Bowlby's the right femur.

Spinal Deformity with Albumosuria and Myeloid Sarcoma.—When, in adult, and especially in advanced life, such deformity comes on as marked dorsal kyphosis, or any other such bone curvature as occurs in osteitis deformans, the urine should be inspected.

In certain rare cases—about eight have been published—a condition termed 'albumosuria' has been found. The sufferers, almost if not quite always, are the subjects of sarcomatous changes in the bones, such as have been described under the names of 'multiple myeloid sarcoma' and 'myelogenous round-celled sarcoma.'

An admirable and exhaustive description of the urine in

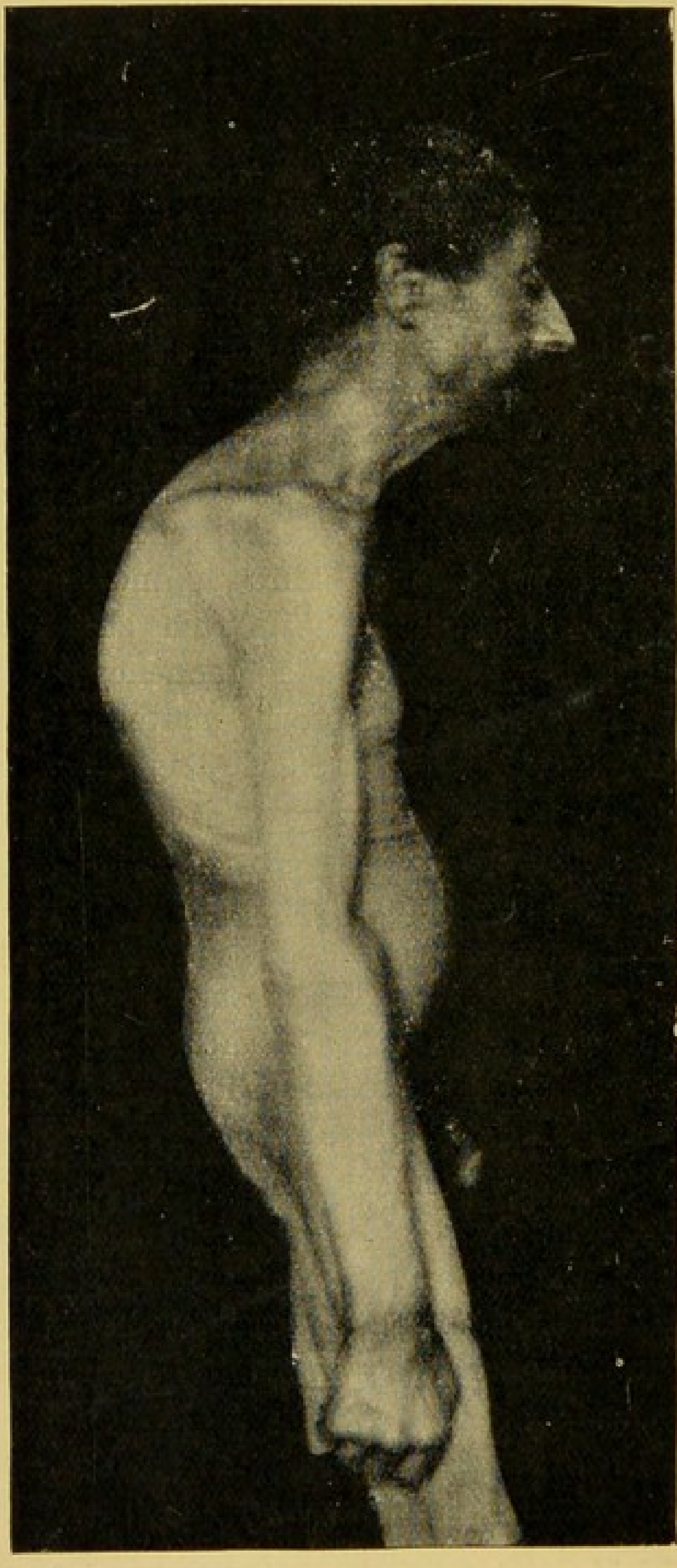


FIG. 213.—DR. BRADSHAW'S CASE OF ALBUMOSURIA.

such a case is given by Dr. Bradshaw, of Liverpool,[1] who has kindly lent me the illustration here given.

The urine contains a nitrogenous compound of uncertain nature. By some it has been regarded as hetero-albumose, one of the products of the gastric digestion of albumin. Bradshaw does not agree with this view. The amount present in his case varied from 6 to 22 per 1,000, and often caused the urine to look turbid and almost like milk or a mixture of milk and urine. An abundant white sediment fell when the urine stood. Collected on a filter, it formed a glue-like mass, which gave the colour reaction of a proteid, and was digested by artificial gastric juice. It was almost insoluble in cold distilled water and in dilute solutions of common salt, but was quickly dissolved in a cold weak solution of caustic soda (2 parts per 1,000), in strong acetic acid, and to some extent in boiling water.

The urine, even when the deposit had been removed by filtration or decantation, was remarkably viscid, almost syrupy in consistence, and formed a persistent froth when shaken in the air.

When carefully heated on a water-bath it became turbid at or even below 50° C., and absolutely opaque between 56° and 60°, throwing down a dense white precipitate.

The proteid body is also thrown down by mineral acids.

Bradshaw further points out that it must not be confounded with the albumose which occurs in minute quantities in the course of specific fevers, &c., which albumose has very different characters.

Bradshaw's patient was attacked at the age of sixty-nine after domestic worry. He had a small rodent ulcer on the side of the nose. It was excised. Two years after the first onset he was reported to be confined to bed in consequence of weakness and distressing pains in the back and loins, much aggravated by movement. Marked tenderness over ribs and sternum. Bronchitis, with viscid expectoration giving the nitric acid reaction of albumose. Spontaneous separation of the second right rib from its cartilage, followed by a localised painful swelling. The lung troubles were, however, got rid of. The

[1] *Trans. Roy. Med. and Chir. Soc.* 1898, p. 259.

patient was able to get up. Vertebral column completely immobile below sixth dorsal vertebra. Apparent loss of two inches of height.

In *advanced life* kyphosis may be due to any of the causes above discussed; for even kyphosis due to rickets does not prevent the child affected from eventually reaching old age.

There is, however, a form of kyphosis which is so common in old age that its absence is regarded as more exceptional than its presence. It is the characteristic old man's stoop, the result of muscular weakness, or of habit, or of both. It often commences in middle life. In fact, it is apt to come on *pari passu* with the disappearance of the elasticity of youth. It is justly considered to be the result of care and loss of gaiety as much as of weakness of the muscular system. The latter, indeed, often does not exist. Care brings thought; thought bends the eyes downward; the head and neck follow, and then come the arching shoulders, on which the load of care is often figuratively said to be borne. And what is to be done?

> 'Oh for the foot that bounds forward,
> And ever the wind it awakes,
> Lifts no lock from the forehead that's whitened,
> No leaf that is withered yet shakes!'

It is vain to preach gaiety and cheerfulness to a man every month of whose life for many a year may have brought home to him the fact that life is more of a tragedy than a comedy. But the simple, commonplace truth remains that habits of erect carriage, such as those of the soldier, will often last far into old age. It is, therefore, in youth and middle age that measures must be taken to ward off the kyphosis of advanced life.

Mere shoulder-straps, such as those which have a dorsal plate behind, from each side of which axillary loops are carried over the shoulders and back again under the axillæ, fail from the fact that the forward drooping of the shoulders is a mere effect of and index to the dorsal kyphosis. The jacket with anterior crutches may be used.

It is while working in the sitting or standing posture that this apparatus should be chiefly worn. While walking or playing the patient should be taught and encouraged to straighten himself (it is usually herself) by muscular force.

Lordosis.

In an immense majority of cases lordosis is simply temporary, secondary and 'compensatory.' Kyphosis, when con-

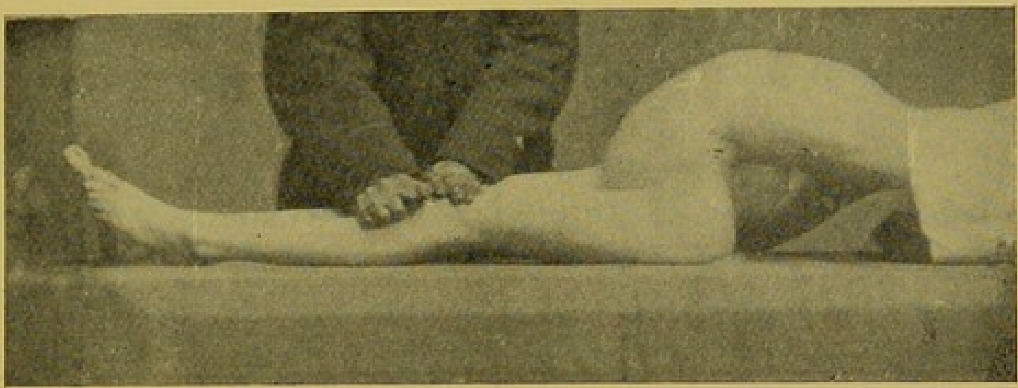


FIG. 214.—EXTREME LORDOSIS DUE TO ANKYLOSIS OF HIP. This disappears when the knee is raised till the thigh becomes perpendicular. It was cured by osteotomy of the hip.

fined to the dorsal region, as it usually is (except in old age, in 'spondylitis deformans,' and in 'osteitis deformans'), is almost invariably accompanied by a compensatory lumbar lordosis.

The flexed and adducted position in which the hip-joint usually ankyloses necessarily causes lordosis, often extreme. So also does the peculiar condition called 'congenital dislocation of the hip.'

The lordosis compensatory to Pott's kyphosis will be noticed along with 'Caries of the Spine.'

Lordosis is sometimes a racial peculiarity, especially among the Hottentots.

FIG. 215.—LORDOSIS FROM CONGENITAL DISLOCATION OF RIGHT HIP.

Lastly, there is congenital lordosis. It may be caused by paralysis of either abdominal or dorsal muscles.

In infants and young children, and more rarely in later life, cervical lordosis occurs temporarily as a symptom of cerebral or cerebro-spinal irritation; and severe lordosis may come on rapidly as a result of infantile paralysis.

Causes of Lordosis.—The principal have just been indicated. There are various circumstances under which persons acquire an habitual carriage with the lumbar spine arched convexly forwards. There is the necessity for carrying a burden in front of the person. This burden may be external to the economy; *e.g.* a heavy tray containing wares for sale. It is more frequently internal, as in the case of fat people with large bellies and of women in the pregnant state. Instead of healthy fat or pregnant womb the abdominal burden may be pathological; *e.g.* ascitic fluid or an ovarian tumour.

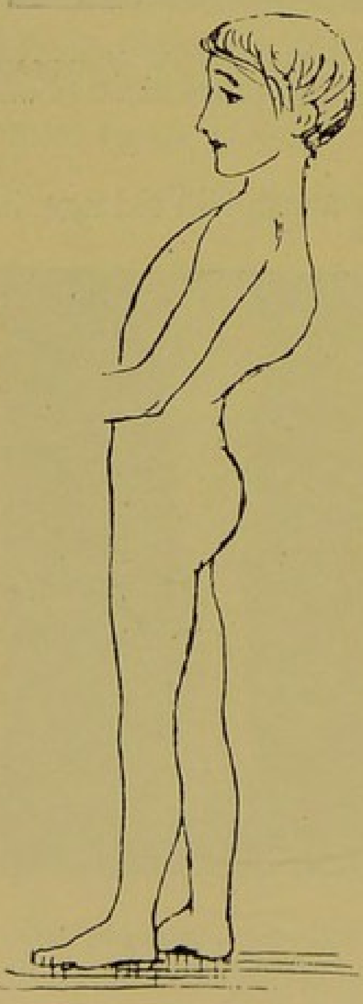


Fig. 216.—Lumbar Lordosis compensatory to Dorsal Kyphosis caused by Caries.

The anatomical changes whereby the habitual lordosis becomes fixed (when it does become so) are said to be rather of the nature of shortening of the ligamenta subflava than marked changes in the vertebral bodies. It is, however, rare for lordosis to become fixed at all.

I have hitherto written of lordosis as if it were almost exclusively lumbar. In truth it seldom affects the cervical, and still more rarely the dorsal, spine. I have never seen anything like dorsal lordosis, except as a compensatory curve in cases of sharp angular curvature from caries, and in a few exceptional cases of scoliosis.

The walk as well as the figure is affected by lordosis.

Sacro-lumbar lordosis makes the sacro-vertebral angle unusually prominent and alters the plane of the pelvic brim. It should be taken into account in midwifery.

Ankylosis of the affected vertebræ takes place much less commonly than in kyphosis.

Treatment.—Lordosis being usually symptomatic, also usually disappears with the removal of the cause. Soon after I began duty at the Surgical Aid Society a patient was sent thither with a lumbar lordosis so marked that when the knees were straight and the patient standing the buttocks presented a kind of horizontal ledge. With her came a note asking for an appliance, including a corset and leg-gear of leather and steel, the cost of which was estimated by our instrument-maker at 7*l*. She had ankylosis of one hip. I did supra-trochanteric osteotomy, which straightened her hip and cured her lordosis. I have since osteotomised thirty other cases, with like result. But I still occasionally see patients in the same state who have been recommended by their medical attendants to obtain a spinal support or a Thomas's hip-splint to correct their lordosis. Upon communicating with the medical men I have, with one exception, always found them ready to agree with that view of the case which I have above endeavoured to set forth. The single exception was that of a hospital surgeon who insisted upon having a Thomas's splint made for a case of hip ankylosis, under the idea that in time the hip would 'come down.' The Pyramids will come down first.

Concerning the lordosis of fat people nothing need be said, and about that of pregnancy little can be said. A good abdominal belt will sometimes relieve troublesome subjective symptoms in either case.

When lordosis occurs as an independent deformity, and not as a mere symptom, the true remedies are to be found in drilling, gymnastics, and in all means of strengthening the general health.

The particular exercises are such as strengthen the muscles of the back and flanks, and train the body to an upright carriage. Rowing is very good, but it must be practised in correct style, with a flat back. The round-backed oarsman may be temporarily correcting his lordosis, but he is not, as a rule, properly exercising his back and flanks. Horse exercise and 'cycling' are good, it still being assumed that they are practised in good style. Simple calisthenic exercises are excellent; *e.g.* keeping the knees straight and bowing forward as far as possible, rising again, and repeating. The horizontal and parallel bars and the rings also are to be recommended. It should be the patient's constant endeavour to carry himself with head erect, abdomen and shoulders back, and chest forward. The gait and posture of the lordotic are so often due to weariness and exhaustion that it is worth while to search for some cause of that kind of trouble; *e.g.* overwork, dissipation, or obscure chronic illness.

It is constantly prophesied that cycling will make the rising generation of young men round-shouldered. Is it really having any such effect? I do not believe so.

CHAPTER XVII

CURVATURE OF THE SPINE DUE TO CARIES ('ANGULAR CURVATURE OF THE SPINE')

CARIES of the spine is in almost every case, without exception, the result of local infection with the *Bacillus tuberculosis*. How far traumatism plays a part in its etiology is a secondary question. The personal and family histories of the patients agree with this view. When a child with undoubted tubercle of the knee or other joint is attacked elsewhere, the second place to succumb is frequently the spine. When, in a patient with caries of the spine, a lung or some joint in the limbs is also attacked, the area newly diseased is found to be infected with tubercle. Just as a certain proportion of tuberculous knees suppurate, while others run their course with signs only of caries sicca, but are none the less tuberculous, so also is it with caries of the spine. And in the knee cases and the spinal cases alike, when suppuration takes place, the burrowing pus forms abscesses whose clinical features are similar and are pathognomonic. One feature alone is enough to define those which are of sufficient duration: they are lined with a membrane which the practical surgeon recognises at a glance, and in which the skilled pathologist demonstrates the bacillus which is the essence of the disease. The case has to be put in this way because there are not the same numerous opportunities of direct examination of a carious vertebra as there are of a diseased femoral condyle. In every case of knee excision the latter may be examined, as it were, *in vivo*; but the vertebra is seldom accessible, except *post mortem*, and *post-mortems* are not common among out-patients, to which class most spinal cases belong.

But it must not be supposed that the tuberculous nature of caries of the spine is suspected or known only from a study of resemblances. It has been laid down that 'the absolute demands of pathological inquiry concerning the tuberculous nature of a given lesion are satisfied by demonstration of the following features:

'1. Presence of the ordinary clinical features peculiar to such cases.

'2. Presence of ordinary histological structures of tubercle, *e.g.* giant cells, &c.

'3. Presence of tubercle bacilli, as shown by proper procedures.

'4. Result of culture experiments.

'5. Result of inoculation experiments.

'For all ordinary purposes it may be held that compliance with any three of the above five postulates will be convincing proof of the tuberculous nature of any case or specimen.'[1]

And the majority of these five postulates can be complied with in cases of spinal caries in which abscess or death has made direct pathological study possible. But, of course, no postulate but the first can be acceded to in the great majority of cases at the time they come under treatment.

Quite recently it was the custom to note intently the complexion of the skin, the texture of the hair, and the colour of the eyes. When the patient's appearance was delicate, the case was pronounced strumous and constitutional; when otherwise, the very nature of the case was supposed different. We do not now, when standing before a new patient with caries of the spine, commence by noting the length of his eyelashes. The backwoodsman might as well pause to measure the snake's tail when he heard its rattle. The surgeon now recognises in all cases of spinal caries (the exceptions are utterly insignificant) the presence of an enemy more deadly to mankind than all the rattlesnakes in America, an enemy which kills a thousand human beings while the cobra and its venomous kindred are slaying ten.

How does the tubercle bacillus enter the body? Generally this is a matter of conjecture. The possibility of inoculation has been proved by innumerable experiments on animals, and

[1] Roswell Park (after Charcot, &c.), *Annals of Surgery*, i. 236.

by a few accidental cases observed in man. But it can hardly be the usual mode of accidental transmission. The food is far more likely to be a common vehicle, especially as the liability of cows to tuberculosis is certain. There is a possible mode of inoculation which is generally out of the question in spinal cases, viz., by coitus. I believe there has been reason to suspect it in many cases in which the wives of tuberculous husbands have become tuberculous. I had, *e.g.*, under my care, with Dr. Henry Wilcox, a middle-aged woman with caries of the spine who has lost her husband from phthisis; and I have this day seen, with Dr. Robert Wharry, a patient whose tuberculous testicle I removed a fortnight ago, and whose wife five years ago died of phthisis. But cases like these are seldom more than suspicious, and, bearing in mind how nearly parallel are the conditions of existence to which husband and wife are subject, one should be slow to assume that both are not merely victims of the same external influences rather than one the infector of the other. There are many ways in which danger of tuberculous infection may occur; for instance, eating food prepared or served by a tuberculous person. The mere presence in the house of an individual with any form of tuberculous discharge cannot be free from danger. A father used frequently to bring to me a child whose tuberculous ankle I had excised. Sinuses existed before, and discharged for some time after. When the child had recovered completely, the father, who had dressed its wounds with his own hands, fell ill, and died of rapid phthisis. Soon his favourite little girl developed spinal caries. The elder children, nearly grown up, who came less

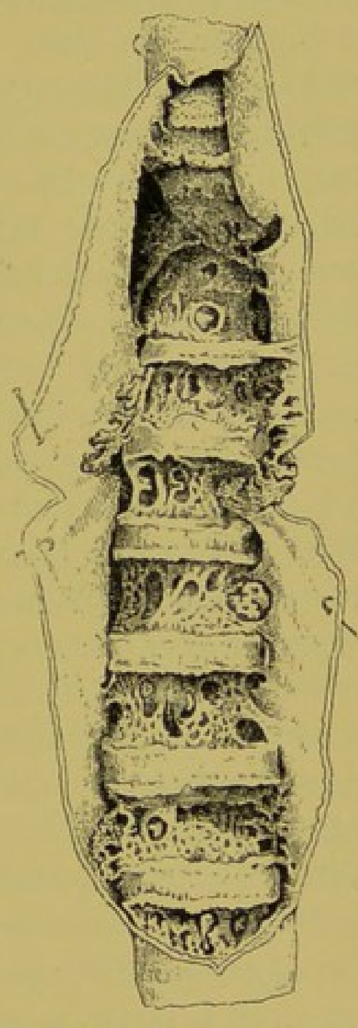


Fig. 217.—Extensive superficial Caries of Anterior Surfaces of Vertebral Bodies (after Hoffa).

in personal contact with the tubercular ones, remain healthy. It would be easy to go on multiplying instances in which personal association has seemed to spread tuberculosis. Formerly by all medical men, and still by many, these, in the presence of blood relationship, are put down to heredity, because, of course, close association is commonest and most intimate in families.

I cannot help being of opinion that the influence of heredity (at least its extent) is still very much an open question, *because* (1) those illustrious surgeons who support it, including even Sir James Paget and Professor v. Volkmann, have never, to my knowledge, made any regular attempt to eliminate such influences as those of intimate personal association, and the parallel circumstances and habits which dominate family life; (2) because their judgments are confessedly rather of the nature of impressions than things weighed and measured; and (3) because in the lower animals comparatively small differences in the *dose* of a bacterial poison are found to exceed the individual differences in susceptibility observed among creatures of the same species.

The entrance of the tubercle bacillus into the human body, or at least its domicile there, seems to be especially favoured by lack of fresh air and light, by excess of moisture, and especially by dampness of soil. Other lowering influences, such as insufficient and faulty food, co-operate.

How is the localisation of tubercle in the body determined? The doctrine of 'pars minoris resistantiæ,' added to the fact that a large proportion of cases presented a history of accident, has been long well known. Further, we have the observations of König and v. Volkmann on the frequency of wedge-shaped infarction-like areas of tubercle in the epiphyses of bones, and the experiments of Max Schüller and others, in which tuberculosis was artificially localised by mechanically injuring the epiphyses of animals by whom tuberculous matter had been taken.

In 1878, Max Schüller commenced a very important experimental inquiry. 'Causing healthy animals to ingest or inhale tuberculous matter, he then inflicted various bruises or injuries about their joints. Around every joint injured under these circumstances there developed that lesion best known as tumor albus, and presenting its proper peculiarities on anatomical investigation, while the animals rapidly succumbed to general tubercular infection.' Professor Roswell Park, from whose admirable essay[1] I am quoting, adds that further experiments made by others have corroborated Max Schüller's statements.

The clinical evidence bearing on the influence of traumatism in their causation is, in the vast majority of cases of spinal caries, very inconclusive either for or against. Injury is mentioned in the histories of a large proportion of cases, and not mentioned in a proportion even larger, unless the surgeon presses the informant with leading questions until a history of injury is invented. The particular injuries accused can sometimes be proved by the surgeon to have followed the onset of the disease, although they have preceded its discovery. It is not so easy to tell whether or not a given accident may have long preceded the localisation of a process so insidious as tuberculosis of bone. Generally the accidents related are such as few children escape. This consideration admits of two interpretations, and has been urged by Professor Sayre in favour of the peculiar views he used to advance, namely, that angular curvature is purely traumatic in origin. He used to go so far as to assert that, the more vigorous the child, the more likely it was to get a diseased spine, and, when no history of accident could be elucidated in a case, would conclude that the injury had been too slight to attract notice, or at least to be remembered.

This view is irreconcilable not only with pathological facts, but with clinical. How unlike any history of pure traumatism is that of those cases of spinal caries which, in spite of rest, and fresh air, and all other treatment, progress implacably!

> Like to the Pontic sea,
> Whose icy current and compulsive course
> Ne'er feels retiring ebb.

A not inconsiderable proportion of cases (I should say 5 per cent.) follow, with rather suspicious closeness, such

[1] *Annals of Surgery*, i. 237.

illnesses as whooping-cough and measles; but the commonness of such diseases of childhood deprives the fact of much significance. Colas found that in 7 cases out of 72 there was a history of pertussis preceding the appearance of spinal caries.

It would not be right to conclude these remarks on etiology without reference to what has been termed 'the scrofulous diathesis.'

The term 'scrofula' and its synonym, '*struma*,' have been used to express the idea of a diathesis rather than that of a disease. The characteristics of this diathesis (if it may really be so called) are neatly given by Billroth as follows: 'Exists chiefly during childhood, though more advanced ages are not free from it.' 'Persons with this diathesis, especially children, are greatly disposed to chronic inflammatory swellings of the lymphatic glands, even after inconsiderable irritations; to certain inflammations of the skin (eczema, impetigo), especially of the face and head; to catarrhal inflammations of the mucous membranes, especially of the conjunctiva, more rarely of the intestinal canal and respiratory organs; to chronic inflammations of the periosteum and of the synovial membranes of the joints.' If we give due weight to the observations and arguments of Koch and others, we shall regard the above-named local lesions as being due to the direct influence of the tubercle bacillus. It becomes then a question whether we have not been in the habit of using the words 'scrofula' and 'struma' in a vague and not quite consistent way, as meaning sometimes a mere tendency to be troubled with a diseased essence (so to call it), which we now know to be the tubercle bacillus, and sometimes, on the other hand, an actual state of suffering therefrom. The use of the words in question is a practice which cannot at present be either easily or usefully given up. However, in view of the uncertainty and want of knowledge respecting what class of persons, if any, are very specially predisposed to be infected with tubercle, the words 'scrofulous' and 'strumous' should be used as signifying actually infected with the tubercle bacillus. Certain general appearances of the person are described as scrofulous types, especially two, viz.: (1) thick lips, muddy skin, coarse features, pot-belly, flabby muscles, often with tendency to fatness; (2) fair, thin, clear skin, long eyelashes, fine hair, pearly teeth, bright, refined, 'delicate' look. These so-called typical appearances are of doubtful diagnostic value; and the appearance of delicacy corresponding to type (2) is often caused by the disease itself, and in no other way indicative of a predisposition to scrofulous inflammations.

Lastly, cases of vertebral tuberculosis may be divided into those which are *primary* and those which are *secondary*, those cases being termed 'secondary' in which the spinal affection has been preceded by a tuberculosis localised elsewhere. But it is by no means clear in each case that the 'primary' and 'secondary' local affections stand to each other in the relation of cause and effect. For instance, both may be the result of the same dose of poison introduced into the blood, and, in cases in which many years have not intervened, the so-called 'secondary' infection may have preceded the primary, but remained latent. Also each local manifestation may be due to a separate infection of a person perhaps specially exposed or abnormally susceptible to tuberculosis. In the practical study of individual cases I frequently find some or all of these questions have to be left open.

Pathology.—If the experiments of Max Schüller above noticed have the force claimed for them, there ought to be a primary stage of osseous tuberculosis, in which signs of some trivial injury—*e.g.* slight extravasation of blood or rupture of solid tissue—would be found co-existent with a small deposit of tubercle. I do not know that any such observation has been made, even in the ten (now twenty) years elapsed since Max Schüller's experiments, either on the spine, or the knee, or the hip, or any other seat of osseous tuberculosis. One must not, of course, forget that the opportunity for such observation is rare. Nevertheless, in the autopsies made on persons who have died of advanced tuberculosis affecting one region it is common to find incipient disease in other parts. How often does local tuberculosis, when thus discovered, and however incipient, coexist with signs of injury, either recent, such as an extravasation, or past, such as a cicatrix? Never, so far as I know.

The earliest pathological appearances in a case of spinal tuberculosis have been found in the substance of the vertebral bodies, usually near the surface, and especially the anterior surface. They consist of aggregations of grey tubercles, usually circumscribed and of limited size, but sometimes diffused over a great part, or even the whole, of the vertebral body affected.

Hence the division, first made by Nélaton, of tubercle of bone into the *circumscribed* and the *infiltrating* variety.

In the first form the resulting sequestra are small, sometimes scarcely deserving the name—in fact, mere spicules and granules—*débris*. In the second, a large part, or even almost the whole, of a vertebral body may be reduced to a single coherent mass of dead bone.

It may be that from the beginning two opposed influences contend, the one destructive, and the other plastic and healing; but at first, and for a long time, the former is in the ascendant. The bone rarefies, its cells undergo a fatty degeneration; the tubercles themselves are similarly changed; and in this way results a mass of ragged rarefied bone, with spaces occupied no longer by living cells and vessels, but with cheesy material. Or, as above stated, of the bone framework itself nothing remains but spicules and granules.

Usually, sooner or later, a 'cold abscess' starts from the seat of disease.

Frequently only one or two vertebræ are affected, but not less frequently as many as four or five. Even the bodies of a dozen have been found destroyed, and in one recorded instance every vertebra, from the axis to the last lumbar, was seen eroded on its anterior surface.[1]

Roughly speaking, the disease commences in the dorsal region nearly twice as often as in the lumbar, and in the lumbar more than twice as frequently as in the cervical. These proportions seem to correspond to the relative number *and mass* of the three classes of vertebræ. Cervico-dorsal and lumbo-dorsal caries occur, and the latter is common. Almost always the several diseased vertebræ are adjacent to one another. Often the tuberculosis is deep in one or more

[1] Gros's case. Lannelongue, *op. cit.* p. 51.

bones, and only superficial in those above and below them. Sometimes the disease is wholly superficial, in which case little or no angular deformity results.

But in the latter class of cases intervertebral cartilages are frequently destroyed. There are no anatomical facts to prove that tuberculosis ever attacks these cartilages primarily.

Consequent on the destruction of the vertebral bodies and discs the spinal column tends to collapse anteriorly, and thus results the posterior 'angular curvature,' projection, or boss. The inflammatory processes are not entirely confined to the bodies of the vertebræ, but they are less destructive to the pedicles and far less destructive to the laminæ, transverse, articular (intervertebral and costo-vertebral), and spinous processes. Indeed, in them plastic activity eventually predominates, resulting in beneficent ankyloses and natural splints.

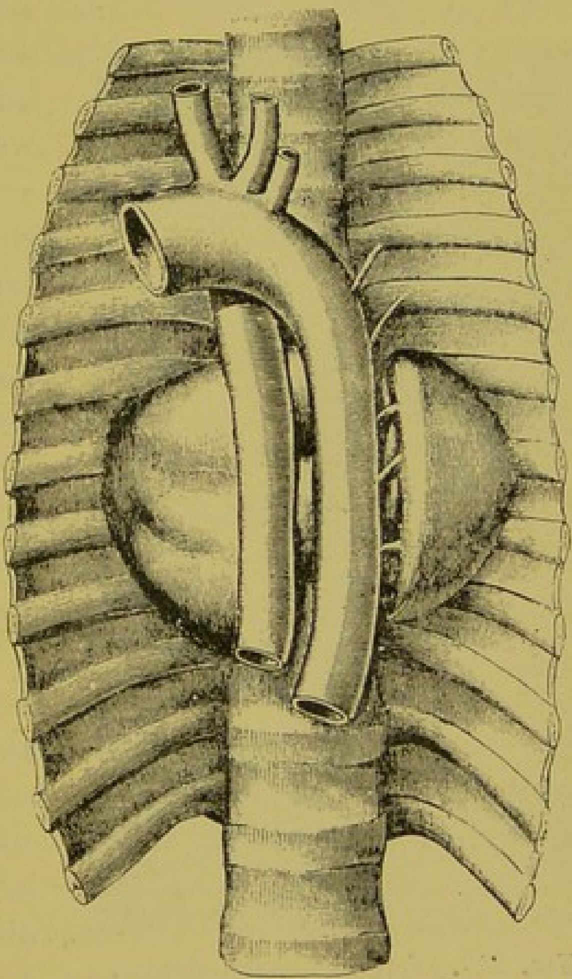


Fig. 218.—Dorsal Caries. Median and Lateral Abscess in the Thorax, traversed by Intercostal Arteries (after Lannelongue).

If only one vertebral body is destroyed, the corresponding spinous process generally appears displaced backwards, and such angle as exists is sharp. When the destruction affects a longer series of vertebræ the boss gets more rounded.

In exceptional cases the destruction is so much greater on one side than on the other that the resulting deformity is latero-posterior instead of directly posterior. This is commonest in lumbar caries.

The upper segment of the spine sometimes falls so far forward and the lower backward that the two actually come in contact. Compensatory lordosis occurs above and below. Secondary alterations result in the thorax and in the pelvis.

In middle and lower dorsal disease the antero-posterior diameter of the chest is increased, often greatly, the larger ribs grow more horizontal, and the sternum presents a bold curve with convexity forwards and upwards.

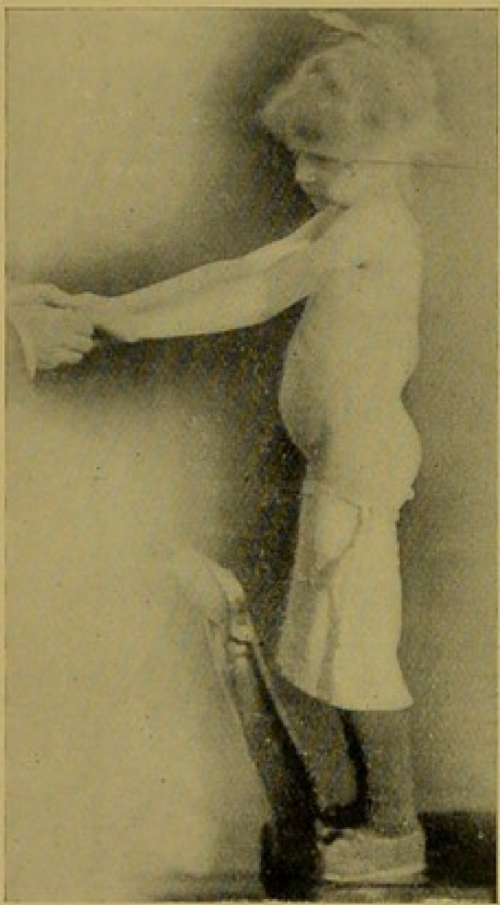


Fig. 219.—Lower Dorsal Caries. (Photo by Dr. James Allan.)

In upper dorsal disease the thorax is, as it were, flattened downwards and backwards, and the ribs tend to descend perpendicularly. The trunk is shortened. Therefore, the arms developing normally, the hands may reach nearly to the knees as the patient stands.

The pelvis is altered in shape only when the disease attacks children or young adolescents. The secondary changes result chiefly in enlargement of the inlet and diminution of the outlet. In dorso-lumbar disease the curve of the sacrum is more or less straightened. The intervertebral foramina are seldom or never narrowed, and are sometimes enlarged. Hence the nerves escape direct pressure by the bones. The vertebral canal is very rarely narrowed sufficiently to cause compression of the cord, which, in its sheath, being much smaller than the canal, normally hangs loose therein.

When compression of the cord or nerves does take place, it is the result mainly of changes in the adjacent soft parts, as will appear presently.

Spinal Abscess

This is the commonest and most important of the serious complications of vertebral tuberculosis. The recognition of the interrelationship of the bone disease and the abscess is curiously recent. Le Dran is said to have noticed the coincidence, but to have been uncertain as to which was cause and which effect. Pott expresses himself on this point definitely as follows: '17. That, contrary to the general opinion, a caries of the spine is more frequently a cause than an effect of these abscesses.' Further, it is clear from pp. 48 and 55 of his 'Remarks,' published in 1792, that he had, practically speaking, as sound knowledge on this point as we have now. He describes the disease as scrofulous, and calls the chronic abscesses 'bags' and 'cysts,' just as we now speak of them by the name 'tuberculomata.'

In fact, though suppuration does in the great majority of cases ultimately complicate vertebral tuberculosis, it is in a great proportion of cases very slow to form an abscess large enough to be seen, or even felt, and frequently never advances so far in the whole course of a given case.

These abscesses have long been distinguished by the prefixes 'cold,' 'congestive,' and 'chronic,' and their rough differences from acute abscesses repeatedly noticed and described. Knowledge of their actual nature is recent. It may be summed up in one statement. They are truly, as Lannelongue names them, 'tuberculomata.' Indeed, they might, not inaccurately, be termed 'tuberculous cystic tumours.' They, excepting those which are small and interosseous, are the products of tuberculous infection of the soft parts near the tuberculous bone. They have a wall, of old well known as pyogenic membrane—their active living part, its outer layers containing Koch's bacilli and grey tubercles, its inner layers comparatively inert, like the fluid contents of the whole.

The most striking feature of these abscesses is their inclination to extend far away from the point of origin, especially downwards. They travel in the line of least resistance, *i.e.* along planes of loose cellular tissue, interfering but seldom with tough fibrous structures, and then only when hemmed

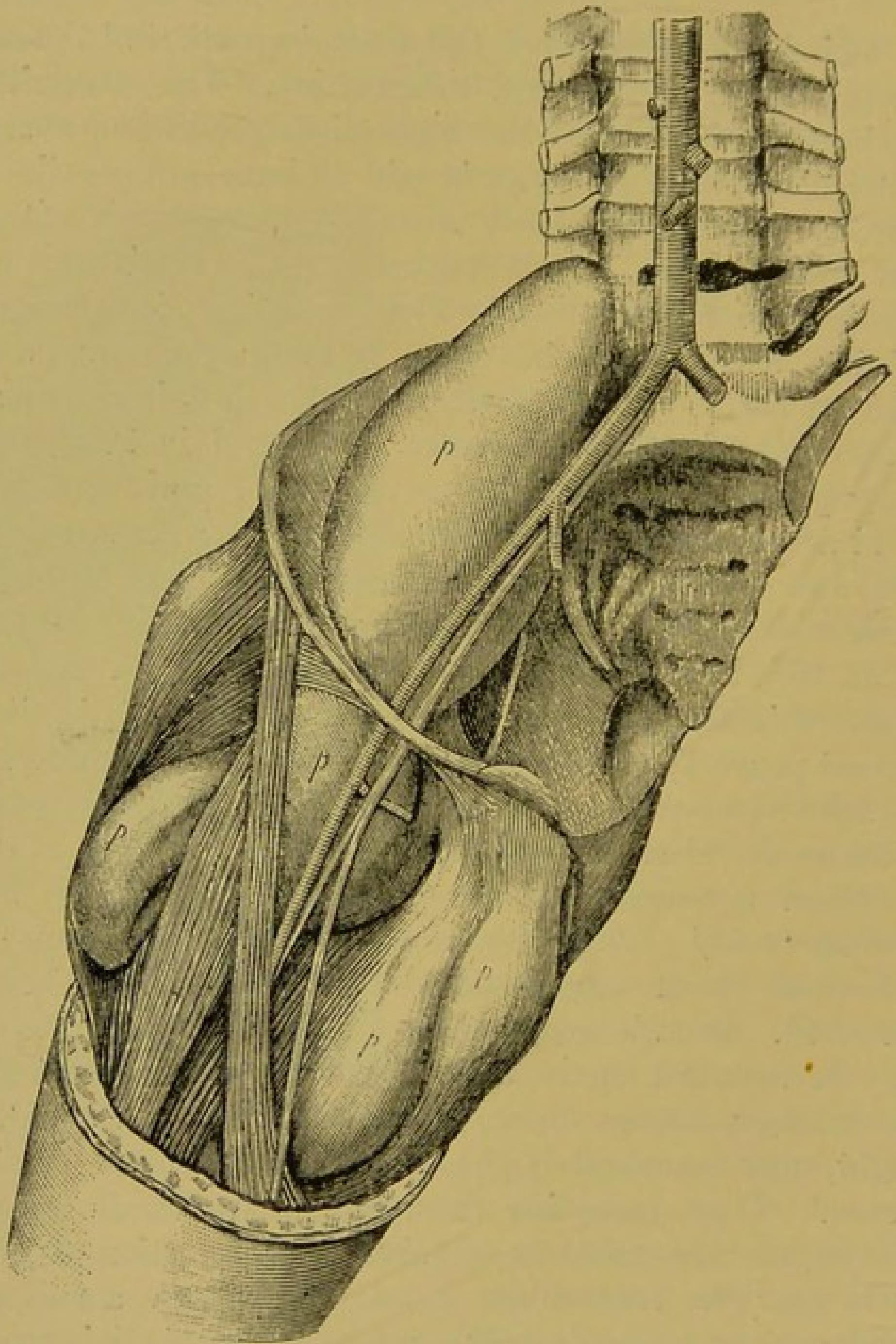


FIG. 220.—LARGE ABSCESS OF LUMBAR ORIGIN, WITH SEVERAL POUCHES (INJECTED WITH PARAFFIN IN THE SPECIMEN). Its course follows the iliacus muscle. From the chief cavity in the thigh it gives off diverticula which turn upwards into the buttock, and others which turn inwards into the adductors. (From Lannelongue, *Tuberculose Vertébrale*, p. 85.)

in. Hence the larger vessels and nerves usually escape destruction.

The exact position of these paths of suppuration varies with the particular vertebræ diseased.

It will be understood, and should be remembered, that when once the pus, after perforating deeper fascia, has become subcutaneous (or submucous), there are no strict limits to its wanderings, so long as it remains unopened. In fact, all large abscesses which have approached near to the surface consist of a subcutaneous *atrium*, as it may be called, communicating with the deeper and more important cavity through an opening often extremely narrow.

With *cervical* caries the abscess, if in front of the spine, raises the anterior common ligament (being slow to destroy either it or its processes), and is 'retro-pharyngeal.' If lateral (it is sometimes bilateral) it tends to present in the posterior triangle of the neck, travelling thither along the nerves of the cervical plexus. Sometimes it perforates the trapezius.

In rare instances a cervical abscess may open below the clavicle or burrow into the axilla.

'Retro-pharyngeal' abscesses are apt to burst into the pharynx, œsophagus, or even the trachea.

With *dorsal* caries, if above the eleventh dorsal vertebra, the pleura, on one or both sides, and the anterior common ligament are first raised and then attacked. The œsophagus and aorta are displaced, and any or all of the thoracic viscera are liable to be compressed. Disease spreading to the pleura, and thence through to the lung, may perforate the bronchi. The abscess may discharge through these or the œsophagus;

Or it may pass backwards between the ribs;

Or even upwards, becoming a cervical abscess (*q.v.*);

Or downwards, through one of the natural openings in the diaphragm, or through an aperture formed by ulceration. The abscess is then, of course, abdominal.

With *caries of the last two dorsal* vertebræ pus usually descends in the sheath of the psoas.

With *lumbar* caries the abscess is usually psoas, lying in the muscle-sheath, either in front, behind, or laterally to the muscle, which is liable to be greatly eroded, or even almost entirely destroyed.

The psoas sheath is perforated either above or below

Poupart's ligament. If the former, the abscess extends in either the iliac fossa or the lumbar region, perforates the muscles of the abdominal wall, and presents either in the loin or the groin, or the 'atrium' may spread downwards over the iliac crest towards the buttock. If the abscess reaches the thigh, it tends to open usually in Scarpa's triangle, but sometimes on the inner aspect of the thigh. Various exceptional courses have been described, without its being clearly stated whether it was the deep part of the abscess or merely the subcutaneous which had travelled so far.

Lumbar abscesses often spread in the perinephric tissue, and may destroy the kidney. Or they descend into the pelvis, open into the rectum, vagina, or bladder, or backwards through the great sacro-sciatic foramen to the buttock. The ureter has been opened (in a case of Lannelongue's), or it may be merely compressed. Compression of the iliac vein sometimes causes œdema of one lower extremity. Both, of course, might be affected.

The abscesses which occur in Pott's disease are not always in direct connection with the carious bone. They appear to begin sometimes as cavities formed by central liquefaction of tuberculous tissue near to, but not in, the bone. The focus thus affected may be quite independent, or it may be merely part of the mass of granulations growing from the seat of spinal caries.

There are, therefore, sometimes two or more disconnected spinal abscesses in the same patient; and these may be on opposite sides or on the same side of the middle line.

Also, a single median abscess may bifurcate, and eventually present in both groins.

Paraplegia and other Nervous Troubles caused by Pott's Disease

Though not nearly so fatal as spinal abscess, the nervous complications are very serious and remarkable, and it is mainly due to the attention Pott gave to them that his name has been attached to angular curvature of the spine.

The chief cause of this form of paraplegia is *pachyme-*

ningitis, the result of pressure, irritation, and eventually infection by the tuberculous granulations springing from the diseased bone. Most of our knowledge of this is due to Professor Charcot. Naturally, it is the anterior part of the dura mater which is first affected, but the disease may invade the whole circumference. In the former case the cord is rather flattened backwards than constricted. The affected part of the dura mater is greatly thickened.

It is possible that in some cases the pressure on the cord may be due to mere compression by an adjacent abscess. Certainly paraplegia sometimes diminishes rapidly after an abscess is emptied. But in these cases the cause may be compound; and conclusive pathological observations are wanting. Even if, after death at a remote period, when the paralysis has long passed away, the dura mater seems healthy, while remains of abscess are found, it is possible that the paraplegia may have been due to other causes; *e.g.*, the pressure of granulations growing from the bone, or that combined with a certain degree of thickening of the dura. Direct compression by dead and by diseased bone has been observed. It is conceivable that if in such a case the patient survived long enough, absorption or displacement might eventually occur and the paraplegia disappear. (See Lannelongue's case, p. 77, *op. cit.*) It should be remembered that the pressure of the fluid contents of an abscess cavity is hydrostatic and definitely limited.

The inflammation of the dura mater may be confined to its outer layers (*pachymeningitis externa*), the inner layers and surface remaining healthy and smooth.

The *spinal cord* is not merely compressed. It is irritated and altered at the seat of compression, at first softened, afterwards sclerosed. Local atrophy takes place, sometimes to an extreme degree, though sometimes very limited. Flattening from before backwards is a more common change of form than general constriction.

The neuroglia increases as the nerve elements atrophy.

Full particulars of these changes are to be found in Michaud's thesis, 'Sur la méningite et la myélite dans le mal vertébral,' Paris, 1871, No. 463; and a good account in

Lannelongue, p. 106 *et seq.* Michaud, a pupil of Charcot, expounds that master's observations and opinions.

Secondary degenerations ensue with a rapidity which is a question of days rather than weeks. The degeneration does not affect the short commissural fibres, and, of the other fasciculi, those which are motor undergo descending degeneration, those which are sensory, ascending. As a work of reference on these matters Lannelongue gives Bouchard's Memoir.[1]

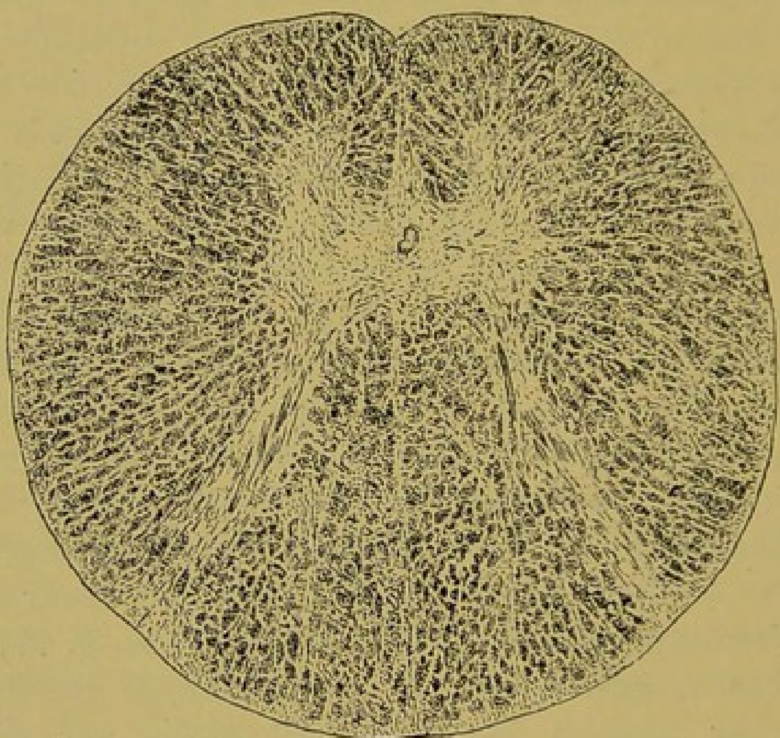


FIG. 221.—TRANSVERSE SECTION OF CORD. LOWER CERVICAL REGION. DIFFUSE SCLEROSIS, THICKENING OF CONNECTIVE TISSUE. (After Lannelongue, p. 125.)

But, historically, the contributions of Cruveilhier[2] and Fürck[3] are not to be forgotten.

In rare cases the degeneration does not obey the laws laid down as above.

After recovery from paraplegia the cord has been found sometimes nearly normal in size, but in at least one case (related by Charcot) narrowed at the affected part to the size of a crowquill. It is remarkable that functional restoration should be possible with such a condition.

[1] *Arch. Gén. de Méd.* 6e Série, 1866, t. i. et ii.
[2] *Anat. Path.* liv. xxxii. p. 15.
[3] *Compt. rend. de l'Acad. des Sciences de Vienne*, Mars 1851, Juin 1853.

The *nerve roots*, *nerve trunks*, and even comparatively small branches, offer as much resistance to actual invasion by tuberculosis, or destruction by adjacent tuberculous abscess walls and granulations, as does the spinal cord itself. But, like the latter, they are readily altered by the evil surroundings. Neuritis is therefore common, and, as consequences, neuralgias, paralyses, and trophic changes.

It is often, perhaps generally, difficult to attribute clinical appearances to neuritis with certainty, because other possible explanations cannot always be excluded. For instance, there is a boy now in Hull Ward, West London Hospital, with cervico-dorsal caries. He has long had extremely rapid breathing. Is this due to interference by an abscess or by granulations with the pneumogastric and intercostal nerves, or to direct displacement of the thoracic viscera by an abscess of whose existence one may feel pretty certain?

So also, to some extent, with regard to the trophic changes which occur in these cases. Even intensely severe troubles of nutrition occur with ordinary joint affections and ankyloses without neuritis, or at least without any reason to suspect it which would not involve begging the whole question.[1] Still, bilateral herpes, which has occurred in a spinal case now under my care in Rothschild Ward, West London Hospital, was almost certainly due either to neuritis or to myelitis.

Among the complications of spinal caries which have been attributed to neuritis are, besides herpes zoster, vasomotor troubles, and consequent irregularities of temperature, spasmodic cough, difficulty of breathing, and even death from suffocation. Perhaps, among out-patients and others with cervical and cervico-dorsal disease, seen only at long intervals by the surgeon, such fatalities are not extremely rare. But it is difficult to be certain on this point, as knowledge of the sudden death does not usually reach any pathologist until the sufferer is buried; and, even were it otherwise, there are difficulties in the way of complete *post-mortem* examination in such cases at the patient's own home.

[1] On a part of this subject, viz. dystrophies after resections, consult Rochet, *Rev. de Chirurgie*, October 1887; also a review of this in *Annals of Surgery*, viii. 113; also Ollier *On Resection*.

The Aorta, Vena Cava, &c., in Spinal Caries.—The great resistance offered by the walls of all vessels, except the smallest, to the encroachments of tuberculosis has been already mentioned. Even when surrounded by an abscess they generally lie outside the pyogenic membrane, in the same manner as that in which the tendon of the biceps humeri lies outside the synovial membrane of the shoulder-joint. Most

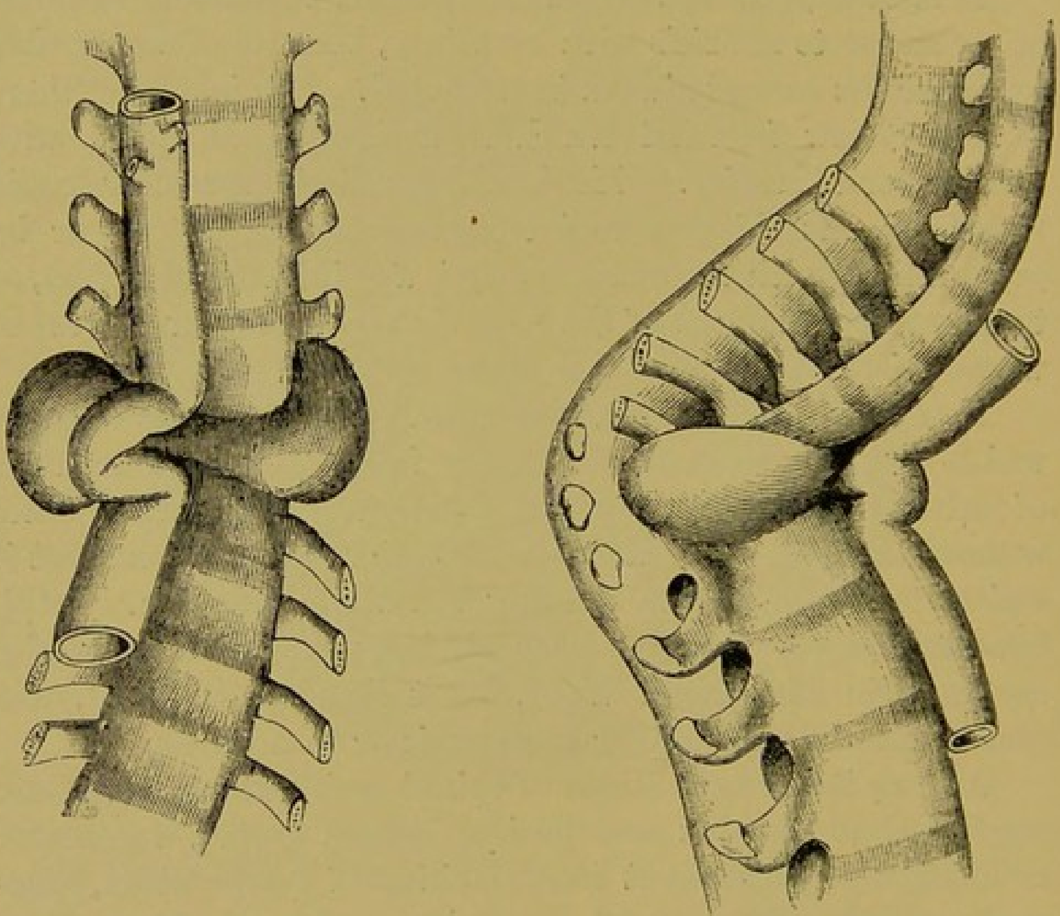


Fig. 222.—Kink in Aorta. Compression of the Vessel in consequence of its adhesion to the Wall of an Abscess. Anterior and Lateral Views of the same Specimen. (After Lannelongue, p. 101.)

likely this safety of the great vessels, as well as that of the nerves, is in great measure due to the small resistance the abscesses meet with in their progress peripherally. In exceptional cases, however, perforation does take place. For instance, the late Dr. Fuller, of St. George's Hospital, records an instance in the 'British Medical Journal' for July 1859. A study of the report of this case leaves one far from certain that it was not syphilitic. The description is meagre, but it is positively stated that no pus was found; the caries was superficial; and the patient was a painter of dissipated habits and thirty years old. Lannelongue gives reference to three other cases, one his own, and also to three cases of perforation of the vertebral (*op. cit.* p. 102).

Displacement of the aorta is common. Curvature, sometimes angular, of the aorta is a necessary consequence of the curvature of the spine adjacent to it. The flexion, if severe,

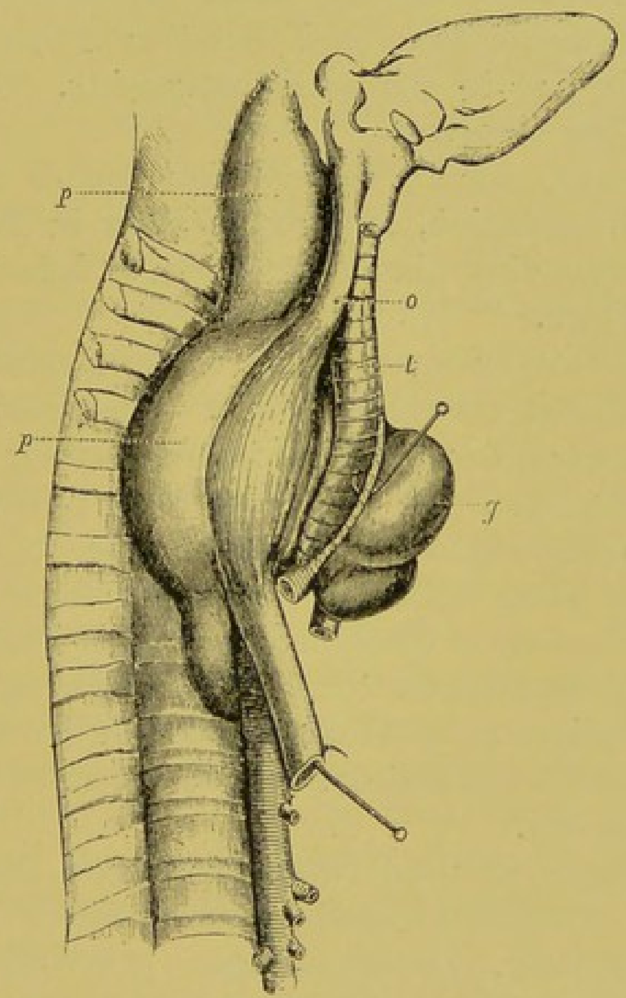


FIG. 223.—A TUBERCULOUS PRE-VERTEBRAL ABSCESS WITH SEVERAL POCKETS DESCENDING FROM SUB-OCCIPITAL REGION. Entering the thorax, it compressed the œsophagus (*o*) and the trachea (*t*), the latter between the abscess and two large caseous glands. The patient died of asphyxia (Asphyxie rapide). (After Lannelongue.)

narrows the lumen of the vessel, sometimes even to a slit. The calibre of the aorta below this is less than normal. It is an unsettled question how much this diminished size of the artery is cause and how much effect of the lessened development of the pelvis and lower limbs in such cases. Lannelongue argues that narrowing of the aorta plays an important part in the production of paresis of the lower extremities. Experimental physiology has demonstrated that an immediate consequence of ligature of the aorta is paraplegia. There is, however, of course, a wide difference between this and gradual, as well as partial, pathological diminution of calibre.

In a case of Goodhart's[1] the aorta was *compressed* in the angle caused by the collapsing bone. In this case there were disease of the aortic valves and dilatation of the left ventricle, both possibly due to the aortic narrowing. Other similar cases have been observed.

The lumbar, dorsal, and cervical *glands* are liable to enlargement, caseation, and suppuration in Pott's disease, just as corresponding glands are liable to infection in tuberculosis elsewhere.

Symptoms and Course.—The commencement of Pott's disease is almost always insidious. The great majority of children are taken to no medical man until their parents have discovered a prominence of one or more spinous processes. Adults frequently only apply for advice when they have noticed an abscess of whose nature and origin they have no suspicion; or if they are aware of the spinal lesion, it is only because their attention has been drawn to it by some accidental fall or blow, which they believe to be the cause. The patients are therefore liable to be numbered among the most miserable of the victims of the bone-setter.

But there are at least two earlier stages than this. The first is that in which a focus is quietly forming in the interior of a vertebral body, or on its surface. It is likely enough that this stage often, if not always, gives no more notice of its presence than a spot of commencing caries in a part of a tooth exposed neither to pressure nor to extremes of heat and cold. Absolutely latent tuberculous foci have been frequently found *post mortem* in the vertebræ (and other bones) of persons dead from other diseases.

In the second stage (or what may be regarded as a later period of the first) the disorder is not so completely hidden.

[1] *Path. Trans.* 1878.

Pain appears, rarely in the spine itself, usually in the nerves which originate near the disease, or which send branches to its neighbourhood—another analogy with dental caries, and an important point of difference from hysterical spine, in which the pain is usually referred to or near the median line of the back. Like neuralgias elsewhere, the reflected and radiated pains of spinal caries vary greatly in character, degree, extent, and distribution. They may be described as burning, as aching, or as stabbing. They may be limited or very extensive, unilateral or bilateral—or first the former, and then the latter. When bilateral they point ominously to a spinal origin, because the spine and spinal cord form the connecting medium between the two sides of the body.

When obscure in origin, bilateral pains in the flanks or abdomen, or in the legs—so-called stitches, lumbagos, and sciaticas—should always direct our attention to the dorsal and lumbar vertebræ respectively; one must not be deceived because the nerve trunks are sometimes themselves tender. Such is the case in neuralgias of various origins.

At first the pains are simply reflected, like the knee pain in hip disease. Later they indicate actual contact of tuberculous granulations or pyogenic membrane with the nerve roots or trunks, and consequent neuritis.

Cramps and abnormal sensations, such as tinglings, are sometimes associated with the pains.

When attention is called to the spine by such phenomena as the preceding, and supposing there is no obvious boss present, one of the first things to be done is to examine the spine for (1) stiffness of its joints, (2) rigidity of its muscles, (3) local tenderness.

Stiffness.—When the naked trunk of the patient is regarded in profile, and he is directed to bow forwards, the movement will be seen to be mainly at the hips, unless spinal disease is absent, or very incipient, or very limited and cured.

Rigidity of the erectores spinæ, sacro-lumbales, &c., may often be seen as well as felt.

Tenderness is best sought for as the patient lies prone, and the examination should be very systematic, deliberate, and varied, so as to guard against mistake. This symptom need not and should not be sought for when the diagnosis is clear without it. Pressure on the head or on the shoulders has been recommended, and also making the patient jump off a stool or chair. I myself use these means only when I am of opinion that a doubtful case has *not* got spinal caries, or when a patient appears quite recovered and it is desirable to make sure of the fact before permitting him to go without support.

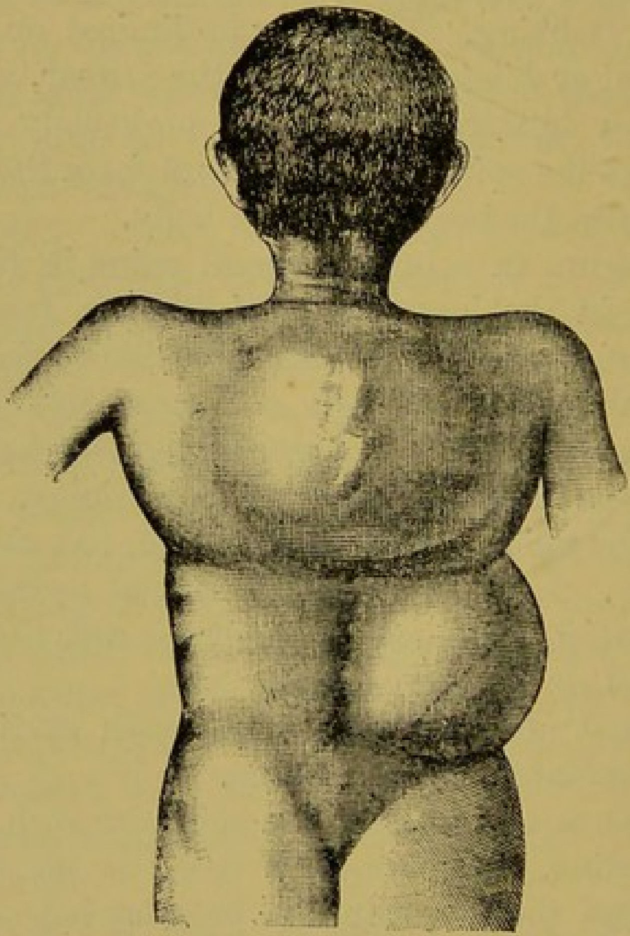


FIG. 224.—LUMBAR ABSCESS. DORSAL CARIES AND GIBBOSITY. (After Lannelongue.)

By the time the disease has fairly reached the stage just noticed the patient is often, but not always, unmistakably losing his weight and his healthy looks, which may have been previously robust; he is readily tired, his appetite lessened, and, in short, if an adult he is himself conscious, if a child his parents see, that *something* is the matter.

The Boss, Gibbosity, or Projection of the Angular Curvature behind.—When observed at its earliest stage this appears as a prominence of only one or two spinous processes. With great rapidity the two segments of the spine above and below this point respectively commence to form an angle with each other—a contrast with hysterical and malingering cases, even when the latter are assisted in their simulation by the presence of one or several naturally prominent spinous processes. As has been stated in the section on Pathology, when only one or two vertebræ are diseased the angle is apt to be comparatively sharp; when several or many vertebræ succumb the 'angular' curve tends to become a rounded hump; but often, even then, has a small angular projection on its summit.

In the cervical and lumbar regions, in consequence of these being normally concave posteriorly, the gibbosity is slow to appear, and when apparent is less prominent than in the dorsal region, where the spine is naturally convex posteriorly. But when the destruction is extensive very marked bosses are seen, even in the neck and loins.

Compensatory curves with posterior concavity appear above and below the boss. These are sometimes quite sufficient, as in fig. 224, and often very pronounced in the lumbar and dorso-lumbar region. But they may be insufficient when the lumbar vertebræ have collapsed; and very exceptional cases are seen in which the patient, when walking, is unable to look forward at all, but goes face downwards, and actually or almost on his four extremities, like a quadruped.

Lumbar, dorso-lumbar, cervical, and occasionally even dorsal curves, are sometimes lateral as well as posterior, and thus simulate scoliosis. But they do so very roughly, and, with care, no mistake ought to be possible. If the lateral inclination in Pott's disease is slight, there is no rotation at all; while the signs of rotation appear in a case of true scoliosis actually before the superficial appearance of lateral inclination. Secondly, the compensatory curves in Pott's disease with marked lateral inclination are less in proportion than in scoliosis; thirdly, the usual positions of the summit of the dominant curve in the former, namely, in or near the upper lumbar or the lower cervical region, are uncommon in scoliosis.

The carriage and bearing of the patient are not less striking than the gibbosity. They vary with the region affected, but are always marked by caution and gentleness.

The facial expression is often spiritless and prematurely careworn.

In cervical and dorso-cervical caries the chin projects, the shoulders are raised, and the head, as it were, sinks between them. The chin may even touch the sternum, although the face looks upwards and forwards rather than downwards. The arms hang down, and are used either to balance or to support the patient in his steady and careful movements. In suboccipital disease one hand holds up the chin.

The patient avoids bowing his spine forward. In order to pick anything up from the floor he squats down, using his hip and knee joints, but not his vertebral, generally propping himself up with one hand on the thigh or on a chair, and picking up the article to be raised with the other. This is so characteristic that surgeons properly make a point of seeing it in each new case under examination.

After the boss, the most important symptoms of spinal tuberculosis relate to the associated paralyses and abscesses.

Paralyses.—These are almost always bilateral, though not necessarily perfectly symmetrical. They are almost always motor, while sensation is almost entirely unaffected. The reverse is very unusual, probably because the grey matter occupies a comparatively protected situation in the interior of the cord.[1] The paralyses come on gradually. At first the legs (assuming them to be affected, as they are in the large majority of cases) appear weak and a little unmanageable by the patient. They falter and bend beneath him, and tend to cross each other.

In the earliest stage there is paralysis with flaccidity. In a few days or weeks, if the patient is, as will be likely, in bed, his legs and feet lie outstretched and his toes bend towards the soles of the feet. This may be called the second stage, or that of ‘temporary rigidity with extension.’ When the ankle-joint is suddenly flexed by pressing on the sole of

[1] This anatomical fact leads necessarily to a clinical contrast between the paraplegia of Pott's disease and paralysis due to intraspinal tumours or to myelitis of intrinsic origin.

the foot, a succession of reflex spasms of that joint results (ankle clonus). The patellar reflex is also often increased.

Third stage.—At a later period contractures ensue, flexions take the place of the posture just described, and reflex phenomena tend to become still more marked. Descending degeneration of the lateral fasciculi of the spinal cord is doubtless the cause of these contractures.

When the paralyses arise from compression of the cord itself, muscular atrophy is, at first at least, much less marked than with paralysis from neuritis. And in the former case the reflexes are increased and electric contractility not lost.

When loss of sensation occurs, it is often irregular, in various ways. It may be asymmetrical, especially in cervical disease. Tactile sensation may be lost, but not sensibility to change of temperature or to pain. The reverse is less usual. Perception of these feelings, instead of being abolished, may be simply retarded.

The nutrition of the paralysed parts is influenced in the usual way, the most usual and important phenomenon being the muscular wasting.

Lannelongue describes a subacute arthritis or hydrops articuli of neurosal origin as occurring in Pott's disease. It must be distinguished from coincident tubercular affection of the joint attacked. It is very quiet, apyretic, and usually ephemeral, lasting only two or three weeks.

For obvious anatomical reasons paralyses are far more frequent in cervical and dorsal than in lumbar cases.

The Abscess.—In adults especially this is occasionally the first symptom which attracts attention.

But it is far more usual, particularly in children, for it to be one of the last. Indeed, it is sometimes concomitant with absolute convalescence from the original bone disease. Therefore the discovery of a spinal abscess must not be assumed to necessarily indicate revived activity of the vertebral tuberculosis itself.

Most of what it is necessary to know of spinal abscesses has been said in the section on Pathology. But figures obtained only from clinical observation indicate a much less frequency of abscess, especially in dorsal disease, than *post-*

mortem examination shows to be the case. And the proportion of cases observed clinically varies with the pains taken by individual surgeons in looking for them. When suppuration reaches the subcutaneous tissues it attracts the attention of every one. But deep-lying and small psoas, as well as retropharyngeal abscesses, have to be searched for by careful palpation. Abscess as an eventual clinical symptom appears oftenest with cervical caries, and least frequently with dorsal. According to Lannelongue, the proportions are—in cervical caries, 9 times out of 10; in dorsal, 5 times out of 10 (*i.e.* one-half); and in lumbar, 3 times out of 4. Bouvier found that four-fifths of cervical cases, three-fifths of lumbar, and only two-fifths of dorsal were complicated with abscess. This was in a series of 112 cases, of which 10 were in the cervical vertebræ (exclusive of the atlas and axis), 59 in the dorsal, and 42 in the lumbar. But, I repeat, these proportions depend somewhat upon the care taken in searching for the symptom.

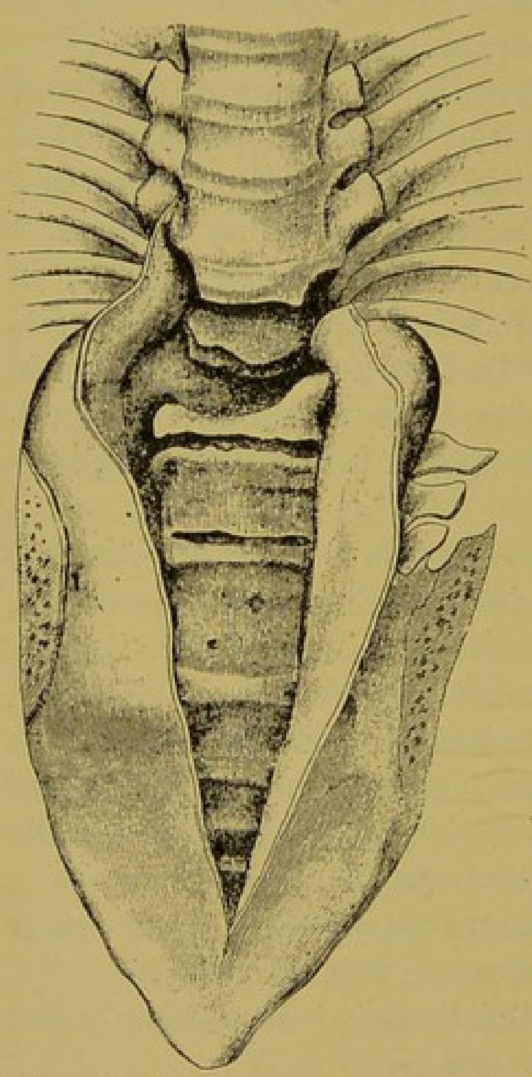


Fig. 225.—Lumbo-dorsal Caries. Destruction of Seven Vertebral Bodies. Tuberculous Abscess descending to the Tip of the Coccyx. (After Lannelongue.)

The existence of abscess may often be inferred long before it is directly discoverable by the occurrence of symptoms referable to pressure on adjacent structures, especially nerves; *e.g.* a small deep psoas abscess may cause slight contraction of the hip and a limping gait, an upper dorsal abscess may interfere with the pneumogastric or with the œsophagus. Sometimes a deep abscess presses upon the cord itself; but it has already been stated that paraplegic symptoms are more usually due to pachymeningitis.

Rarely do spinal abscesses form or extend inside the spinal canal itself. Their symptoms are then, of course, almost entirely referable to pressure on or irritation of the cord and nerve roots, or of the meninges.

In lower dorsal and lumbar disease the place to examine for fulness or fluctuation in order to detect abscess early is between the brim of the pelvis and the crest of the ilium. To reach that region the anterior wall of the abdomen must be pressed backwards by the fingers of both hands placed between the umbilicus and the anterior superior iliac spine. The two sides must be carefully compared together, and the parts relaxed as much as possible at the time of examination.

The natural course of spinal abscesses is towards spontaneous opening, either through the skin or into one of the internal cavities; *e.g.* the pharynx, œsophagus, trachea, bronchi, pleural interspace, pericardial sac, the stomach, intestines, or bladder.

A spontaneous opening through the skin is usually followed by compound infection and decomposition of the residual pus and pyogenic membrane, and grave danger, first, of septic poisoning, secondly, of prolonged suppuration and lardaceous degeneration. How these may be prevented belongs to a future section.

Symptomatology (continued). Spinal Caries divided according to Regions.—The old division into cervical, dorsal, and lumbar is so precise, and otherwise convenient, as well as customary, that it is never likely to be abrogated; but in this section it will be better to adopt Lannelongue's just classification into

1. Suboccipital disease.
2. Cervico-dorsal disease.
3. Dorso-lumbar disease.
4. Lumbo-sacral disease.

All writers on spinal caries are continually obliged to use the above terms, partly because the spinal cord is not placed with any reference to the common anatomical spinal divisions, and partly because combined cervical and dorsal as well as dorsal and lumbar caries are so common.

Upper Cervical; Atlanto-axial; Suboccipital Disease

Considerable as may be the deformity produced by tuberculosis of the first and second cervical vertebræ and the adjacent bones, the orthopædic aspect is unimportant compared with the great danger to life in this, proportionally, by far the most dangerous form of vertebral caries.[1]

The special terrors of this affection are due to the relations of the vertebræ in question to *the medulla oblongata*, to the gravity of the functions of that part of the central nervous system, and to the anatomical arrangement which makes so much depend on the integrity of a single small piece of bone—*the odontoid process* of the axis. When this is partly destroyed and separated from its base, or from its ligamentous connections with the atlas and occipital bone, the danger is imminent of *sudden death*, due to the head's falling forward and the medulla oblongata's being compressed between the axis process in front and the occipital or atlas behind.

In less unfavourable cases the separation of the odontoid and the destruction of ligaments and of such portions of bone as segments of the ring of the atlas, of its articular surfaces, of the body of the axis, &c., may take place gradually, and, under the protection of either appropriate treatment or of simultaneous processes of repair and ankylosis, this danger of sudden death may be averted. And though the medulla may, even in these cases, be greatly and permanently compressed, paralysis, at least of vital organs, may be averted. Or, if such paralyses as those of the limbs supervene, they may eventually be recovered from.

Abscess is proportionally less common in these cases, perhaps because so many of the patients die suddenly, in the way above indicated, before suppuration has time to supervene or to spread. Its best-known form is that of *retro-pharyngeal abscess*; but, as in other cases of cervical caries, the pus may extend outwards, or, more rarely, backwards, or into the

[1] The general mortality is said to reach nearly 50 per cent.

spinal canal, or even, in very exceptional cases, upwards into the cranial cavity.

Dislocation as a result of suboccipital disease may take place in various directions. Lannelongue, who has collected records of 52 cases, classifies them as follows:

Occipito-atloid dislocation	3
Atlanto-axoid dislocation	27
Double dislocation	2

Of the 27 atlanto-axoid, no less than 19 were directly forward.

Instead of sudden dislocation, *gradual displacement* may occur, and, when simultaneous or eventual ankylosis takes

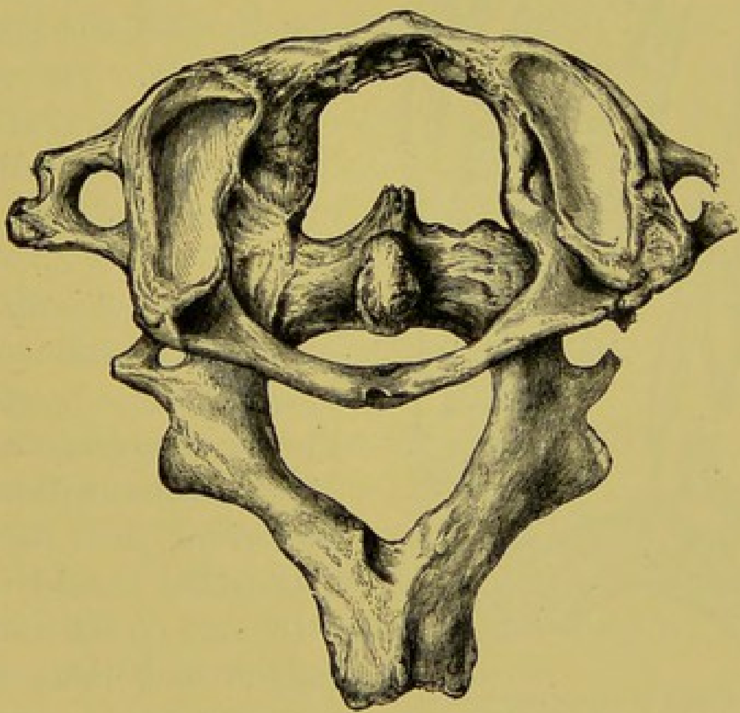


FIG. 226.—DISPLACEMENT OF THE ATLAS FORWARDS UPON THE AXIS AS A RESULT OF POTT'S DISEASE. The bones are firmly ankylosed together. (Specimen in St. Bartholomew's Hospital Museum.) From Howard Marsh's 'Diseases of the Joints and Spine.'

place, it is wonderful how greatly the spinal canal may be narrowed without death or even paralysis occurring.

Abscesses connected with suboccipital disease are usually retro-pharyngeal in situation. They are occasionally intra-spinal, and may even extend into the cranial cavity itself. In one of three cases quoted by Lannelongue from Simon almost complete motor paralysis of the tongue, with discoloration ('flétrissure') of its anterior third, was observed—phenomena doubtless dependent on affection of the hypoglossal nerve or its centre. Coincident tubercular meningitis is rare, but pulmonary tuberculosis common. The cervical glands are sometimes infected.

Symptoms.—This disease is commoner in the young than in the old, and perhaps more common in adolescents and young adults than in children. Males are affected twice as often as females.

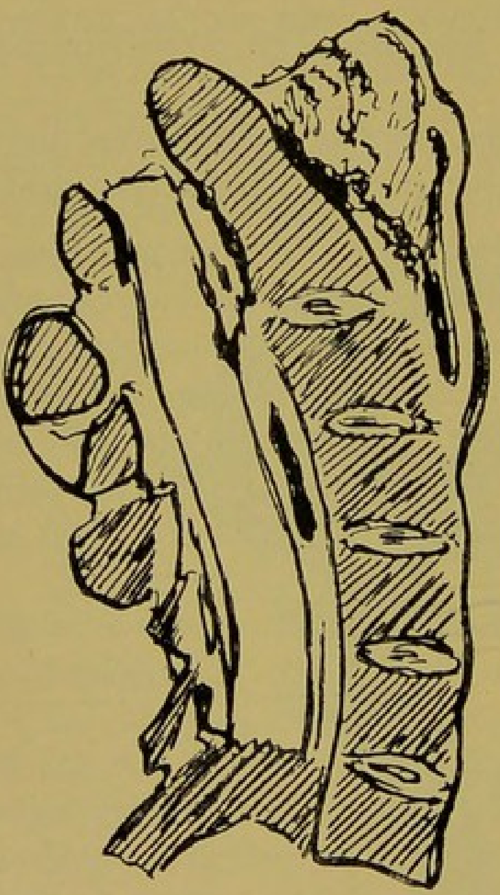


Fig. 227.—Partial Displacement of Atlas forwards. Abscess between it and Odontoid Process. (From Hunterian Museum.) Specimen presented by Mr. Edmund Owen.

As in the case of disease affecting other spinal regions, the earliest symptoms are usually pain and limitation of movements. The pain is felt either in the seat of disease or in the course or distribution of the nerves connected with it.

Tenderness is discoverable, especially in the sub occipital fossa, and also by pressing on the spinous processes and by digital examination of the posterior wall of the pharynx. The latter should be effected with very great caution, lest sudden and fatal dislocation be produced.

In looking to right or left the patient turns, not his head, but his body.

Thickening may be discoverable in the upper part of the neck, and it may mask the normal prominence of the uppermost cervical spines, unless the case is so advanced that forward dislocation of the atlas has occurred, when the spinous process of the axis should be more prominent posteriorly than before. But in this case deformity is marked.

The deformity resulting from luxation forwards of the atlas consists of a combined bending and sliding forward of the head towards the sternum, usually with a slight deviation to the right or to the left.

With regard to the symptoms due to compression of the medulla, it is noticeable that their immediate cause is quite different from those which usually produce nervous symptoms in disease of other segments of the spine. In the latter, direct pressure of bone on the medulla is the exception; in suboccipital disease attended with paralysis, &c., it is the rule. Hence in the former case the compression is comparatively diffuse, but in suboccipital disease apt to be limited to definite points.

Thus may be explained the not uncommon occurrence of brachial monoplegia as a symptom of suboccipital disease. Hemiplegia is sometimes seen. Sensation is lost, as well as motion, in hemiplegic cases. In the few cases which have been reported the loss of sensation affected one side, that of motor the other. The motor reflexes are increased in the parts affected with motor paralysis.

When the functions of the bladder and rectum are affected, retention and constipation are more usual than incontinence.

The innervation of the functions of swallowing, speaking, masticating, that of the movements of the eyes and of the jaws, even that of the heart and muscles of respiration, are apt to suffer. Difficulty of deglutition may be present, either from this cause or from the mechanical effect of retro-pharyngeal thickening or suppuration.

Diagnosis.—(1) From rheumatic stiff-neck. This comes on suddenly, rarely persists, and the tenderness is of the affected muscles—*e.g.* the sterno-mastoid—not of the bones immediately beneath the occiput. (2) From non-tuberculous affections of the suboccipital articulations. This diagnosis has to be made by a careful consideration of the history and course. The patient may be, on the one hand, rheumatic, or, on the other hand, strumous in some other joint. Rheumatic and 'osteomyelitic' attacks usually come on suddenly, with fever and acute pain, tuberculous attacks more insidiously.

The evil *prognosis* has already been indicated. Even with careful treatment the danger is grave.

Treatment.—The principles are the same as those on which tuberculosis in other spinal regions should be treated. Perhaps the application is more difficult. The ordinary jury-mast and collar may be arranged to give some degree of extension, but not fixation enough for suboccipital disease. A collar embracing the chin and occiput is essential. It is customary to get counter-extension, or at least support, from the shoulders; but I do not think them fixed enough, and recommend rather an apparatus reaching to the hips. A close-fitting pelvic girdle, two lumbo-dorsal uprights (like those of a double Thomas's hip splint), shoulder-pieces, and straps suffice. When the patient is a child, if rest in bed is

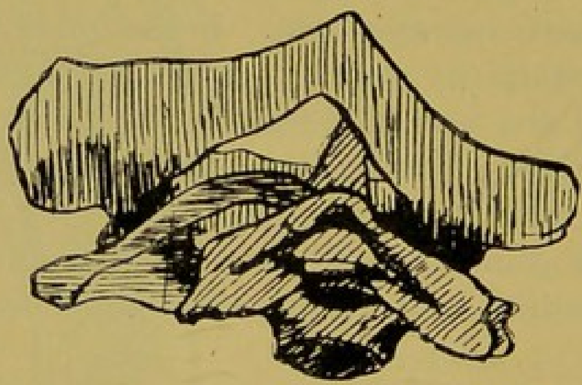


Fig. 228.—Diagrammatic View of Specimen showing Displacement of Atlas to Left and of Axis to Right, and Projection of Odontoid Process upwards through Foramen Magnum. Axis is shaded downwards to left, occipital bone perpendicularly, atlas horizontally. From a child of twelve who had recovered from the cervical caries, but who had died afterwards of lumbar caries. A cervical abscess was 'absorbed.' Case by Lawrence in *Med.-Chi. Trans.* xiii. p. 400 (1825). Specimen in Roy. Coll. of Surg. Museum.

to be employed, leg-pieces, also like those of Thomas's hip splint, should be added. With these and a padded plate fixed to support the back of the head a kind of trough splint is formed, on which the patient can be safely moved about.

Theoretically, and in most cases practically, I do not think simple dorsal decubitus in bed with sand-bags packed round the head and neck sufficient. But cases occur in which the patient seems to chafe at and pine under any fixation or extension with splints or weights.

When luxation has taken place, unless improvement in position results from the above-mentioned treatment, it is best to be satisfied, and certainly not safe to attempt violent or sudden rectification.

Mid-cervical and Cervico-dorsal Disease

Many of the peculiarities of disease in these regions have been noticed in the preceding general remarks.

The radiated and reflected pains and abnormal sensations are often felt in the upper extremities. Innervation of the thoracic viscera, and even of the diaphragm, may be interfered with.

Locally, examination should be directed to the sides of the neck and to the back of the pharynx. Thickening, tenderness, or fluctuation may be found.

Resulting paralyses may begin in either the upper or lower extremities. They are apt to present peculiar and irregular phenomena, dependent probably on irregular extension of the transverse myelitis.

In severe cases difficulty occurs in micturition and defæcation. (With dorso-lumbar caries paraplegia causes incontinence.)

Either myosis or mydriasis may result from cervical caries, and also epileptiform attacks.

Dorso lumbar Disease

Also noticed repeatedly in preceding general remarks.

The great normal flexibility of this segment of the spine makes stiffness of it an especially valuable early sign of Pott's disease here, and all the more because the gibbosity is slow to appear in the lumbar region, and indeed often absent altogether.

Paralytic complications usually take the form of paraplegia. In Lannelongue's words, 'when Pott's disease attacks at the level of the three last dorsal or two first lumbar vertebræ —*i.e.* at the level of the lumbar enlargement of the cord— the paraplegia, whether complete or incomplete, is generally without contractures, and reflex movements are abolished or weakened.' Whereas disease above the level of the tenth dorsal vertebra causes a paraplegia in which the reflexes are generally increased. With lumbar disease paraplegia is far less common than with dorsal.

In dorso-lumbar disease with paraplegia incontinence of urine is common. The spinal centre for the reflex movements of the bladder and its sphincter is placed at the lower end of the cord (Budge). When it is impaired in function in lumbar disease, the voluntary abdominal muscles remain unparalysed, and the urine is liable to be expelled by their contractions, because the sphincter of the bladder, part of which (*i.e.* the non-prostatic) is involuntary, does not retain anything like its normal power. But when the cord is affected high up, all the voluntary expulsors of the urine are paralysed, and of the sphincter only the prostatic part is affected. Indeed, the involuntary part is more free to act than before. Hence in the latter case retention is apt to occur.[1]

The physiology and pathology of the innervation of the colon and rectum are analogous to those of the bladder.

Lower Lumbar and Sacro-lumbar Disease

As the spinal cord does not descend below the second lumbar vertebra, lower lumbar and sacral disease are marked especially by neuroses of individual nerves or groups of nerves. Hence the lesions, instead of being bilateral, as in medullary compression, are often unilateral, or, if bilateral, they are unsymmetrical.

Tuberculous Disease of the Sacro-iliac Joint

Deformity is one of the least serious effects of this disease, although lameness is one of the commonest.

Concerning its etiology, there is nothing to add to what has been written on that of Pott's disease, excepting that though, fortunately, not common at any age, it is least un-

[1] Budge, *Zeitschr. f. rat. Heilk.* xxi. pp. 5 and 174; also in Pflüger's *Archiv f. Physiologie*, Bd. 2, p. 511. Quoted by Charcot.

common among adolescents and young adults, while it attacks the male more frequently than the female sex.

Symptoms.—Erichsen, whose account of this affection is classical, set the example of arranging these in five groups, viz. pain, swelling, lameness, alteration in the shape of the limb, and abscess.

It is also possible to divide the course of the affection into two or three stages, and to give the symptomatology of each. An obvious and practically important distinction to make is into a period before and one after the formation of abscess. And sometimes, even now, a third and fatal distinction has to be made when the abscess is open, infected and septic.

The *pain* varies greatly in degree in different cases, and in different stages of the same case. It is aggravated by movements, even by such physiological ones as coughing and defæcation. It is usually more or less localised to the neighbourhood of the joint, which is almost always tender. The tenderness may be evoked in various ways; *e.g.* by direct percussion and by moving, especially by abducting, the corresponding limb. The latter manœuvre does not elicit tenderness if the pelvis be so thoroughly fixed as to prevent any movement except at the hip-joint.

2. *Lameness* is almost as early a symptom as pain. It is really tenderness elicited by walking. A sense of pain and weakness is felt when an attempt is made to bear weight on the limb of the affected side. The patient, if a man, resorts to a stick. He leans forward, lowers the pelvis on the side affected, and at the same time flexes the hip and knee, the object being to protect the sacro-iliac joint from pressure. The result is a more or less characteristic attitude; *i.e.* an attitude indicative of some affection of that articulation, but not necessarily signifying *tubercular* disease.

3. *Swelling.*—After pain has lasted some time, swelling appears, unless the posterior part of the joint remain free from disease. It corresponds in position, and at first in area, to the joint, and is therefore elongated from above downwards. Later, if pus forms and burrows, swelling may appear in the loin, or in the buttock, or elsewhere.

4. *Alteration in Shape.*—Some surgeons, including Erichsen,

assert that the swelling of the articulation not only pushes forwards, but rotates downwards, the anterior and superior portion of the ilium. Lannelongue says that in the great majority of cases of *post-mortem* examination recorded enough of the interosseous ligament remained intact to make such movements impossible. Delens was of opinion that in all the alleged instances of lengthening or of shortening the change was only apparent.[1]

The muscles, not only of the buttock, but even of the limb below, sooner or later tend to waste.

Abscess may form on either the posterior or the anterior surface of the joint. In the former case it is immediately manifest. In the latter it may be undetectable for some time, even by rectal examination. The course of its extension varies. It may find its way forwards like an ordinary psoas or iliac abscess, or inwards to the rectum, or even backwards through the great sacro-sciatic foramen into the buttock, or downwards to the ischio-rectal fossa or to the perinæum. When presenting in any of these situations its origin is liable to be misunderstood.

Course and Prognosis.—Sacro-iliac disease has usually a long history, and only too often a fatal termination at the last, *i.e.* when it is tuberculous and not rheumatic, when genuine and not neuromimetic. In this disease, as in many others, the more careless the diagnosis, the better the prognosis alleged, the mortality of rheumatic and of imaginary diseases being small enough.

Nevertheless, cases not too far advanced and not already complicated with phthisis, with intestinal or with peritoneal tuberculosis, or with hectic fever due to septic abscess, ought to be generally conducted to a successful termination. The younger the patient, and the larger his means or those of his friends, the better in these as in other chronic cases.

Diagnosis.—From (1) hip disease, (2) disease of ilium or of sacrum, (3) spinal disease, (4) neuralgias (lumbago, sciatica, &c.) and neuromimetic affections.

The diagnosis of abscesses and sinuses of sacro-iliac origin also sometimes presents certain difficulties.

[1] *Thèse de Paris*, 1873; quoted by Van Hook, *Annals of Surgery*, viii. 401.

In hip disease, the movements of the hip-joint are far more limited than in sacro-iliac; and although the seat and character of the spontaneous pain may be confusing, the seat of *tenderness* and the modes in which it may be most easily evoked in the two cases are very different.

Disease of the ilium or of the sacrum may cause difficulty, especially if situated close to the joint, or if causing an abscess which spreads over and covers the joint. When such an abscess is opened the finger or the probe may discover the seat of caries.

Spinal disease affecting the lower lumbar region is not unilateral, as is sacro-iliac disease; though in the early stage diagnosis may be very difficult. Later, when deformity arises, or even when the seat of tenderness can be localised, the difficulty lessens and disappears.

Lumbago affects the muscles of the loins, and, so far from causing tenderness of the neighbouring bones and joints, may even be relieved by pressure on them.

Neuralgias and neuromimeses are most liable to be confounded with sacro-iliac disease when affecting young women. It may be necessary to make two or three careful examinations before positively diagnosing such a case. Ten years ago I saw a young lady who at the first and second consultations alleged great tenderness over one sacro-iliac joint. At the third she localised the pain in quite a different part, and none could be elicited by pressure or percussion on the joint. There was nothing whatever about her to suggest tuberculous disease anywhere, but there was ovarian hyperæsthesia. I do not think the diagnosis remains doubtful. She got no worse, and has long been married and the healthy mother of children.

Treatment. — The general principles must be already familiar to the reader. The two most important questions to discuss are: (1) *How* best to give local rest to the joint; and (2) the question of operation. I am in favour of a combination of ordinary extension from the limb of the corresponding side downwards, with transverse extension from the upper part of the thigh outwards. It can be conveniently applied in the simple box-splint I use for osteotomies of the hip and other cases. The limb of the affected side is kept extended by a strapping extension, the stirrup of which is connected with a cord which passes through a hole in the transverse foot of the splint, and at the same time the upper part of the thigh of the same side is bandaged firmly to the corresponding lateral part of the splint. A piece of leather or poroplastic is moulded to the inner side of the thigh and applied beneath the bandage. The foot of the bed should be elevated, and either a mattress in segments or transverse bands of strong canvas stretched between the sides of the splint, so arranged that defæcation may be performed without disturbance of the patient or his joint. Many surgeons recommend splints of leather moulded to the pelvis and pelvic belts. I do not see how they can be of much use. Sayre believes himself to have been very successful with a treatment which consists in the application of a weight to the foot of the affected side, and a patten raising the other foot, while the patient gets about with the aid of crutches. Having regard to the position and size of the joint, the plane in which it lies, the natural shortness and tightness of its ligaments, it is not easy to see how such a treatment can give either rest or extension, except when the disease mainly or entirely affects the upper part of the joint; but of course *à priori* argument must not be set obstinately against alleged experience.

Operative Treatment.—A strong reaction is taking place against the doctrine predominant up to lately, that sacro-iliac disease should not be operated on. Whenever it is sufficiently limited, and the actual seat of disease accessible, and unless some special reason to the contrary—such, *e.g.*, as advanced lung disease—coexists, the gouge, sharp spoon, and iodoform should be resorted to. When the posterior surface of the joint alone is affected, operation is very easy. When the anterior, operation may be practised on the lines recommended by Van Hook in the 'Annals of Surgery' for February 1889, p. 126. He writes: 'The systematic operation may be performed as follows: The patient lying on the unaffected side, with the thighs in exaggerated flexion on the pelvis, the site of operation will be brought into the greatest prominence possible. An incision 2 or 3 inches in length will expose to view the posterior superior spinous process of the ilium, which should be freed from periosteum and tendinous connective tissue by scraping with a dull instrument. A chisel about 1 inch in breadth is then used to remove successive small fragments from the exposed bone, always holding the chisel edge parallel to the spinous processes, till the finger can enter the pelvis major and palpate the anterior surface of the diseased joint.' Afterwards, Van Hook recommends curved instruments to remove detritus, &c.

Cases of extremely advanced and extensive disease which have been operated on abroad have not given encouraging results. I would add that, in order to deal satisfactorily with the anterior part of the sacro-iliac articulation, it is necessary to remove bone *freely* from the adjacent part of the ilium, and that if the disease is extensive a second incision should be made, over the posterior border of the great sacro-sciatic foramen, and the articulation attacked from below. If an intrapelvic abscess exists, it can be more thoroughly dealt with in this way, and if drainage is thought necessary the two openings permit it to be more thorough.

If the pus has burrowed in the loin and groin, other incisions should be made in the loin, and also above the anterior superior iliac spine. Hæmorrhage should be stopped promptly and diligently, chiefly by sponge pressure, as the operation proceeds. In this, as in all prolonged operations done behind the patient's back, his condition should occasionally be inquired after by the surgeon of the anæsthetist. For scraping the walls of abscess cavities a blunt spoon is often preferable to a sharp one, and the final spooning out should be thorough. Iodoform crystals in moderate quantities should be placed, especially, in the deeper pockets of the cavities.

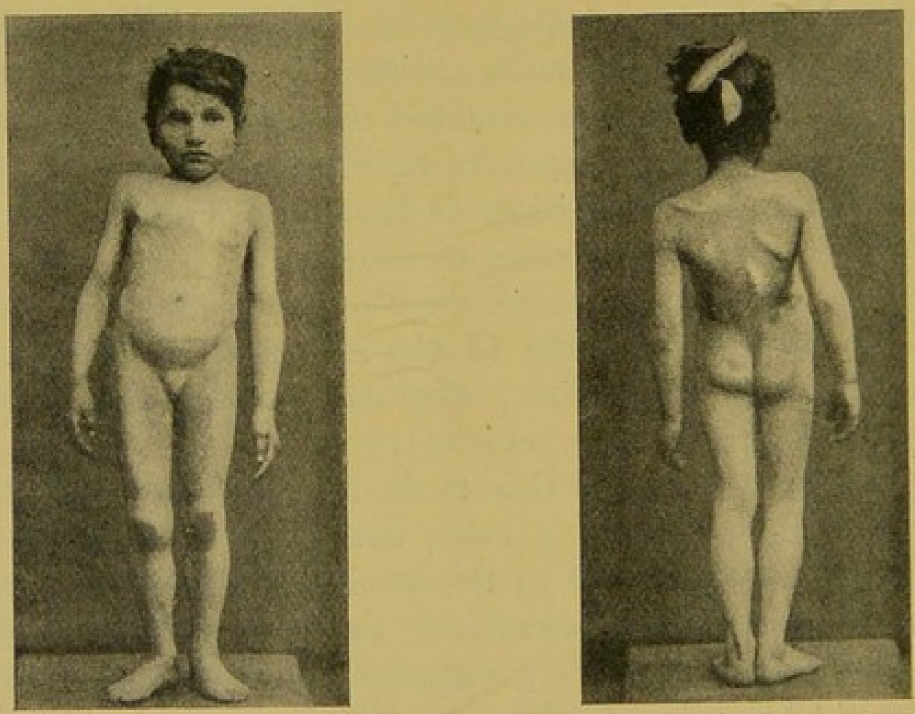
General Diagnosis of Spinal Caries

If a patient suspected of Pott's disease be told to pick up something on the floor, and he then *squats* down, with rigid and nearly perpendicular back, bent hips and knees, supporting himself with one hand on the thigh, and picking up the article with the other hand by his side or between his legs, a symptom has been exhibited which is, practically speaking, pathognomonic.

If a characteristic boss or angular curve exist, it is enough, unless there is a clear history of sudden appearance *immediately* after severe accident, and *no further* progress. Even with these the diagnosis may be doubtful, and the case should be very carefully watched.

The earliest symptoms of the less clear cases have already been described.

Neuromimetic cases are at the date of origin generally young adults or old adolescents. They almost always present one or two, sometimes several, rather prominent spinous processes in the dorsal region. They complain of pain in the



Figs. 229 and 230.—Lateral Inclination secondary to Caries. (After Hoffa.)

spine itself, and that structure bends freely and with a regular curve, especially in the dorso-lumbar region, where they often locate their pains. Such patients are often females with menstrual irregularities, perhaps even uterine, ovarian, or tubal disease.

The cases of angular curvature with lateral deviation are still angular. They *never* present the predominant rotation, the regularity and evenness of the compensatory curves, and the freedom of movement of the lumbar and cervical vertebræ, which are found *combined* in cases of true scoliosis. But congenital scolioses, such as are associated with spina bifida, sometimes have one or more curiously sharp angles in the place of curves. The history of these, and often the concomitant abnormalities, settle the diagnosis.

The abscesses associated with dorsal and lumbar superficial caries in adults cannot always be referred with certainty to their true cause during life. The elimination of other causes —*e.g.* renal and pelvic disease—will sometimes make the diagnosis highly probable. But renal disease may coexist and be merely a consequence of a perinephric abscess of spinal origin.

In connection with caries of the spine, the surgeon's powers of diagnosis are chiefly called into play either (1) to decide upon a case suspected of being one of incipient spinal caries, or (2) to determine the origin of a chronic abscess in one of the many situations where spinal abscesses present themselves. In the first case angular curvature is sure to be either absent altogether, or else represented merely by a slight prominence of one or two spinous processes, probably no greater than is occasionally seen in perfectly healthy subjects. In order to effect the diagnosis carry out the following rules:

(1) Undress the patient completely down to the great trochanters.

(2) Get him to successively stand and walk, and notice if he carry his back stiffly or flex it freely, if he spread his arms out and, as it were, balance himself, or if he swing his arms as healthy people do in walking. Notice also if he tread softly and seem afraid of jarring himself, or if he step out carelessly. I have already described the attitude and carriage of these cases under the head of 'Symptoms' above.

(3) Throw some object down before him, and direct him to pick it up. If there be spinal caries he will almost certainly refrain from bowing forward to reach it in the ordinary way. He will get right up to it or alongside it, and, supporting himself with one hand either on his own thigh or on a

neighbouring chair or other firm object, he will squat down by bending his hips and knees, keeping his back straight, and thus reach the object to be picked up.

(4) Get him to bow forward, while you watch both his spine and the spinal muscles on each side of it. Often the latter can be seen and felt rigid, and striving to prevent the spine from bending. Near the seat of disease especially the *stiffness* of the spine can scarcely escape careful observation. It may be demonstrated by tracing a strip of soft metal along it, and reapplying the metal strip as the patient places his spine in different positions.

(5) Inquire as to the existence of pain and as to its seat. Elicit tenderness by the methods described in the section on Symptoms.

(6) Inquire into the history. Learn if there has been any known injury to the back, or if there is any manifestation of tubercle elsewhere. The latter would furnish a presumptive proof of great strength.

(7) Does the child cry out in its sleep ? is it losing flesh ? is it falling off generally and becoming more 'delicate' ?

(8) Is there any sign of abscess, psoas, iliac, or lumbar ?

Very rarely can a careful investigation conducted on the above lines leave any room for doubt.

With regard to the diagnosis of the cause of chronic abscesses suspected of being of spinal origin, certain general remarks may be made upon it, and certain special ones, according to the locality.

In general, spinal abscesses are accompanied by other signs of spinal disease. In the majority of cases there is an obvious angular curvature, for abscess belongs to a late more than to an early stage of the disease. The rare cases in which there is no manifest hump or angle are usually cervical or lumbar. In both these cases thickening may almost always be detected about the spine at the point diseased ; in the latter case the last rib is often found nearer than usual to the iliac crest, and in the neck the loss of normal mobility can often be made out. If the case be one of retro-pharyngeal abscess, osseous deformity may sometimes be felt with the finger in the pharynx. If the abscess has opened, dead bone may occasionally be reached with a long probe; and not unfrequently small sequestra, or smaller particles of bone not worthy of the name of sequestra, come away in the discharge. Most of the abscesses occurring in the regions in question, if not of spinal origin, are connected with obvious causes—*e.g.* glands in the cervical region, hip disease, or appendicitis, or venereal infection in the groin.

Turning to special points in the diagnosis of some of the more important varieties—

(1) With regard to *psoas abscess*, the following extract from a diagnostic table by Mr. Timothy Holmes may be studied :

—	Reducible	Fluctuation	External inflammation	Impulse on coughing	Resonance on percussion	Other chief symptoms
Abscess:						
psoas . .	Partly	Yes	No	Frequently	None	Evidence of diseased spine. Swelling in iliac fossa
glandular .	No	Yes	Yes	No	No	Probably other inflamed glands and some disease in the parts from which the absorbents come
from diseased hip	No	Yes	Varies	No	No	Pain, involuntary resistance, or grating on passive motion of joint
simple .	No	Yes	Yes	No	No	Resilience of fluid in a limited cavity. Inflammation of neighbouring skin
Cysts . .	No	Yes	No	Very seldom	No	Resilience of fluid in limited cavity. No surrounding inflammation
Hernia:						
common .	Yes	No	No	Yes	If large	Disappears occasionally, spontaneously, or on taxis
incarcerated	No	No	No	Yes	If large	Similar history at one time. Has since become irreducible
strangulated	No	No	No	Not usually	Occasionally	The sickness, constipation, umbilical pain, and other severe symptoms attendant on strangulation [1]
Aneurism .	No	Variable	Seldom	No	No	Pulsation and bruit in most cases; affection of the pulse in the trunk below

[1] The most significant symptom of strangulated hernia is the local tension.

A table like the above is specially useful to a beginner, if only he will take the trouble to study it thoroughly. As experience familiarises the surgeon with the *individuality* of diseases, his mind ceases to go through any elaborate process of excluding *seriatim* this, that, and the other remote possibility, and instead addresses itself directly to some single point, should any doubt be felt at all.

It is more especially from abscess in connection with hip disease that psoas abscess has to be diagnosed, and the chief

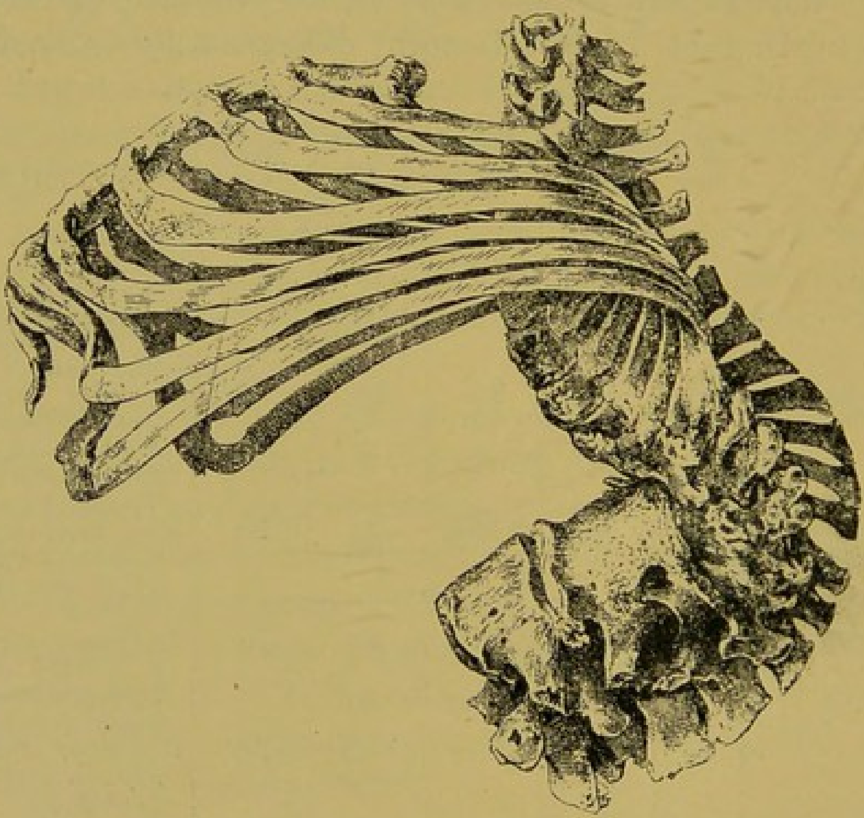


FIG. 231.—DEFORMITY OF THORAX SECONDARY TO LUMBAR CARIES. (From Hoffa's 'Lehrbuch.')

distinguishing features are given in the above table. In the first place, there is usually no semblance of a sign of hip disease present, except the psoas abscess itself, and perhaps a certain amount of stiffness, easily referable to the presence of the abscess. Within a certain range, and especially in the direction of flexion and adduction, the hip is perfectly, painlessly, and smoothly mobile. The head of the femur may be firmly pressed against or struck against the acetabulum without eliciting pain. In fact, anything may be done with the hip-joint so long as the abscess in front of it is not made more tense. If the abscess be evacuated—as it usually should be, with, of course, strict antiseptic precautions—the healthy state of the hip is still more easily made out, and it is usually clear that the pus which escapes must certainly have in great part come from above Poupart's ligament. A long probe (which should be introduced with the greatest gentleness) may demonstrate the course of the pus plainly, and will sometimes reach the diseased vertebra.

In exceptional cases disease of the hip-joint and disease of the spine occur simultaneously, being simply two coincident local manifestations of the same tuberculous infection.

Spinal abscess has been known to present itself below Poupart's ligament, internal to the femoral vessels. Hence a certain possibility of its being mistaken for femoral hernia. When, however, we reflect upon the rarity of this incident, and upon the rarity also of a large spinal abscess without other obvious signs of spinal caries, we see what a waste of space it would be to contrive a theoretical system for the diagnosis of such an unlikely event as a combination of the two rarities.

In certain cases the diagnosis between angular and lateral curvature may present a little difficulty, because, as already mentioned, in lateral curvature the spine is sometimes bent in an angular rather than in the ordinary rounded manner. In such cases of the kind as I have met with the concomitants have been conclusive. Also, in caries as well as in scoliosis, the spine is not unfrequently inclined laterally, especially in lumbar caries. A lateral inclination in dorsal caries is generally accompanied by a still more marked antero-posterior bend, which, with the presence of other signs of caries and the absence of rotation, sets the diagnosis at rest.

Presumably, few surgeons will be in danger of mistaking the vertebra prominens for a commencing angular curvature. But in many healthy normal people the spinous processes of other vertebræ, besides that of the seventh cervical, are a little more prominent than their neighbours. This usually attracts no attention, unless the patient be hysterical or suffer from pain in the back or stomach, when an examination of the spine by some friend of the patient's, or by a surgeon, reveals the slight prominence in question, and excites a suspicion of incipient caries. An examination on the plan already suggested shows complete normal flexibility of the spine. In hysterical cases there will be the characters described in the chapter on 'Hysteria.'

It is easy to imagine an immense number of *possible* sources of confusion, such as a combination of spondylitis deformans with a congenital prominence of one of the middle dorsal vertebræ. And no one will study a long series of cases of caries of the spine without meeting with one or two sources of difficulty of diagnosis, the possibility of which no amount of forethought, experience, or ingenuity could have foreseen.

Painful affections of the epigastrium and the sides, as well as of the back, sometimes give rise to a suspicion of vertebral disease, which suspicion is held to be confirmed or otherwise according as further examination does or does not bring to light other signs of spinal caries.

Prognosis of Spinal Caries

Not every case of angular curvature which comes before the surgeon is suffering from *active* tuberculous disease.

Even spinal abscesses belong sometimes to the class which Paget has named 'residual.' And an abscess may so far outlast the original bone disease which started it that the latter may be far on its way to cicatrisation before the former is discovered. The rapidity with which such abscesses can sometimes be cured and the patient get about with a strong, fairly mobile, and quite painless spine tends to prove this.

But with a recent or obviously active case of Pott's disease the mind must be made up to persevere with treatment for years—two, three, or even ten or more.

Many cases of spinal caries pursue a sure, though often slow, course to a fatal termination. The angular deformity increases, abscess appears, and signs of paralysis come on. The patient emaciates, his appetite and strength fail, he becomes bedridden. He may have been sent to bed and kept there from the first. The prominences of his thinly covered bones become the site of pressure sores; the abscess bursts, or is opened without antiseptic precautions; its extensive walls do not completely collapse; it becomes a well of pus, overflowing rather than discharging beneath the dressings, septic, and continually pouring doses of septic poison into the blood of the patient, who now presents every symptom of hectic fever, high temperature, excessive perspiration, great thirst, anorexia, &c. Delirium leads through unconsciousness to death. Or at any stage, early or late, of this course signs of tuberculous infection of other parts appear—*e.g.* in the knee, the hip, the elbow, the pleuræ, the perineum, or the arachnoid. Or a cough attracts attention to the chest, and the stethoscope tells the rest. Or an ominous and steady pain in the head, with perhaps ptosis and other signs of irritation in or about the base of the brain, excites the alarm of the surgeon, to whom a sad experience has too surely taught its meaning. The commonest of all the fatal intercurrent complications of spinal caries is doubtless tuberculosis of the lungs. In 44 autopsies on patients who had died while suffering from abscess in connection with spinal caries, 14 are said to have shown that death was due to pulmonary phthisis (Michel). When a septic abscess does not speedily cause death from septicæmia, it yet will often, after some

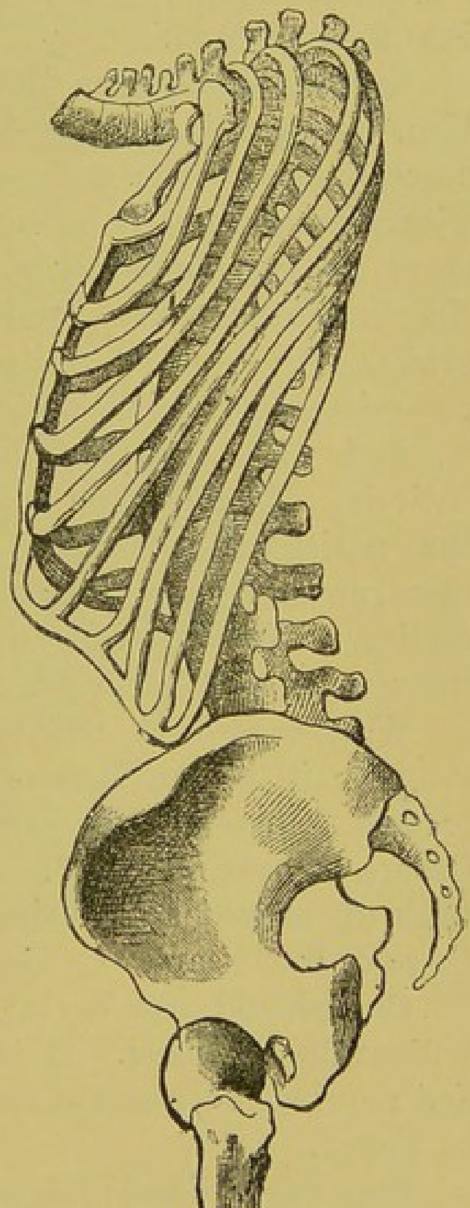


FIG. 232.—DEFORMITY OF THORAX ATTENDING UPPER DORSAL CARIES. (From Hoffa.)

time, produce an equally fatal amyloid degeneration of the kidneys and liver.

Or the case may stop short of actual death: the disease may pass away, but leave terrible permanent effects, such as a tremendous hunchback or a chest, as it were, crushed down into the abdomen.

In some cases even the most severe deformity, suppuration, and paralysis may develop with so little pain as to scarcely attract the sufferer's notice. But fortunately, even with what practically amounts to no treatment at all, many cases are spontaneously arrested at some stage or other of the downward course, and the patients convalesce, almost always with some deformity, but with little else to record the pre-existence of spinal caries.

And *with suitable treatment* the prognosis is altered entirely. To arrest the progress of the disease and to restore the patient to health and strength, in the majority of cases, are problems of which the surgeon has no difficulty in finding a solution. How they are solved will be discussed in the section on Treatment.

With regard to the prognosis when paralysis has developed, it is the reverse of hopeless. Many such cases recover completely the power of both motion and sensation. Others recover partially. Patients are occasionally seen to walk about well after being nearly absolutely paraplegic for three or four years.

One should not be in too great a hurry to consider a patient finally cured. It is rather years than months which are required to reach a stage in which relapse can scarcely be feared.

Rare cases die of such accidents as cervical dislocation, an abscess opening into the trachea or pleura, or even into great vessels, or by its pressure causing suffocation. Some die less suddenly after opening has taken place into the stomach, intestines, or bladder.

The greater the extent of the disease, the greater the danger.

The remarkable way in which large abscesses are occasionally, *but not often,* seen to retrograde and most of their contents become absorbed has been already referred to.

It is sometimes impossible to prevent the boss from getting worse (through anterior cicatricial contraction), even while the patient is recovering. It can only be removed or

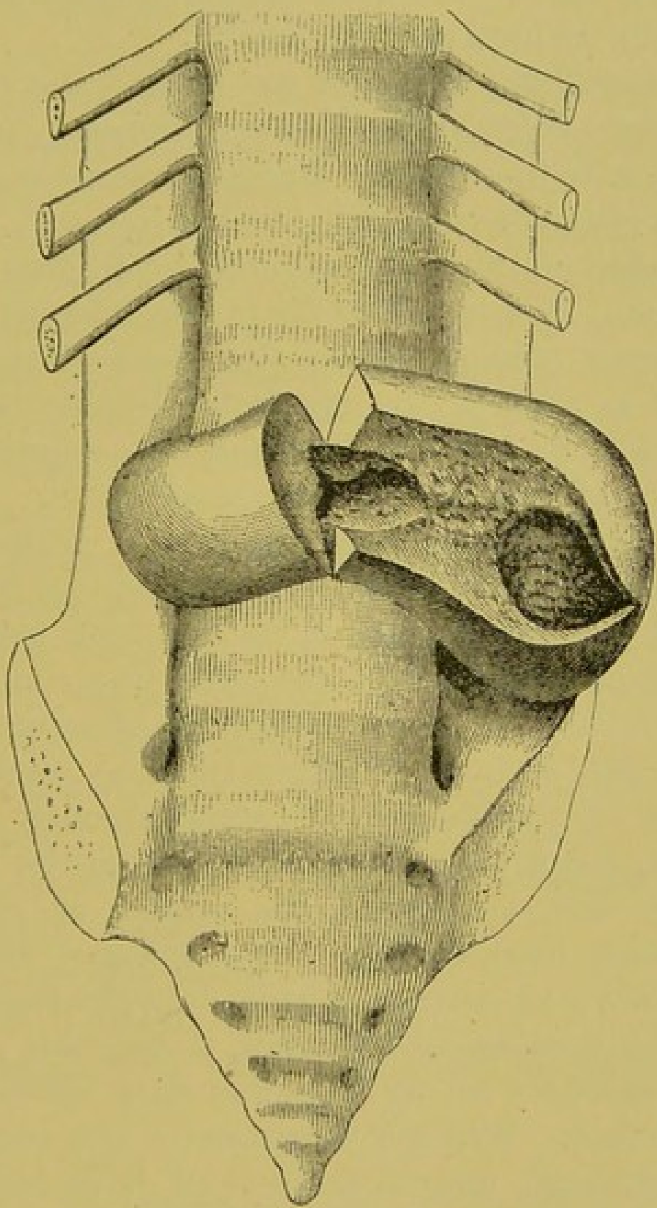


Fig. 233.—Lumbar Caries. Cure of an abscess by thickening and transformation of its wall into fibrous tissue. (After Lannelongue.)

materially lessened by operation. To what extent such interference is justifiable, and what hopes it offers, will be discussed in the section on Treatment.

Treatment of Spinal Caries

The measures to be taken by the surgeon may be first classified into (1) local and (2) general.

Before describing them let me remind the reader, as I have often done before in the 'Index of Surgery,' that tubercle, like most, if not all, infectious diseases, has an unquestionable tendency to ultimate recovery. And this result occasionally happens under all kinds of general conditions, perhaps in spite of them. But too often the organs affected are so vital that the owner cannot survive that destruction which is a usual event as regards the particular locality infected. Or his powers fail to last out the long *time* required for spontaneous cure of tubercle of organs not vital. If recovery take place, whatever treatment the patient is undergoing at the time is said to have cured him. If he has been in bed, general rest gets the credit; if he has been getting about, exercise may be thanked. In the same way comes the turn of plaster of Paris, of metal apparatus, of setons, cauterisations, pure dry air, &c. Fashion rules to some extent in these modes of treatment; but, simultaneously, there have always been, for a century at least, authorities who loudly praised one and denounced the others, or such of the others as were then known. Time changed the fashions, sent them out, and once in a while brought them in again; and while he thus amused himself, it was this old but not altogether unkindly enemy who was slyly effecting most of the cures himself. Without time none of the boastful remedies were effectual, and with time all have been, in many instances, seen to be, if not superfluous, at least non-essential.

There are numbers of middle-aged, and not a few young persons, quite convalesced from caries of the spine who have never been submitted to any but a nominal treatment, and some may be met with who did not get even that.

These considerations are not to lead us to be supine. Nature needs all the help we can give her in battling with the disease in question. But when we read praises of this or that method, let us listen critically, and remember how many good men, from Pott himself downwards, have been misled into vain aggrandisement of their own methods and despite of those of others.

Local Treatment.—In the vast majority of cases the indications are to secure fixation and extension. In some fixation alone, and in others extension alone, is attainable.

Direct operative treatment, in the shape of excision or erasion, is rarely indicated, because, by present methods, it can so seldom be *thorough*, and excision or erasion of tuberculous parts should as a rule be effected completely or not at all. I shall therefore discuss non-operative treatment first.

The local treatment of complications, such, for example, as abscess, is special, and must be dealt with separately.

Local fixation and extension can be effected only by local appliances. There are surgeons who are content to keep their spinal cases in bed, on their backs, without any form of local appliance. I do not know one of these who would treat diseased knees and hips in the same way. Yet the spine is as mobile as the lower extremity.

Whether the patient is in bed or not, the diseased segment of his spine should, if possible, be fixed and extended.

To effect these objects we have at our disposal—

1. Weight (or elastic) extensions.
2. Sand-bags and cushions.
3. Jackets of plaster of Paris.
4. Jackets of such plastic materials as poroplastic felt, leather, &c.
5. Stays of steel.
6. Stays of whalebone and light materials in general.
7. Steel splints.
8. The jury-mast.
9. Various special contrivances, such as trough-like splints of wire, inflated collars, &c.

The indications for keeping a patient in bed or allowing him to rise and get about will be discussed hereafter. *But some patients* MUST *be confined to bed. How are they to be fixed and extended?*

In a large number of cases the plaster-of-Paris jacket is as much the best appliance for patients recumbent as for patients getting about. In fact many, especially paralytic cases, are, by the proper use of the plaster-of-Paris jacket,

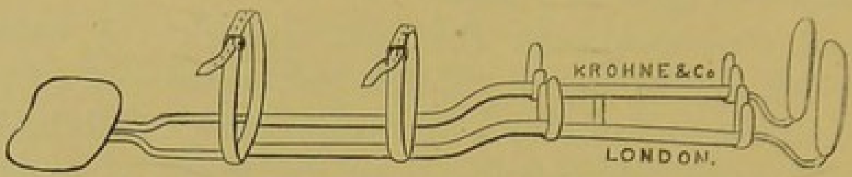


FIG. 234.—DOUBLE THOMAS'S HIP-SPLINT FOR SPINAL CASES, AS MADE BY MESSRS. KROHNE AND SESEMANN.

with great and striking rapidity transferred from the category of bedridden to that of ambulatory patients.

But under some circumstances it is difficult, if not impossible, to use the plaster jacket successfully with patients confined to bed, viz.:—

1. When they are very emaciated, and especially when they have also a very prominent and angular boss. The tendency is then great for pressure sores to form on the sharp bony projections covered by skin only.

2. When the jacket covers the openings of abscesses or mouths of sinuses which discharge freely and require frequent changes of dressings.

Neither of these two contra-indications is absolute, and we must beware of using them as excuses to enable us to avoid the small amount of extra trouble by which the difficulties can often be met and surmounted.

3. The seat of disease may be in the cervical region, or so high up in the dorsal that a plaster jacket does not control it.

Even then the plaster jacket may be the best means of fixing the lower portion of the metal splint employed to fix and extend the head.

Jackets of poroplastic differ only from those of plaster of Paris in being a little more expensive to the patient and a good deal less expensive of time to the surgeon; but the latter must not expect an instrument-maker to produce a poroplastic jacket which will fit as well as a plaster-of-Paris case made by himself, unless a cast is taken. To take a cast is nearly as much trouble as to make a plaster jacket.

I have repeatedly seen poroplastic jackets made and *applied* by instrument-makers, and turned out as good fits, into some parts of which the blade of a penknife could be thrust in perpendicularly up to the hilt without touching the patient's skin.

If the surgeon wishes to do justice to poroplastic, he must apply the jacket himself. Minute directions will be found further on.

Leather jackets are expensive and deficient in rigidity. They are often strengthened with steel. Then they are more expensive and fit worse.

With regard to spinal appliances consisting of steel or iron pelvic girdles, lateral or posterior uprights, axillary crutches or straps, plates to give pressure or support on or near the boss, whether they have single or multiple screw actions or spring actions, or are simply intended to be passive, they are costly, pretentious, and inefficient.

They are naturally praised highly by the appliance-makers, and by surgeons who have invented or imagine they have invented new forms of them. How far these gentlemen are qualified to judge between such contrivances and the plaster-of-Paris jacket will be seen clearly by the reader when their criticisms on the latter are dealt with in future paragraphs.

It must be obvious how much more difficult it is to make a steel appliance fit with absolute accuracy than a plastic one which the surgeon with his own hands, or a skilled assistant, moulds directly on the patient's form. Secondly, steel corsets, stays, and splints have nothing like the extensive and complete *hold* of the body, either above or below the seat of caries, which the plaster jacket has, when applied to a suitable case. Thirdly, the patient evades the action of axillary crutches by raising his shoulders.

Nothing is here said about comparative expense, because that is not always a consideration. Moreover, the application of the plaster jacket takes up a good deal of the surgeon's time, which, of course, has to be paid for by patients who can afford to do so.

In writing on lateral curvature I have stated how I have frequently, by direct measurements, shown how powerless steel instruments by the best makers, superintended by experienced orthopædic surgeons, are to do what their screws and keys and plates and pads are said to do.

Stays of whalebone and canvas are often recommended for use during convalescence. I think they are usually quite ineffectual; that they are needless if the patient is really convalescent, and dangerous if he is not so, because then the parents may be misled by the sham treatment into postponing calling the surgeon's attention to the prematureness of the diagnosis of convalescence.

It must not be supposed that I deny *all* beneficial action to such apparatus as Taylor's splint, or as Chance's or Baker's stays, or the more recent instruments of Lannelongue.

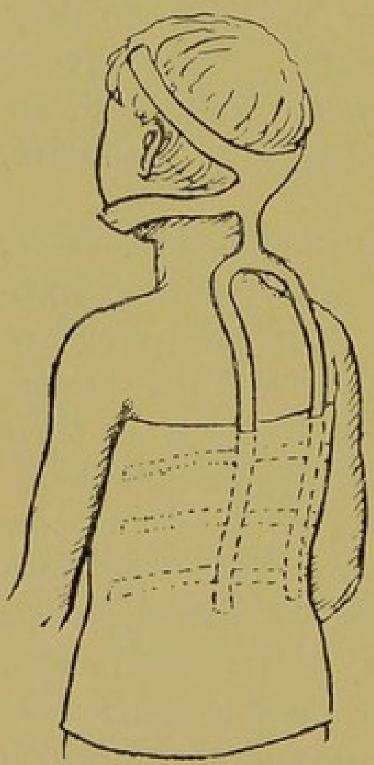


Fig. 235.—Head Support for Cervical Caries.

What I may say with emphasis is, that they are *comparatively* inferior, and that their inferiority is so decided that they ought seldom to be employed.

Jury-masts are not adapted for use in bed. On the other hand, trough-like appliances of different kinds may be very useful.

A simple and inexpensive contrivance to support the head and steady the neck in cases of cervical and cervico-dorsal caries is the following. It has also the advantage of acting effectively in both the upright and the recumbent positions, whereas the ordinary jury-mast and collar are useless, and even in the way when the patient lies down. In fig. 235 it is represented as combined with a plaster-of-Paris jacket, but it can be easily fixed to a poroplastic one or to orthopædic stays. It resembles the ordinary jury-mast from the nape of the neck downwards, but above that point, instead of arching up over the top of the head, it stops short at the occiput, and gives off on each side two arms, one passing forwards above the ear towards the forehead, the other passing forwards and downwards, and so curved on itself that it grasps and supports the chin and lower jaw, nearly meeting its fellow of the opposite side.

This splint is made of the same soft iron as Thomas's hip-splint, but of course lighter, and is leather-covered and padded where it touches the head and lower jaw.

The intention is to imitate the steadying and supporting action of a person standing behind the little patient and

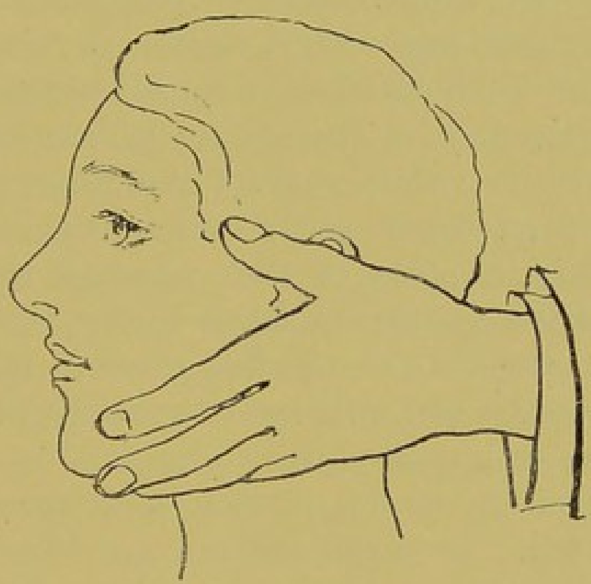


Fig. 236.

grasping his head, with the two hands placed one over each ear (fig. 236).

This appliance has one drawback: it is rather troublesome to fit. The instrument-maker must attend particularly to the set and curve of the jaw-pieces; and the surgeon also, if he fit the appliance to a plaster case or a felt jacket.

The addition to the instrument of joints worked by a key would make the process of fitting easier, but of course add to the expense.

The chapter next after the present, on the application of plaster-of-Paris jackets, felt jackets, jury-mast, &c., applies to both angular and lateral curvatures. It was written some years ago, when I was regularly applying every week, with my own hands, many more jackets than I now have time to do; and I feel that I might rather spoil than improve it by re-writing it.

That method of securing local rest which excels all others is, in my opinion, and in the opinion of the great majority of the surgeons who have given it an extensive trial, whether in these islands or on the Continent,[1] the application of a jacket of plaster of Paris carefully moulded to the body from the armpits down to below the iliac crests. Such a jacket has, of course, little or no effect on that considerable minority of cases of angular curvature in which the disease is localised in the cervical and highest dorsal vertebræ. For these a special arrangement is necessary, such as that just described.

In writing of 'Scoliosis' I have explained the secret of the matchless effectiveness of the plaster jacket, and especially pointed out how the perfection of its fit and its rigidity (when properly made) enable it so to seize every *point d'appui* beneath it that, in spite of the ceaseless movements of respiration and the changes in shape due to digestion, it will keep the spine extended month after month. If it can thus keep up extension, it can still more certainly prevent movement, that is to say, secure *rest*.

Next in efficiency to the plaster jacket comes the jacket of poroplastic felt. In shape the two are identical, making allowance for the fact that it is not possible always to secure so perfect a fit when working in a material like the poroplastic felt as when working with plaster of Paris, a substance which can with ease be moulded into exact casts of objects almost microscopic. Still, the art of the manipulation of poroplastic felt has now reached a degree of perfection which makes it, for an immense number of cases, as practically effective as plaster of Paris.

It is the universal custom to contrast plaster-of-Paris with felt jackets and appliances of steel and leather, on the ground that plaster-of-Paris jackets are immovable, while felt, leather, and steel apparatus are readily removed and re-applied. In actual truth this contrast does not exist. As will be shown in Chapter XVIII, and by ways which have been published years ago, one by Professor Sayre and the other by

[1] See, for example, the debates on the subject at the International Medical Congress, 1881, at the German Congress of Surgeons (Berlin), 1884, and at the British Medical Association (Belfast), 1884.

myself,[1] the plaster-of-Paris jacket can be made as easily removable and re-applicable as a laced boot. And, on the other hand, by means of small rivets the poroplastic felt jacket can be made as immovable as a new plaster jacket.

The immovability of the plaster jacket (so long as it remains uncut) is a property of the greatest value, which in the treatment of spinal caries must not be hastily sacrificed to any consideration of cleanliness or comfort, whether real or fancied. If the deadly character of the disease be considered, it would seem as reasonable to give first-class importance to such considerations as it would be for a military officer to be more anxious about his men having soap in their knapsacks than ammunition in their belts.

With regard to the objections which have been offered to the plaster jacket, some have been dealt with in treating of scoliosis; those which specially belong to the plaster jacket when used as an *immovable* splint have been left to be dealt with here. They are, in the main, the alleged dirtiness, and the pretended difficulty of detecting serious evils going on beneath it, such as the formation of pressure sores and of abscesses.

First, with regard to dirtiness. The plaster jacket is only dirty with dirty people, and where is the orthopædic appliance which will make dirty people clean? If the patient (or his mother or nurse, if he be a child) will take the trouble to keep a cotton or linen chemise or two pocket-handkerchiefs next his skin, beneath the plaster jacket and jersey, and to change them frequently, a great deal will be done for comfort and cleanliness. Full details about this are given in Chapter XVIII. Not only the linen beneath, but also that over the plaster jacket, should be kept clean, and changed with reasonable frequency. Then the jacket will look clean as well as be clean. If the perspiration of the patient's armpits smell, they should be sponged daily with very hot water, and then carefully dried. Just before the soiled chemise or handkerchiefs are removed from beneath the jacket they should be vigorously seesawed up and down; or a narrow strip of rough towel can be similarly used.

[1] *Trans. Internatl. Med. Congress*, 1881. See also Chap. XVIII.

At any time the jacket *may* be easily cut down in front, taken off, replaced, and refixed after the patient has been bathed; but the more rarely this is done, the better. I repeat that the patient's friends and medical attendant cannot too strongly imbue themselves with the idea that they have to deal with a very terrible, life-destroying, figure-spoiling, happiness-undermining disease, in fighting against which æsthetic namby-pambyness is out of place, and a little fussiness on their part may qualify them to rank with the widow Muggeridge, who in Douglas Jerrold's parable is said to have washed her husband to death.

Next, with respect to the alleged difficulty of detecting what is going on beneath the jacket, it may, in the first place, be said that it is better that there should be nothing to detect than that there should be any particular ease in detecting it. If, for the pleasure and profit of preventing spinal abscess in, say, two cases, I have to leave it undetected for a short time in a third, I shall consider that I have made a very good bargain. But there is no such price to pay. What surgeon is there who is always palpating the abdomen on the off-chance of discovering a spinal abscess, even if his patient does not wear a Sayre's jacket? And as for lumbar abscess, which more speedily manifests itself to the eye than does suppuration in the abdomen, how much harm is a patient likely to suffer, even if it should go unnoticed for a month or two?

It will not be forgotten that the plaster-of-Paris and poroplastic jackets secure local rest in two ways—first, by fixation; and, secondly, by extension. The amount of the latter obtainable in many cases of angular curvature is often apparently extraordinary, and really not inconsiderable.

By real extension I mean the actual separation of diseased surfaces, indicated by the opening out of the angle of an angular curvature. At the International Congress of 1881, Mr. Edmund Owen spoke warmly of the barbarity and danger of attempting to effect this; and the reply made by Professor Sayre consisted mainly of a fierce denunciation of v. Langenbeck, of Berlin, for suspending patients under anæsthesia. Let us descend from the empyrean heights of eloquence to the dead-level of commonplace fact.

Whoever will take the trouble to apply a strip of lead to the spine of a recent or progressive case of angular curvature, while the patient is being suspended as if for the application of a Sayre's jacket, will frequently, if not constantly, find the angle of the angular curvature perceptibly opened out. I am assuming that the suspension is gentle and moderate—in fact of a character rather pleasant to the patient than otherwise. It is only the commonest justice to Professor Sayre to say that no other kind of suspension has ever been recommended by him.

Therefore, in the living subject, even gentle suspension really does separate the diseased surfaces and more or less open out the angle itself.

But, of the *apparent* extension effected by suspension and the application of the jacket, the greater part takes effect in the parts of the spine above and below the seat of disease.

If the treatment of caries of the spine be considered from an historical point of view, *counter-irritation* will be found to occupy a position scarcely secondary to that of rest. Indeed, there have been times when the question of the treatment of this disease was mainly one of what particular *form* counter-irritation should assume; whether, *e.g.*, the moxa or the hot iron was preferable.

The more severe counter-irritants have long almost entirely given way to such milder applications as tincture of iodine. But the former really appear to have done much good in many cases. They must also have frequently failed. About the year 1880 I had under my care a child with very severe lumbar caries and psoas abscess. A few years before the actual cautery had been used pretty freely along each side of the lumbar spine by an eminent provincial surgeon well known for his faith in counter-irritation. Only a year or two before this, I remember Mr. Holden being under the impression that the recovery of a case of spinal caries under his care was due to an issue established, I believe, by the 'moxa.'

These counter-irritants were believed to be capable of causing the resolution of spinal abscesses.

They have all, however, almost entirely given place to the treatment by local and general rest, and, in the case of abscess, to treatment on the principles I shall enunciate presently. Corsets interfere with the use of counter-irritants, because, even if the former are removable, the latter tend to make the skin beneath them too sore to bear pressure.

The Treatment of Abscess due to Spinal Caries.—When a spinal abscess is discovered, it should be operated on. Possible exceptions to this rule are small abscesses so deeply seated that they are only discoverable by a very careful search for deep fluctuation in the abdomen. Unless the surgeon is very experienced in antiseptics, and in a position to superintend *all* the after-dressings himself, at least during the first month, he had better not be in a hurry to dissect down to and freely open such cases. Very few junior house-surgeons, and still fewer dressers, have had practice enough to perform the repeated dressings which may prove necessary without, sooner or later, permitting the antiseptic precautions to break down. Then a septic sinus may result, which is not only an evil itself, but also makes difficult or altogether prevents the wearing of a good plaster-of-Paris jacket, and even results in more abscesses.

But all abscesses of such a size as, for example, a psoas abscess, which has reached to or near Poupart's ligament, should be emptied without delay.[1]

Open them freely; scrape out the lining tubercular membrane, only using a sharp spoon when a blunt spoon fails to remove it properly; wash out (by sponging and syringing) the cavity with warm sublimate solution 1 : 2,000 (1 : 1,000 diluted with hot boiled water to a temperature of 100°); try to discover, and treat in the same way, any diverticula which may exist; and make one or more counter-openings to favour the operative procedures (and after-drainage, if needed). Should a sequestrum be discovered, it will of course be removed.

[1] The instruments which should be prepared, although they are not all required in every case, are—a scalpel, two pairs of dressing forceps, at least eight or ten of compression forceps, polypus forceps, director, long flexible probe, retractors, sharp and *blunt* spoons, long sequestrum forceps, curved and straight needles, needle-holder, fine catgut (green, chromicised), silkworm gut, drainage tubing of different sizes, two or three asepticised safety-pins, a Higginson's syringe and a glass syringe for injecting iodoform solution; as well as steriliser, carbonate of soda, carbolic lotion (1 : 20), sublimate solution (1 : 2,000), iodoform crystals, iodoform gauze (20 per cent.), and abundance of absorbent dressings.

Generally, just before covering up with the dressings, I pass a long drainage-tube as deeply as I can, down to the carious vertebræ, if possible, and inject through it 2 or 3 drachms of a concentrated solution of iodoform in ether. By this means, if the abscess cavity is empty of pus and of lotion, a layer of iodoform will be deposited on its walls; and I think the boiling of the ether, caused by the heat of the patient's

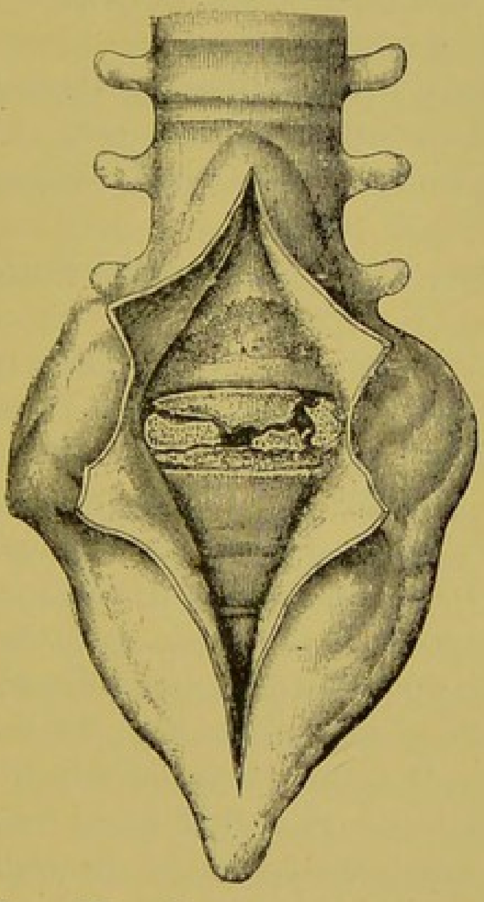


Fig. 237. — Lumbo-sacral Caries; Sacro-coccygeal Changes; Sequestra of the First Sacral Vertebra. (After Lannelongue.)

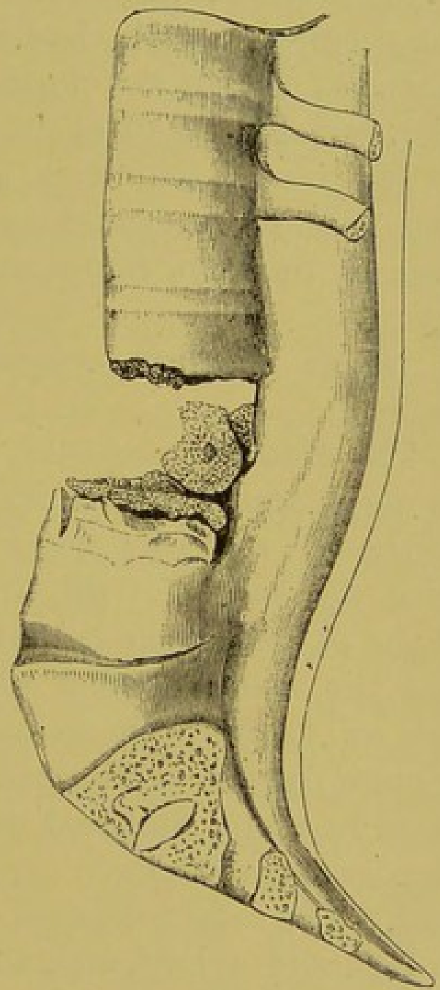


Fig. 238.—Lumbar Caries. Large Cavity involving two Vertebral Bodies and containing Free Sequestra. (After Lannelongue.)

body, favours its reaching the recesses and crannies of the abscess. I prefer an ethereal to an oily or glycerine solution of iodoform, for the purpose in question.

But the injection must be effected with certain precautions, or the pungency of the ethereal solution of iodoform will temporarily almost blind the surgeon and his assistants.

The ethereal solution should be freshly made; the dressings should be absolutely ready, and they should be at hand and applied the instant after the injection has been given.

Although never in the treatment of spinal cases, once or twice after injecting this ethereal solution into tuberculous joints, that part of the solution which overflowed the skin has excited an eczematous inflammation; and once, in a patient of Dr. Campbell Pope's and mine who had a curiously strong idiosyncrasy, and who had had iodoform eczema previously, a cutaneous slough was formed. It was, however, very superficial, and did not affect the joint or retard the case.

The reason why it is best to use a solution which has been recently prepared is that solutions which are old seem to undergo some change and increase in irritating powers.

Where iodoform crystals can be placed solutions are needless.

The dressings are—(1), next the wound, a square piece of iodoform gauze (about 20 per cent.) of eight or ten folds, moistened with 1 : 2,000 sublimate solution, and about twice the length of the wound beneath it. A single layer of the gauze should be cut away from the rest and placed next the wound, a plan which I owe to Mr. Cecil Banting. This will facilitate the painless removal of the whole. (2) One or more pads of sublimated wood-wool, sewn up in sublimate gauze bags and flattened out with a rolling-pin kept for the purpose, as in Macewen's wards. (3) A thick layer of salicylic wool. The total thickness of the dressings should be at least an inch and a half, and, where much discharge is expected, even more. The greatest extent of the dressings should be in the direction in which gravity is likely to draw the discharges, *i.e.* towards the back; but the dressings must be very snug in the fold of the groin. The bandaging should be particularly careful, even, and firm, and strips of strapping should be freely used here and there, between and over the bandages, to bind them together, keep them in place, and increase the general snugness. With these and wood-wool pads, properly managed, and salicylic wool used here and there, rather for its physical than for its 'antiseptic' properties, india-rubber bandages are needless. Iodoform gauze should be kept in 1 : 20 carbolic lotion. This lotion is washed out by the 1 : 2,000 sublimate solution.

Soon after antiseptic surgery had made it safe to open spinal abscesses surgeons ceased to be content to merely let out the pus of a psoas abscess at any spot, however distant from the prime disease it might chance to present itself. First, Lister went above Poupart's ligament; next, Chavasse went a little higher, getting at the abscess in the iliac fossa by an incision somewhat similar to that by which the external iliac artery is tied. The next step was to open the abscess at or near its source by a lumbar incision. This was taken by Dr. Macewen, Mr. Treves, and myself, working independently, and very likely by others; but the attention of the profession was first called to it by Mr. Treves, at a meeting of the Royal Medical and Chirurgical Society, in January 1884. An interesting discussion followed, and in it I took the opportunity of relating my own cases.

My own object in operating was not merely to drain the abscess cavity at a point as near as possible to the seat of caries, but also to bring into as thorough a contact with it as possible iodoform, in whose specific action on tuberculous disease I thoroughly believe. At the same time, if it turned out to be possible to safely scrape a carious surface or to remove a loose sequestrum, so much the better. My first case turned out to be merely one of caries of a transverse process, which I was able to thoroughly scrape. In none of the others did I meet with sequestra of size larger than microscopic. Small sequestra occasionally occur in connection with spinal caries, and may be discharged or extracted. Large ones are very unusual. Both small and large are too rare to be either expected or counted on. The lumbar operation usually enables the surgeon to examine with his finger the bodies of the lumbar vertebræ, and, under certain circumstances, the last dorsal, of course on the side towards the operation wound. I hope I shall not be misunderstood when writing of scraping a carious spine. One is not likely to forget the existence of the aorta, the spinal cord, cauda equina, and a few other structures.

H H

The Lumbar Operation to give access to the Bodies of Diseased Vertebræ.—If a large abscess exist, whether it present in the lumbar or inguinal region, the proceeding is simplified. But the surgeon must not expect that, as soon as he has opened a lumbar abscess which has come near the surface, all he will have to do in order to examine the vertebral bodies will be to pass in his finger and move it about in a spacious cavity. On the contrary, he will probably first enter a kind of superficial antechamber, communicating with the deep ante- or para-vertebral part of the abscess by a constricted passage through the quadratus lumborum, or through the lateral and anterior muscles. He will, therefore, have to make a free incision into this 'antechamber,' and, after clearing it out, find the passage through the muscle. This passage, again, will have to be enlarged upwards and downwards, in order not only to admit the finger, but to allow it room to move about freely and exercise its tactile functions.

With regard to the length of the incisions, the superficial one should be about 4 inches, or as much larger as may prove convenient; the deep one should be much shorter. In enlarging it, the immediate neighbourhood of the last rib should be avoided, as the pleura comes down to and even beyond it, and might easily be wounded. This direction would be by no means easy to follow in some cases, in consequence of the close approximation of the rib to the ilium, which is occasionally found. On the other hand, the deep incision may be lengthened right down to and along the iliac crest.

The line of incision should be along the outer border of the sacro-lumbalis, and afterwards forward above the iliac crest.

A little trouble is to be expected from hæmorrhage, and the deeper dissection must be carefully and watchfully conducted. The lumbar arteries proceed outwards, in lines alternating with the transverse processes; and they are sometimes vessels of considerable size. If divided, they must be thoroughly secured. It would never do to run the risk of recurrent hæmorrhage from them into a large abscess cavity. A good light is essential.

If the abscess has been already opened in the iliac region, a long director or probe must be very gently passed upwards and backwards along the abscess track towards the spine. The carious bone may be sometimes reached and felt; but that does not matter. The probe itself cannot always be easily felt from the loin, even where the superficial part of the lumbar wound has been made. The probe usually passes inwards, as it were, under cover of the transverse processes, and, of course, lies in the deepest part of the abscess. If difficulty be found in getting a long probe from the groin to the lumbar spine, it should be remembered that the abscess track almost always passes beneath Poupart's ligament, and the superficial inguinal opening may be enlarged, in order to enable the probe to pass through the abdomino-inguinal abscess aperture at a more favourable angle. The principle of this proceeding is the same as that of slitting up the canaliculus before probing the nasal duct.

If there is no abscess near the surface, either in the loin or in the groin, the operation may be conducted as follows: The patient should lie in the prone or semi-prone position, with the loin to be operated on rendered prominent by a thick cushion or cushions beneath the abdomen and opposite flank. If there is marked angular curvature, some little trouble may have to be taken to arrange and fix the patient satisfactorily. And, the patient being anæsthetised and unable to protect himself, care should be taken not to sprain his diseased spine.

Make out by palpation the position of the last rib, the crest of the ilium, and the outer border of the erector spinæ. Incise the skin from the rib to the ilium, along the outer border of the above-named muscle. Carry the incision down to the posterior surface of the quadratus lumborum. If the erector spinæ be thick, it will have to be retracted inwards a little while the quadratus lumborum is being incised; and the incision of the latter muscle must be directed inwards (*i.e.* towards the spine) as well as forwards, with a view to getting near the transverse processes. The tips of the latter should be searched for with the finger as soon as the quadratus lumborum is reached. In fact, the first part of the operation may be said to be directed with a view to reaching the tips of the tranverse processes of the vertebræ. The 'abdominal' branches of the lumbar arteries (except that of the first) usually run outwards, across the superficial surface of the quadratus lumborum, but occasionally even one or two of the lower ones run in front of the muscle. *And the pleura sometimes descends even as low as the transverse process of the first lumbar vertebra.* Therefore the deeper part of the incision should not be carried too near the last rib; and the operation should always be so conducted that the surgeon can *see* the effect of each movement of his knife, and be able to seize or compress at once any artery he may divide. By remembering that the lumbar arteries correspond to the intervals between the transverse processes the surgeon may be able to make a passage large enough to admit one finger through the quadratus without dividing one of the lumbar arteries. In front of the transverse processes and of the inner border of the quadratus lumborum lies the psoas muscle. And, lastly, along the inner border of the psoas are the vertebral bodies and intervertebral cartilages.

When the quadratus lumborum has been penetrated the psoas abscess, if one exist, cannot be far off, and a little tearing of the sheath and fibres of the psoas muscle with a blunt-pointed instrument, such as a director, inclined inwards and slightly forwards, may bring the pus to light. Following the same course, in the same way room may be made for the forefinger to reach and palpate the vertebral bodies. The ease or difficulty of the latter proceeding depends greatly upon the thinness or stoutness of the patient.

In all these operations on the spine a point of considerable importance already referred to must not be neglected. Care must be taken in moving the patient about, especially in changing him from the supine to the prone position, while in a state of anæsthesia. His muscles and sensations are not awake, to protect the diseased and weak part of his spine from sprain or other serious injury. A heavy man, whose psoas I explored in the way just described, suffered considerably for a short time after the operation from pain brought on, I believe, by movements of his spine while under ether.

Although I have been quite prepared to scrape the spine if circumstances should appear to justify it, yet most of the cases on which I have operated have not offered the opportunity or any justification to go so far. I will only say that I would never use the sharp scraping spoon to the spine, except under circumstances in which I could guide it with safety and certainty, and hope to complete a fairly thorough operation. But the concentrated ethereal solution of iodoform should be injected, in every case where access can be had, to the caries itself, or to the abscess cavity near the caries (which is practically the same thing so far as injections are concerned).

Before the solution of iodoform is injected, the abscess cavity and its walls should be cleansed as thoroughly as possible of all débris of tubercular membrane, granulations, and bone spiculæ, if any of the latter be present. This is done by sponging and by douching with warm weak solution of corrosive sublimate (1 : 2,000, diluted with hot boiled water to a temperature of about 100°). To cleanse the depths of the cavity two pieces of drainage-tube are conducted, side by side, into the deepest recesses of the abscess, the warm solution is forced by a Higginson's syringe down one, and a free return provided for it by the presence of the other. Superfluous fluid is sponged up before the iodoform solution is injected.

As a rule, it is best not to keep the patient out of his Sayre's jacket for more than a few days or a fortnight after operation. A jacket should have been made over wood-wool pads, &c., of a certain size and in a certain marked position before operation. It will then fit over dressings made and adjusted to the standard pads, which should be kept for a pattern. When an opening has been made near Poupart's ligament, it is desirable to fix the hip. In the case of children a weight extension, or a long splint, or a Thomas's splint combined with a Sayre's jacket, may be used. A back splint will help to prevent the knee from being drawn up. I am writing of cases which are still aseptic. When a case has once become septic, experience of the individual case will alone enable one to discover the best arrangement of splints or other apparatus, and the best position with which to keep the abscess as empty and its outlets as open as possible.

As soon as ever the discharge is reduced to a minimum, and the abscess to a sinus, the sooner the patient goes in a plaster jacket to a bracing seaside watering-place, the better. A few weeks at Margate will do more to close up such a sinus than any treatment in town. One of the quickest convalescences and most complete recoveries in my experience occurred in the case of a young adult in whom a huge lumbar spinal abscess was treated as above (at the West London, September 30, 1887, case of A. W.). He kept his bed for less than a fortnight, left the hospital within a month, and a few weeks afterwards started for a voyage to China. The sinus closed before the steamer arrived there, and he returned, and remains well (1899).

Residual abscesses will sometimes form, and present themselves some years afterwards, and cause a sinus to reopen. They are sometimes very superficial. They should be scraped out and treated locally. Here again, also, the treatment indicated is a plaster jacket and a stay at the seaside or in a bracing and breezy country place. Often have I seen a sinus which resisted all other treatment yield to this.

Occasionally old sinuses can be got to close by injecting them with 'red lotion' through a fine drainage-tube kept inserted into their orifices for a few weeks and gradually shortened.

With regard to the question of drainage, although I am certain that the proper use of the drainage-tube is attended by no such evils as have been laid to its charge—that, for example, it does not involve confinement of the patient to bed and to the house—yet experience has shown that it can be dispensed with. Owing, however, to the difficulty of operating on spinal cases with the thoroughness which can be applied to more superficial affections, the surgeon must be prepared to reopen, perhaps several times, an undrained spinal abscess, and let out a re-collection of serum or sero-purulent fluid. He should then take the opportunity of repeating the iodoform injection.

In opening a psoas abscess more care is desirable than many people think. Especially should a careful observation of 'landmarks' be made, in order to determine the exact bearing of the femoral artery and vein. I believe it was in opening a psoas abscess that the Dublin surgeon, Dease, accidentally opened one of these great vessels. He went home and, making a similar opening in his own femoral, bled to death. A distinguished English physician some years ago called in a surgeon to a case of psoas abscess, and during the consultation told him the story of Dease. The two then re-entered the patient's room, where the surgeon straightway passed his knife through the abscess into the femoral artery!

The safest plan is to steadily cut down *on* and into the abscess; although when an abscess is full, prominent, and comparatively superficial, it is, of course, unnecessary to proceed in that way.

The Direct Operative Treatment of Caries in the Dorsal Spine

The idea of this has not found much favour, because of the difficulty of attaining *thoroughness* in such cases. In many, perhaps in most, this difficulty would amount to impossibility. The guide to the site of operation is of course the angle or boss; but the disease may have spread superficially up and down the whole length of the dorsal spine, and beyond it, and burrowed in various directions between the soft parts, forming fistulas and sinuses which cannot be slit up to their terminations, as they could if they were in the limbs.

However, as I have said elsewhere, absolute thoroughness in operating on tuberculous cases, though very desirable, especially with regard to the risk of general tuberculosis when a focus is disturbed but not exterminated, is not a *sine qua non*.

But when there is a risk of an operation on tuberculous bone not being thorough, *the necessity of absolute asepsis is imperative.* Nearly all the worst cases of long-continued suppuration from spinal disease, ending in death from fever, amyloid disease, secondary infection, and exhaustion have dated their descent downhill from some slight operative interference, such as the puncture and drainage of an apparently superficial abscess, the slight and insufficient operation having often been carried out by a medical man not accustomed to practical surgery. The general practitioner should, as a rule, let spinal abscesses alone; and both specialists and general practitioners should be chary of probing fistulas and sinuses leading to tuberculous bone.

Operations on the dorsal spine for tuberculous disease may be classified as follows:—

(1) (The most common) Laminectomy.

(2) Laterally trephining the vertebral bodies.

(3) Following up the tracks which burrow between the ribs and lead from the intrathoracic disease to the superficial abscess (when an abscess presents), or to a sinus opening in the dorsal region.

(4) Various arrangements for drainage.

1. *Laminectomy*

About 1882 or 1883 [1] this operation first came into vogue, with the object only of relieving paraplegia due to Pott's disease. Highly praised by those who practised it, the results they published did not satisfy many surgeons, who were aware of what time and fixation (applied properly) could do for these cases. A large proportion of the cases operated on died more or less soon after the operation, though not perhaps as a consequence of it; and of those cases in which relief followed, it was obviously doubtful, in a considerable proportion, if the cure were due to the operation.

However, incidentally, many laminectomies for paraplegia led to the exposure and evacuation of spinal abscesses protruding into the spinal canal, and even to the removal not only of granulations and tubercular foci, but also of small sequestra.

[1] Macewen, *Brit. Med. Journ.* 1888, ii. 308; Horsley, *Brit. Med. Journ.* 1890, ii. 1298; Lane, *Clin. Soc. Trans.*, Oct. 23, 1891. Also Jackson, Southam, Wright, Kraus, Schoenborn, Demous, J. Duncan, Richardson, J. W. White, Kraske, Schede, Abbe, &c. For refs. *vide* Chipault, pp. 311 *et seq.*

In some the relief of paralytic symptoms was both immediate and persistent.

The operation thus became an established one; but too much must not be expected from it, and the cases in which it is to be applied should be carefully selected.

It is probably not often suited for cases in which there is evidence of active tuberculous disease combined with burrowing, septic sinuses, and high temperature. Nor should it be used in ordinary paraplegic cases until a fair trial has been given to plaster of Paris, fresh air, rest, and time.

Nevertheless, in any case of spinal caries in which the surgeon feels justified in attacking the disease by a latero-posterior operation, such as trephining the vertebral body through the pedicle, transverse process, and rib-head, he need have little or no hesitation in doing laminectomy at the same time, if he thinks that it will assist him to make his operation more thorough, and especially if the presence of paralytic symptoms suggests tuberculous invasion of the spinal canal.

The incision should be longitudinal and, if a mere laminectomy is intended, median. If a postero-lateral trephining and rib resection are to be combined, the incision may be made an inch to one side, or the median incision may be combined with a transverse cut. The arrangement and direction of the muscle and aponeurosis fibres do not lend themselves to the reflection of musculo-cutaneous flaps. After a long incision, carried down to the vertebræ, and hæmostasis, mainly by sponge pressure and finger-pressure, the tissues should be pushed outwards from the bones by a sharp rasp and held there by retractors, which will themselves help to check bleeding. The laminæ to be removed should be partly cut through with a Hey's saw or with a chisel and mallet, and the division completed with cutting forceps. Sequestrum forceps will remove the loosened pieces. Attached ligamentous or other fibres should be cut close to the bone.

The dura mater should then be carefully inspected. If granulations be seen, they should be scraped away, preferably with a rather blunt instrument; if any firm, fibrous new tissue, it should be cut away carefully, because it is not desirable to open the theca.

Usually the cord in its sheath can be drawn sufficiently away, first towards one side, and then towards the other, to expose the posterior surface of the vertebral bodies, and to permit disease to be removed by a small spoon and by swabbing.

If an abscess is seen, it can be opened either directly or by way of the pedicles and rib-heads, thus avoiding intraspinal contamination with pus.

Iodoform crystals or glycerine solution can be inserted, but not before, by the use of small swabs, all accessible cavities have been cleansed of tuberculous material. Lastly, the wound should be completely closed. Only in exceptional cases should a drain be left, and that should not enter the spinal canal, except in the rare cases in which much pus has been found therein. Then two drains should be used, either side by side or at the opposite ends of the opening in the spinal canal. Large thick dressings should be applied both snugly and securely.

If there be evidence of the presence of tuberculous material or fibrous neoplasm inside the dura mater, that membrane may be opened by a median longitudinal incision, and the disease dealt with. As soon as the theca vertebralis is opened cerebro-spinal fluid begins to flow out. It is then well to follow Horsley's practice and to lower the patient's head. Obliteration of the subdural space between the sheath and the cord is indicated by an absence of the normal pulsation.

2. *Laterally Trephining the Vertebral Bodies*

The following case is an example of this procedure, and was the first, so far as I know, in which it was followed :—

Frank F——, æt. 14, of Toppesfield, Halstead, Essex, had suffered for four years from paraplegia, practically complete, the result of caries with angular curvature in the mid-dorsal region. He came under my care in 'Accident' Ward, West London Hospital, early in 1890, and I applied, under extension, a Sayre's plaster-of-Paris jacket. In a few days he was able to stand, and even drag himself round the ward with the aid of his hands and the chairs, tables, &c. But no further improvement took place. Therefore, on September 19 I removed the laminæ of three middle dorsal vertebræ. At the same time I trephined the body of the vertebra corresponding to the angle of the curvature by perforating the transverse process and pedicle (on the right side, in a direction from without inwards and forwards). I used some rather large centre-bits made specially for the purpose and worked by an ordinary drill, enlarging the canal thus bored by means of a gouge and sharp spoon. I did not find any tuberculous focus, or granu-

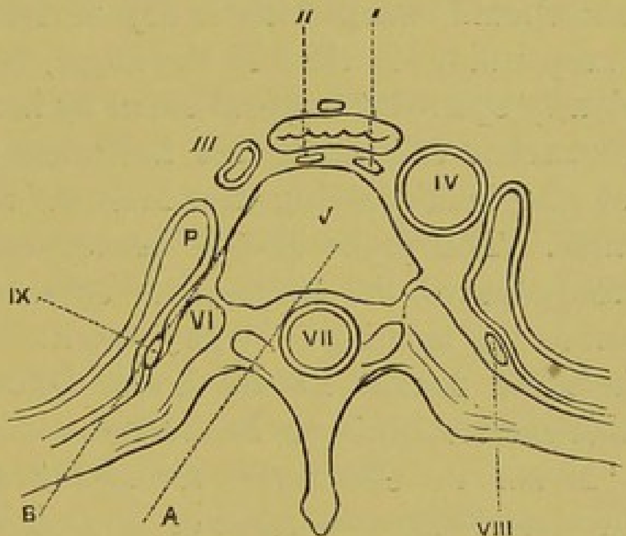


Fig. 239.—Outline Diagram based on part of a Drawing in Gray's 'Anatomy.' Between the straight dotted lines B and A lies the postero-lateral path of access to the bodies of the middle dorsal vertebræ (viewed from below). I, thoracic duct; II, right pneumogastric nerve; III, vena azygos major; IV, aorta; V, vertebral body; VI, rib-head; VII, spinal canal; VIII, left sympathetic nerve; IX, right sympathetic.

lations, or pus. In fact I believe the caries, which was of old standing, had ended in cicatrisation and ankylosis. The wound healed by first intention, but even after several months the patient was no better as regards his paralysis than on his admission, and worse than when merely treated by suspension and Sayre's jacket. He went home into the country on April 23, 1891. Two or three years afterwards I met the Rev. Dr. Taylor, of Banstead, who agreeably surprised me by saying my 'operation had cured the young man,' who was then walking about well and strongly. I do not think his recovery was due to the operation at all.

The fact is that paralysis from spinal caries nearly always gets well spontaneously if the patient lives long enough, and most of the 'cures' reported as results of laminectomy are merely examples of *post hoc, ergo propter hoc* reasoning. I have read the reports of many, and have little doubt about it. The exceptions include, of course, the cases in which laminectomy has led to the liberation of pus and the exposure and erasion of pre-vertebral foci.

The space to trephine in is, of course, bounded on the inner side by the spinal canal and on the outer by the pleura. The operator should work with a dry vertebra or two, of position corresponding to that of the angle, before him. If he has previously opened the spinal canal by laminectomy, he has a further means of guiding his instruments. The head and neck of the neighbouring rib may be trenched upon without scruple. The probe should be repeatedly and carefully used, to judge of the progress of excavation, and the finger as soon as the opening is large enough.

The vessels and nerves lie above and below the pedicles through which the trephining is conducted.

In the 'Revue de Chirurgie' for 1892,[1] M. Vincent of Lyons, while describing two cases of erasion and drainage, pointed out that the operation above described was feasible, and gave a diagram which might almost serve for an illustration of the operation which had actually been performed by me two years before, but not reported.

When there has been much destruction and little cicatrisation, granulations, débris, and perhaps pus, should be quickly discovered. Then a blunt spoon will be safer and more useful than a sharp one.

3. *Following up the Tracks which burrow between the Ribs and lead from the Intrathoracic Disease to the Superficial Abscess, when an Abscess presents itself or a Sinus opens in the Dorsal Region*

To do this effectively proceed as follows :—

If a fistula exists, scrape its track carefully to begin with,

[1] Page 279.

and cut or scrape off the soft edges of its orifice. Then slit it up as far as its passage between the ribs.

If an abscess presents, open it freely, scrape and swab its interior thoroughly, and discover the sinus which leads into it from the thorax ; scrape that gently.

In either case make any further incisions (preferably longitudinal) necessary to expose the neighbouring vertebral laminæ, transverse processes, and adjacent parts of the ribs.

Remove as much of the transverse processes and rib heads and necks as may be necessary to follow the sinus inwards and forwards to the side, or even front, of the diseased vertebral body or bodies.

Cautiously remove as much disease as you can find, with blunt rather than sharp instruments, remembering that the aorta is not only very near, but that it may in a severe case even be abnormally kinked in the angle.

Gently swab and wash out the cavity with warm 1 : 2,000 sublimate lotion.

Fill it, if small, with iodoform crystals. If large, inject an ounce of saturated solution of iodoform in glycerine. If there has been an open fistula, insert drains.

If the abscess has not spontaneously opened, close the whole wound completely by sutures of silkworm gut.

Dress with gauze, wood-wool pads, &c.

Lastly, apply a plaster-of-Paris jacket. Cut this jacket open longitudinally down the back, so that it will not interfere with dressing.

If there has been an open sinus, dress frequently, at least once daily.

If there has not, do not dress for a week, when the wound should be found closed. If there is pain or a rise of temperature, dress at once ; give egress to any distending fluid.

Keep on the plaster jacket for months.

Have a number of wood-wool pads all the same size for each individual case. Use one of them in the first dressing. Then the plaster-of-Paris case will fit over the others.

If a sinus remains, inject it frequently—*e.g.* every other day—with a saturated solution of iodoform in glycerine. Get the patient to a bracing seaside place if possible.

4. *Special Arrangements for Drainage*

Vincent, in the paper above referred to, strongly recommends carrying a drainage-tube right round, across (the front, or preferably through when possible) the body of the diseased vertebra. His procedure resembles that just related. He enumerates six or seven steps. They may be compressed into five:—(1) A T-shaped incision of which the cross-cut runs longitudinally, just outside the transverse processes, while the stem is at the apex of the angle or boss. (2) Resection (if necessary) of one or two ribs. (3) Similar procedures on the other side of the spine. (4) Putting aside the intercostal muscles and the pleura with a blunt instrument or the finger. (5) When a sufficient passage has thus been made the drain is carried through. A curved stylet with an eye at the end is used. The drain is passed from one side to the other, in front of or through the vertebral body, or perhaps, to write more correctly, the place where the disintegrated body has been. (See Vincent's illustrations, 'Revue de Chirurgie,' 1892, pp. 276–7.)

I have seen considerable benefit from this operation in disease of the lumbar spine. In dorsal disease I have always been satisfied to employ unilateral drainage, but do not doubt that cases occur well suited for Vincent's operation.

General Treatment of a Caries of the Spine

All tuberculous diseases appear to make more rapid progress when the health is deteriorated by other causes. It is therefore imperative to supply patients suffering from spinal caries with good and sufficient food, and with clothing fitted to protect them thoroughly against cold or changeable weather. They require also dry and pure air, sunlight, cheerfulness, and change. So long as they can get about they should be allowed to do so. It is very striking how the appetite is apt to fail, and all appearance of health and strength in the countenance disappear, soon after tuberculous patients have been confined to bed in some slum of a great city.

I once happened to assist for some years in a department presided over by two different surgeons successively. The first surgeon kept his spinal cases in firm local supports, but moving about. They for the most part did remarkably well. His successor sent them all (or rather all whose mothers he could frighten or persuade into carrying out his wishes) to bed. The change seemed, according to my observation, to have an immediately evil result in all the cases and a lasting one in many. Occasionally the parents, after finding their children going steadily backwards for three or four months, used to rebel and wish to have the poor little things relaunched on the old course of treatment, under which they had benefited so much.

Of so little value is mere rest in bed in the treatment of spinal caries that instances are not uncommon in which the disease first appears while the sufferer is bedridden for some other disease. There was an instance of this in the children's ward of the West London Hospital, where these lines were written, and Mr. Maitland Thompson, the house-surgeon, put his patient up in plaster of Paris and got her out of bed.

Of course there are cases where, because of extreme exhaustion, or because of excessive discharge from an abscess, it is practically impossible to get the patient up and about. Yet in some of these cases an attempt should be made to move the patient's cot into the open air, if the weather be fine and not too cold.

Of *drugs*, the most valuable are cod-liver oil, in as large doses as the patient's palate and digestive powers will stand, Syr. Ferri Phosphatis Co. (' Parrish's Chemical Food '), and, occasionally, for a short time, Vinum Ferri. It should be remembered in prescribing the latter for children that alcohol, even in the form of steel wine, can do harm when given in regular and long-continued, though small, doses. I therefore usually prefer Syr. Ferri Phos. Co. to Vinum Ferri.

The particular kind of air which is best is that which is purest, driest, and most bracing. Sea air, Margate air: these are of great efficacy. Low and damp localities are very unfavourable.

Extension is applied to a patient in bed by means of an arrangement of strapping precisely analogous to the ' stirrup ' by which a leg is extended. The extensive force is a weight connected with a pulley. Cases treated by extension in bed are generally either cervical or upper dorsal. The stirrup is then attached to the head, and counter-extension can be obtained by raising the head of the bed, or, if preferred, by extension from the hips downwards. If the disease is lumbar, the strapping should be applied, not to the head, but to the skin of the thorax. The latter should not be nearly encircled by the transverse strips, lest respiration be impeded.

Patients, especially children, do not submit to extension for spinal disease so readily as for hip disease. Its advantages are not nearly so obvious to them, and indeed are sometimes very doubtful even to nurse and doctor.

I only use it myself in exceptional cases in which, for some reason or other, fixation is inapplicable. Some surgeons, however, especially Lannelongue, speak highly of extension. It is possible that greater experience of what is to them a favourite remedy makes it more satisfactory in their hands than mine.

Previously to applying strapping to the head the hair should be either shaved or cut off very close.

A mode of rest which tends to effect extension in some cases is the *prone couch*. There are several *a priori* arguments which appear to tell strongly in favour of this. But in practice the prone couch, if used continuously, is generally more disagreeable to the patient than beneficial to his spine. I know of no results attainable with it which the surgeon cannot more conveniently attain without it.

Reduction of the Deformity in Pott's Disease

MM. Chipault and Calot have recently revived a treatment which, though described, and no doubt practised, by surgeons in past centuries, had long been discarded and viewed as barbarous.

It is probable that this revival would have taken place nearly twenty years ago but for the strong protests of Sayre, for which that ingenious and eloquent surgeon used to take as a text a fatal case of application of the plaster corset under chloroform. As I shall show in the section on 'Sayre's Treatment,' the ordinary extension used therein opens out the angle of curvature a little in all cases not ankylosed, and a great deal in some.

But the practice of M. Calot was, when first published at least, the bold, forcible, and rapid breaking down of whatever resisted the straightening out of the spine, followed immediately by fixation in a plaster-of-Paris corset extending as high as the chin and occiput.

M. Chipault is more cautious. He advises only gentle traction and light compression under chloroform. Cases which will not yield to these he regards as unsuited for rectification. And an essential part of his procedure is suture of the spinous processes to one another, for which he at first used silver wire, and latterly, following the advice of Gayet and Delcroix, suture of the periosteum of the laminæ.

According to Calot—between whom and Chipault there is a difference of feeling, if not of opinion—on the point of priority, Chipault was anticipated in the matter of suture of the spinous processes by 'Hadra,' an American (1889). Calot himself freshens the edges of adjacent laminæ, and when he has brought them into contact unites the reflected portions of periosteum, &c., together. He observes that he has done this ten times, but does not tell us in detail the precise results, apparently regarding osseous union as a necessary and obvious result.

This is one of several of Calot's views which probably few other surgeons find confirmed by their general experience. Another is that the use of silver sutures provokes suppuration. A third is that, as late as 1897, a surgeon in presence of a tuberculous knee in a bad position lightly proceeds to break down 'osseous trabeculæ infiltrated with tubercle,' in order to straighten the limb. I think the surgeon should open such a joint, remove the disease with care and approximate, or even absolute, thoroughness, and *then* straighten the knee.

I am afraid that M. Calot is too much carried away by a perhaps natural enthusiasm.

Serious and fatal consequences have now been repeatedly observed after the forcible straightening of angular curvatures: general tuberculosis; intra-thoracic tubercular infection and respiratory troubles; abscess and paralyses. The latter may have been mere coincidences; but the occurrence of the former could have been foreseen from experience of meddling with such joints as the knee in the manner which M. Calot regards as still customary.

My own belief is that the gentler methods of Chipault, and of Calot as expounded in his later contributions,[1] are justifiable. I have used them myself in several cases without harm. I have found a difficulty in preserving the gain with plaster of Paris alone, although I am certain it is the best of all external supports. Chipault says that recurrence has taken place in all deformities in which the spinous processes or laminæ have not been sutured together. I am surprised myself at the success reported as a result of the latter operation; it is claimed for it that it even does away with the necessity of external support.

I should expect ankylosis to much more surely follow a combination of removal of the articular cartilage from the *articular* processes with silver suturing of the spinous processes.

Calot wisely recommends that when an abscess is discoverable it should be cured before the spine is straightened.

A question I have felt disposed to ask is, whether it would not be right to trephine the spine postero-laterally through the pedicle, rib-heads, &c. (as already described), and clean out any tuberculous material found, as a routine process before straightening out the angle.

With regard to the *manner* of straightening out the spine, it is done by combined extension of the patient and compression of the boss. The patient is laid prone upon a table; the hips and the upper part of the sternum are raised on padded blocks. The extending force, whether manual or machine, is applied on the one hand to the legs, on the other to the head, and sometimes also to the arms, if the angle is not too high in the dorsal region. Calot puts the limit of justifiable force at eighty kilogrammes, or one hundred and fifty-six pounds.

[1] See *Clin. Soc. Trans.* vol. xxxi. p. 29 (1898).

Theoretically, it would be best always to use a manometer; but care should be taken to see that it is correct and working properly.

The pressure on the boss should be of less weight than the extension, and time should be taken. The anæsthetist should see that the child's head is properly supported, and exercise great watchfulness.

A jersey should be placed on, as for Sayre's treatment. Little or no cotton-wool padding should be used. And the plaster bandages should never be applied at all tightly to a patient under anæsthesia, for fear of hampering respiration. Means of cutting the case open rapidly if necessary should be close at hand. Thin wadding or flannel may be used between the plaster and the neck and chin.

If the patient is afterwards allowed to get up, my 'anterior crutches' may be added to keep the shoulders back.

Robert Jones and Tubby give as an average duration of after-treatment two or three years, which is probably not too much, though more than that stated by the French surgeons. Jones and Tubby were well-pleased with their results ('Brit. Med. Journ.' and 'Lancet,' November 20, 1897). They employ a double Thomas's splint instead of the plaster jacket. R. W. Murray, who reported fourteen cases at the same meeting (of the Clinical Society), was not quite satisfied with his own results, and had decided to discontinue the operation, at least until he had time to study the more distant effects.

CHAPTER XVIII

THE APPLICATION AND MANAGEMENT OF PLASTER OF PARIS, POROPLASTIC FELT, ETC., IN THE TREATMENT OF SPINAL AFFECTIONS

The following chapter aims at giving more complete and detailed directions for the treatment of spinal diseases on Sayre's principles than any hitherto published. It was written years ago, but when I had already an experience of over 1,000 applications of the plaster jacket, and of some hundreds of the poroplastic jacket, besides numerous re-mouldings, and a small experience of the use of paraffin, and considerably more than 1,000 suspensions for measurement as well as for jacket-making. A great part of this experience had been obtained whilst working in the orthopædic department of St. Bartholomew's Hospital, under Mr. Willett and Mr. Marsh successively. The rest had been gained as surgeon to the Surgical Aid Society. Whoever was then acquainted with the department referred to will acknowledge that, in the treatment of spinal caries, plaster of Paris had as fair and as skilful a trial as possible at the hands of Mr. Willett; while Mr. Marsh, by inviting Mr. Cocking, the inventor and maker of poroplastic felt, to bring his material himself and take an active part in its use, certainly did a very great deal to show what *can* be done with the felt jacket.

Thus, besides having been allowed by the above-named gentlemen to manage a considerable number of cases on the lines of my own ideas, with as little interference as it was possible for a responsible and conscientious head of a department to make, I had the advantage of being able to watch closely the methods of Mr. Willett and of Mr. Marsh.

The principles of Professor Sayre, as I understand them are, in the treatment of *angular curvature* :

1. Fixation by a plastic, irremovable corset;

2. The obtaining and maintaining the best possible position of the healthy as well as the diseased part of the spine during the application of the apparatus which is to secure the perfect fixation.

As regards *lateral curvature*, the principles of treatment are, roughly speaking:

1. Extension by self-suspension;

2. Immobilisation in the position of extension.

To this may be added a *third* essential principle, namely, the repeated reapplication or readjustment of the corset, in order to maintain the ground which Professor Sayre believed to be gained by daily or twice daily suspension.

I do not propose to go out of the way here to discuss the value of Sayre's treatment. The expression 'Sayre's treatment' will throughout these remarks be used as signifying a treatment conducted on Sayre's *principles*, and not refer merely to an exact imitation of all his methods. I am aware of the danger, the great danger, of departing in the slightest degree from an inventor's directions, and of the risk thereby run of saddling him unjustly with failures. But no one who has worked so much at any subject as I have at this can altogether repress his own individuality; and all that can be expected of me is to point out what management of details recommended here really seriously differs from Sayre's practice, so far as it is known to me.

I. The Materials and Apparatus

For Suspension.—A strong hook in the middle of a beam in the ceiling or the lintel of a doorway (but doorways are apt to be draughty, and are generally rather narrow for the purpose); or the tripod, or a tall 'pair of steps,' or even a ladder, well secured at the bottom and with the top placed against the wall as high up as possible. The ladder is the most inconvenient and unmanageable thing of all. The legs of the tripod get in the way, and without certain precautions (see below) the whole tripod may easily be pulled down. The best point of suspension is either a hook in a beam, or a hook on a transverse iron bar going across the room from wall to wall, as at St. Bartholomew's. The most convenient height for such a bar is 7ft. 6in.

Precaution in using the Tripod.—When it is erected, its legs should be so fixed (best by a suitable contrivance at the apex) that they can neither open nor close any further. If this be neglected, the person dragging on the pulley rope may gradually, and without his action being noticed by anybody, pull the tripod into a position of such instability that the slightest push may upset it. I have never seen it actually knocked over, but I have several times seen an approach to this accident sufficiently near to frighten the patient and embarrass the operator.

Pulleys.—A light child can, with care, be safely extended and suspended without any block at all, the suspending cord being merely passed over the hook. But pulleys are essential in most cases, and should be obtained as a matter of course. They should consist of two blocks, with not more than three wheels altogether, and of a good strong cord. On the cord wooden balls may be strung, for the hand is apt to find prolonged traction rather painful. Take care to fix the pulleys the right end up, and to see that they are not too much twisted to work. To prevent this twisting, take them down and put them away carefully after use. The wooden balls should be left loose on the cord until the patient has been extended to the desired extent. They should then be fixed at the proper height by a simple loop, as in fig. 240, which can be pulled out instantly by traction on the end A.

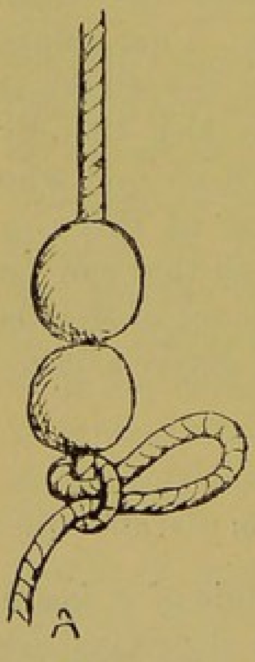


Fig. 240.—Loop on Pulley Cord.

Caution.—On no account tie a knot, for that might make it impossible to lower the patient in a sudden emergency. For of course the wooden balls when fixed limit the extent to which the pulley cord can run through the block.

Yoke.—This is desirable, but not essential. It may be of wood or iron. I used iron for three years, but now much prefer a round bar of wood, which is lighter, cleaner, quite strong enough, and less likely to hurt the patient's head if suddenly lowered by either his own or anybody else's stupidity. It should be deeply notched on the upper side, to prevent the rings of the collar and the straps of the armlets from slipping.

Head-gear.—A very comfortable, as well as the simplest and cheapest, is a broad chin strap with a comparatively narrow occipital strap, both of soft felt,[1] and applied as in the figure. The chin strap should be placed well under the chin, but not so far back as to press against the larynx. The occipital strap should usually pass under the back hair, and be drawn far enough through the buckle to bring the back edge of the chin strap up to the ears. A little cotton-wool is useful here and there, especially just in front of the ears and beneath the occiput. The leather collar, if used at all, should be soft throughout, and hollowed to a sufficient depth where the chin fits in. Moreover, as the supporting straps usually run freely through rings on the yoke or crossbar, it is as well to tie a piece of bandage across the occiput from the straps of one side to those of the other, or else the patient's chin is apt to gradually tilt up until it reaches the uncomfortable position of a bird drinking. The collar should be padded with cotton-wool beneath the ears and thickly padded between the occiput and the buckling strap. Other little pads of wool may be required, especially on each side the chin.

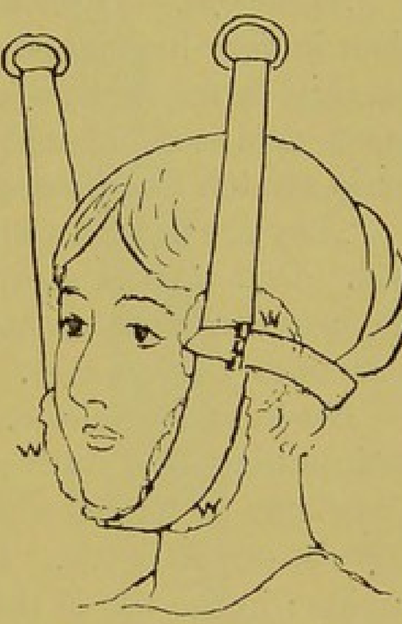


FIG. 241.—HEAD-GEAR.

Note.—The general principle in padding should rather be to pad close by than immediately over the point of pressure.

Both the leather collar and the chin strap used to be employed to produce extension in spinal curvature many years ago.

[1] Mr. Cocking used to make and sell this for 3*s.* 6*d.*

Extempore Headgear.—In the absence of anything better two pocket-handkerchiefs may be used, one as a chin strap, to bear most of the weight, the second to go round the occiput and brace back the first. Take care not to tie the knot on the second handkerchief where it would press against the head. Get this handkerchief also well *beneath* the occiput, or it will slip up. A stout safety-pin or two will improve this contrivance.

Arm-loops.—These are sometimes, but rarely, useful, and then in very heavy and feeble people. Also, in some cases of cervical caries, when a jacket is being applied to carry a jury-mast, arm-loops should be used, lest the headgear dangerously stretch the diseased part of the spine.

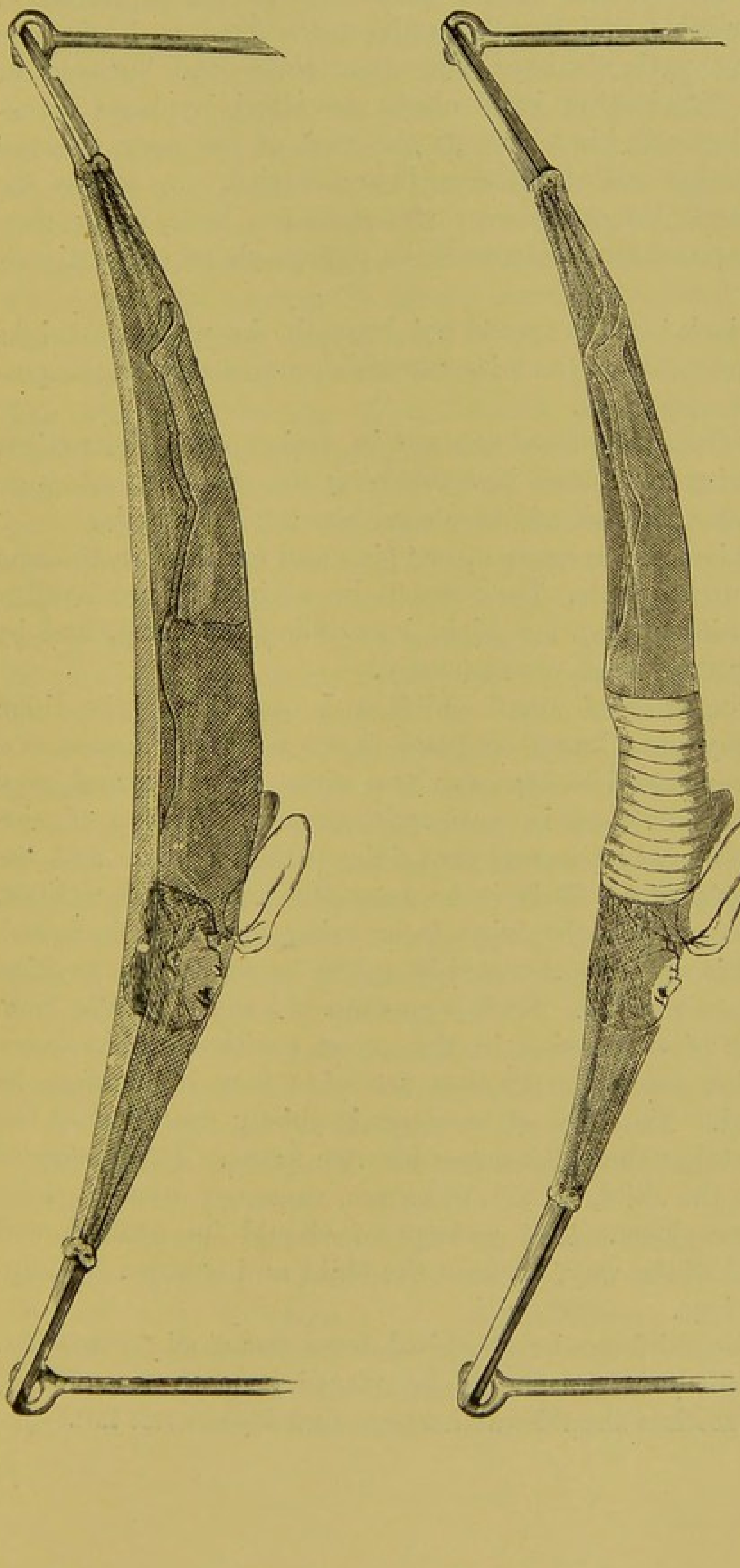
They are padded rolls of leather having a strap at each end. One of these straps has a buckle, by means of which the loop can be shortened or lengthened to match the headgear in any given case.

Horizontal Position.—There are three chief modes of maintaining this during the application of Sayre's jackets. They may be named after their originators—(1) Walker's, (2) Davy's, (3) Willett's. In the use of No. 1 the patient lies supine; in the use of the other two he lies prone.

Walker's Method.—Dr. Walker, of Peterborough, placed the patient supine upon a number of many-tailed bandages well charged with moist gypsum paste, and then applied the bandage.

Davy's Method.—Mr. Davy, of Westminster Hospital, introduced the practice of applying Sayre's jackets in the prone position. He slung the patient, face downwards, in a light hammock, and when the plaster had set cut away the ends of the hammock, leaving the middle inside the jacket. (See figs. 242 and 243.)

Willett's Method.—In the case of an adult this requires more elaborate arrangement than in the case of a child. As practised by Mr. Willett it may be thus described. The apparatus are two sets of pulleys, a jack-towel, and a broad band of leather with rings at each end. This band of leather is divided longitudinally from each extremity to near the middle, so that it may be said to have four tails.



Figs. 242 and 243.—Davy's Hammock.

The patient lies in the prone position on a stretcher, truck, or table, and the two pulleys are fixed to hooks, one above the patient's head, the other above the buttocks or thighs. The leather band above described is placed transversely beneath his chest, at the root of the neck, the two tails at either end of the strap being carried, one across the axilla, and the other over the shoulder, both being then carried up and connected with the pulleys above the patient's head.

The jack-towel is spread out beneath the patient's thighs from hips to knees, and its two ends connected with the posterior set of pulleys.

Now the two pulleys are put in action until the patient swings with his elbows just touching the table beneath him. Some soft article should be placed beneath the elbows.

In this position cramps, or 'pins and needles,' in the arm are not unfrequent. They are to be avoided by not hauling up the leather strap too high, by rubbing the arms, and by applying the jacket expeditiously.

In the case of small children, I sometimes take them across my own knees or place them across an assistant's. The knees should be kept dry by a piece of waterproof, such as the jaconet used in antiseptic surgery. A loop of wide bandage should be passed round the patient's hams and the supporter's foot. This is to keep the hips flexed a little, and thus prevent the loins from being too much hollowed. Without it the patient would be apt to be fixed in a position of extreme lordosis. Such a position of lordosis results from any form of suspension in the prone position, unless some precaution analogous to this use of a loop of bandage be employed. The loop of bandage is chiefly useful when the surgeon takes the child across his own knees. If an assistant supports the child, he can, of course, spare one hand to keep the knees down. The waterproof should be pressed well down out of the way, beneath the child and between the supporter's legs.

Or the child can be stretched from one stool to another. Some soft material should be placed beneath its elbows, and its mother should watch to see that it does not fall.

Or—and this is *the best extempore form of this series of arrangements*—place two chairs, and a pole of wood across them from the back of one to the back of the other. The whole can, if desired, be placed on a long table instead of on the floor. The pole is preferably square in section. It should be firmly lashed to the chairs. The hips are suspended by a towel, *not* spread out, lest it keep the knees up, and thus produce that excessive hollowness of the lumbar spine which is to be avoided in dorsal cases. The head rests on the patient's arms on the seat of one of the chairs. The chairs are arranged like the seats of a phaeton, not *vis-à-vis* like those of a victoria. There is little or no danger of the head and shoulders slipping off the chair; but all anxiety on that score can be set at rest by an assistant's grasping the patient's arms. The apparatus should be so arranged that the whole anterior surface of the trunk is freely accessible from an inch below the anterior superior spines to near the top of the sternum. While getting the patient into position, it will add to his comfort if some one supports his abdomen by the hand spread open beneath it.

Preparation of the Patient.—He should be well washed, as a bath will be impossible for some time when the jacket is once applied. Any pustular eruption should be cured. In the rare cases in which scabies complicates acute and urgent caries of the spine the patient should be thoroughly washed with soft soap and hot water, then sulphur ointment should be gently rubbed on and into every part of the skin affected, left on, and the jersey and plaster jacket applied over it. Such cases must be seen and carefully examined every few days, lest pressure and the scabies combined produce ulceration.

In dealing with the children of dirty people, the late Dr. Oxley used to sprinkle sulphur inside the jersey, as a prophylactic against parasites in general.

The Jersey.—A jersey is put on before the plaster bandages are applied. This jersey should fit absolutely close, without any wrinkles. Its circumference, unstretched, should therefore equal that of the narrowest part of the trunk, usually the waist. These jerseys may be had retail of some of the instrument-makers, and wholesale of Messrs.

Morley & Gray, 36 Gutter Lane, E.C. They are made of six sizes, numbered 1, 2, &c., from the smallest. The wholesale prices were:

For No.	1,	13*s.* 6*d.*	per doz.	
,,	2,	16*s.*	,,	
,,	3,	19*s.*	,,	according to size.
,,	4,	21*s.*	,,	
,,	5,	25*s.*	,,	
,,	6,	29*s.*	,,	

They can be obtained retail of any surgical instrument-maker, though some do not keep them in stock. In the absence of a well-fitting jersey, I think I should consider a carefully applied, rather broad flannel bandage preferable to a badly fitting or too thin jersey.

Underlinen.—I sometimes place two thin pocket-handkerchiefs or strips of linen, or of silk, or of thin woollen material, well spread out, beneath the jersey, one anteriorly, the other posteriorly. These can afterwards be changed by stitching clean ones to them. Then, as the dirty handkerchiefs or linen strips are dragged out, the clean ones slip in. The latter can then be smoothed out by dragging up and down and from right to left with a seesaw motion; a paper-knife is sometimes useful in this smoothing process.

Dr. Oxley applied two jerseys, in order that the under one might be changeable. An objection to this is the extra thickness, which must be heating in summer, and is always calculated to impair the delicate fit of the Sayre's jacket itself, a point of no small importance. There is, furthermore, the expense; for of course this method requires not less than *three* jerseys, one to be at the wash. In hard-pressed charities every additional half-crown has to be considered. On the whole, I am sure that for all classes the kerchiefs or strips will be preferred, on account of their smoothness, comfort, and easy procurability; while for the poor they will be preferred for the sake of cheapness.

Pads are made of cotton-wool or wadding. I have sometimes used well-covered horsehair for permanent pads; but cotton-wool is the only essential and universally useful padding.

The situations for the pads depend upon the nature and position of the patient's disease, and partly also upon personal peculiarities. For many patients a stomach pad is necessary. But a good dinner does as well. All female patients, except young children, should have breast pads.

Cases of angular curvature may have small pads placed over the angular projection; but they must not be relied on to prevent chafing. I shall return to this subject in the next paragraph but three.

Very thin persons may have pads placed over such bony prominences as the iliac crests and anterior spines or a very projecting sternum.

Note.—Pads over angular and bony projections are best placed, as Mr. Golding-Bird recommends, between the jersey and the plaster case.

I usually place the iliac pads in position after the case is applied and dry, and then I apply them behind and beneath the point where pressure is complained of, so that they, so to speak, lever the case off that point. They are seldom necessary in a properly moulded jacket on a fairly well-nourished patient, especially if he be a child.

Pads are sometimes required to protect the sacrum from the lower margin of the jacket.

The only reliable way of ensuring comfort where there is a projecting angular curvature is to *incise the jacket over the boss*. This incision should be perpendicular or, better, crucial; and the centre of the incision should be distinctly above the top of the boss, as the pressure is exerted chiefly downwards. But as, in occasional positions, pressure is exercised upwards, the incision should extend over and beyond the whole boss.

It is chafing combined with pressure which irritates such prominences.

Nothing tends more effectually to prevent chafing and pressure than a perfect fit. Sayre's jacket is in this respect analogous to a boot. It is true, therefore, that often there is no necessity for any incision or pad whatever to prevent abrasion, any more than there is necessity for cutting holes or for placing pads inside a good boot.

Care must be taken to both cut and place the stomach and breast pads symmetrically. If the patient is a female, much mental distress may be produced by carelessness in this respect. The stomach pad should not be a mere irregular lump; it should be flat, square, and rather thin than thick. A single thickness of cotton wadding, 6 inches square, does for most adults. Its upper border should lie over the ensiform cartilage. It should be placed inside a loop of bandage whose ends should hang down just below the lower edge of the jersey. When the plaster case is dry and hard this loop can be twisted round and the stomach pad pulled out by it. Neither the stomach pad nor the breast pads should be removed till the case is quite hard and dry, not only because parts of the case would then be left unsupported, but also because the fit of the jacket at the flanks might be loosened and spoilt.

The breast pads should be cut out of a sheet of wool with scissors. Ordinarily each pad should consist of two rather thick layers, one rather smaller than the other. The small one should be placed exactly over the centre of the larger, and the whole pad thus formed placed beneath rather than over the breast, because the latter ascends when the arms are raised in self-suspension. But the larger the breast, the thicker should the pad be made, by adding other layers.

Stomach pad and breast pads are placed next the skin after the jersey is on, and are all removed when the case is hard and dry.

There is always a tendency for the jacket to press backwards at the thorax, and thus to flatten the breasts anteriorly. This can be partly prevented by placing a permanent pad of wool opposite the sternum, between the breasts, after the jacket is hard and dry. I intend to try the effect of a caliper or truss to take its support from the back and to press on the case in front between the breasts while setting and drying are going on, and afterwards to be removed. In this way I hope to get the section of the jacket at the nipple-line more like a transverse section of the body at that level.

A *common calico roller* bandage should be at hand, out of which to cut loops for various purposes.

A few *safety-pins* are very useful.

The *plaster of Paris* should be of the best quality, such as is used by Italian cast makers, or still better by dentists,[1] and not the coarse stuff to be bought in many general dealing shops. It should be pure white and absolutely free from grittiness. It is very cheap; a few pence buy enough for the largest jacket. Too large a quantity should not be bought at once, as the fresher it is, the better. It should be kept in a dry place, in a tin box with a well-fitting lid.

'*Crinoline*' is the material of which the bandages are made. It should be very strong and coarse. That kind which is made of linen is of no use, as the plaster will not adhere to it. Crinoline can be had of most drapers. I should be happy to forward a specimen of a good kind of crinoline for the purpose, by post, to any one who will ask for it and send a stamped and directed envelope.

The Bandages.—Their most convenient size is 4 yards long by 3 to 3½ inches wide.

The plaster is rubbed into the bandages dry, either by hand or machine, but preferably by hand. Use a table not less than 2½ feet long. Place a mass of plaster upon it. Spread some of the plaster over the table before you. Throw the bandage over the opposite end of the table, holding fast one end. Place a handful of plaster upon the piece of bandage which lies on the table, and, leaning rather heavily upon it, rub the plaster into the bandage with the palm of the hand. A single heavy sweep of the palm of the hand presses the plaster into 2 or 3 feet of bandage. Roll up rather loosely than tightly the piece of bandage thus plastered, rub in another 2 or 3 feet, and so on. *Roll the bandage very loosely.*

The water in which the bandages are to be soaked should be lukewarm,[2] for the sake of the patient's comfort, and it should be changed once in the middle of making an adult case, as after soaking half a dozen bandages it does not act so well as at first.

[1] Very good can be got at Rutterford's, in Poland Street, W.

[2] But not hot.

The bandages should be placed *upright* in the basin; the water should completely cover them; two, neither more nor less, should be in the basin at the same time; as soon as one is taken out another should be put in. The surgeon should always take out the bandage near him, and the dry bandage should be placed in the water on the side away from him. The bandage is sufficiently soaked when it ceases to give off air-bubbles.

Every one of the above directions concerning plaster, bandages, and water should be minutely followed. Then the bandages will be found soaked in a thick cream of plaster of Paris. Deviate from any one of the above directions, and you may have a bandage the folds of which will scarcely adhere to one another, and cannot possibly make a strong homogeneous jacket.

Various simple *machines* for rolling plaster bandages have been invented.

Almost all bought ready-made bandages are objectionable in some respect or another. Many are very inferior.

The Process of Application.—Fit the patient with a jersey so tight, even at the waist, that there shall be no wrinkles anywhere. Pin this jersey down at the lower edge, in the case of a female to the petticoats, in the case of a male to the trousers, in the case of infants and young children to a piece of bandage passed between the legs. Unless safety-pins are used, take care that the pin points do not project, as you will be likely to afterwards scratch your fingers.

Leave the front of the jersey unpinned till the dinner pad is inserted.

Put the underlinen, or silk strips, and the dinner pad in place, with its attached fold of bandage hanging down. Pin the jersey down in front.

Place the breast pads and the pad over the boss, if you mean to use one.

Pin the jersey over the shoulders, or tie the pieces provided for the purpose.

Suspend the patient, or otherwise place him in position, and review what you have done, taking care that (1) the head-gear is perfectly comfortable, pressing neither upon the ears nor painfully upon the jaws or nape of the neck; (2) that the necessary pads have not been forgotten; (3) that the jersey is close-fitting, free from creases, and its lower margin pulled down well below the level of the anterior iliac spines.

You should have an assistant, if possible, and he should sit or stand on the opposite aspect of the patient to you.

Place two bandages in the water. After it has ceased to give off air-bubbles take out the first,[1] squeeze out the superfluous fluid, and apply the first roll of the bandage round the waist so that it shall fit close, but not tight. Then gradually carry the bandage downwards to the level of 1 inch below the anterior superior iliac spines. Each roll should only slightly overlap its predecessor. Give the bandage a turn as each roll is completed. I usually make these turns at the back. Each makes an angle with its apex downwards. Having completely covered the lower half of the trunk, and taken an extra pair of horizontal turns round the lower edge of the jacket, return to the waist, and thence bandage gradually up to the upper margin of the jacket—that is, to a level 2 or 3 inches higher than the inferior angle of the scapula. Most of the bandages should be applied in the same regular methodical progression used in bandaging a leg, or there will be danger of leaving some part of the case soft and weak. But from time to time a few extra layers, and even a little thick paste made with plaster and water, should be rubbed into certain parts, namely:

1. All the concavities.
2. The flanks.
3. Just below the breasts.
4. Over the epigastrium and umbilical region.

These are the parts where the strain is greatest; for the jacket, when it gives way, does so by crushing, not by tearing, just, indeed, as does a hollow iron girder. Hollow iron girders, when made scientifically, according to the principles of Fairbairn and Stephenson, are extra thick on the side on which a rupturing force would crush.

No free plaster should be applied to the extreme outside

[1] Replace it with another.

of the case, as it tends to crumble off. As soon as the jersey has been covered with a layer or two of bandage, each successive layer should be well rubbed into the subjacent one. Any attempt to rub the earliest layers into one another would simply wrinkle them, as they do not adhere sufficiently to the jersey.

If the above-written directions concerning making and soaking the bandages be carefully followed, little or no additional moisture will be required while the case is being built up. If from any accident a bandage should not be moist enough, a wet pad of cotton-wool serves much better to moisten the case than the operator's hand, which splashes the water about very uncomfortably. Superfluous moisture is greatly to be avoided, as it delays the drying of the case; and, so long as the case is not quite dry, slight influences are apt to spoil its shape or even break it down altogether.

From time to time the ball of the thumb should be used to shape the jacket to fit well the crests of the ilia (and the boss in a case of angular curvature). The number of bandages, $4\frac{1}{2}$ feet by $3\frac{1}{3}$ inches, required for an adult woman's case is usually about twelve. But even a child three years old will require five such bandages, and an average girl of twelve would probably require nine. But size is, of course, not always proportionate to age; while other most important considerations are the shape of the patient and the nature of the disease. The more the patient's figure approaches the simple cylindrical, the thinner may the jacket be made. Severe examples of lateral curvature require very powerful jackets.

The finishing touch is put on the case by polishing it by means of vigorous friction with the wet hand.

Taking the Patient down.—A child can be carried from the suspending gear to a couch by the operator with his hands in its armpits. For larger patients a truck is very useful. The truck in use at St. Bartholomew's may be thus described. It consists of a horizontal board about 6 feet long, with a ledge at the foot, and swinging on an axle placed nearer the foot than the head. This axle is at the top of a stand which moves on three small wheels. To transfer the patient to the board, it is swung on its axle from the horizontal to the perpendicular position, and then wheeled up till it is in contact with the patient's back. His heels should rest on the ledge at the foot of the board.

The problem then is to keep up extension while the transference from the perpendicular to the horizontal is being effected. To do this I attach a double or triple fold of calico

Fig. 244.—Board used at the West London Hospital for taking down from Suspension. Note small spikes at lower end to prevent it from slipping on floor.

bandage to the patient's head-gear, carry this bandage over the head of the board, and there hold it in my right hand. When the pulleys are unhooked from the head-gear this loop of bandage supports the patient; but without delay the board should be swung on its axle. The patient then lies flat on the top of the truck. The head-gear is then completely removed, some article of the patient's clothing placed beneath his head for a pillow, the bolt inserted which fixes the board, and he is ready to be wheeled in front of the fire.

A large mass of cotton wadding should be placed between the boss of an angular curvature and the board whilst the board is still perpendicular. This helps to produce that accurate fit over the boss so necessary to prevent sores.

As an extempore substitute for the truck a plank, a fracture-board, an unhinged door, or a school form may be used.

They have a certain advantage in that on them the patient can be placed at a lower level, more immediately before the fire, when drying.

When the jacket has been applied with the patient in the prone position, the truck, couch, or plank should be simply placed beneath him, so that he can be lowered down upon it and then gently turned over.

Setting and Drying.—These two processes are not always quite clearly distinguished. The setting takes place in a few minutes. But the jacket is not firm till it is dry, and in the damp climate of England drying may sometimes, unfortunately, occupy twenty-four hours. If possible, the horizontal posture should be kept during the whole time of drying. Always place the patient before a fire, with the jacket completely exposed. The arms and shoulders may be wrapped up, and the lower extremities should be kept warm. With these precautions there is no danger of catching cold. But when the application is made at the surgeon's house, or in a hospital out-patient department, at least an hour in dry weather, and two, three, or more in damp, should elapse before the patient's removal. In very damp weather no attempt should be made to construct a jacket at all, except in urgent cases of angular curvature, and then active steps should be taken to dry by means of hot bottles and large fires.

When the case is thoroughly dry, and not before, remove the dinner and breast pads.

Frequently a semilunar piece has to be cut out of the top of the case, on each side, to prevent it from chafing the axillary folds.

But never on any account cut away the bottom of the case higher than an inch below the anterior superior iliac spines. If it is uncomfortable in that region, place pads of cotton-wool between the jersey and the case, just behind the seat of pressure.

On the patient's first visit after the application the points to be attended to are chiefly those noticed in the last two paragraphs; also the state of the boss, if the case be one of angular curvature, and the condition of the patient generally and locally, as compared with the state of things before the application. In lateral curvature also the patient has to be measured. I shall return to the subject of measurements. Of course, also, the jacket must be examined to see if it has given way anywhere. The whole jacket must be seen—a rule to be enforced at every visit.

How to convert the Jacket from a Fixed Apparatus into an easily removable Support. Method of Lacing (Triple-Lacing).—Saw the jacket down the middle in front with an ordinary meat-saw. I find a large powerful saw, supplemented by a short-bladed clasp-knife, a broken table-knife, or a pair of cutting-pliers, convenient for even making the crucial incision over the boss.

Separate the jacket from the jersey beneath, give it a half-turn round the patient's body, so as to get the back and front to present in the two axillæ respectively, and then slip it off sideways. Now bore a row of holes on each side the division made by the saw, about an inch and a quarter apart and about an inch from the edge. These edges may be bound by strips of adhesive plaster over them. Thread a cord staylace up and down each row of holes till between each pair of holes a loop of cord extends. When the jacket is reapplied, it can be closely fixed by lacing a third lace in and out these loops. In reapplying the jacket, reverse the manœuvre by which it was taken off, slipping it on sideways, and then twisting it round to the front.

Note.—The surgeon should never be too anxious to cut up the jacket, or too solicitous to gratify the patient's wishes in this respect. The moment he does so a grave alteration has been made in the treatment. I am afraid that the gravity of this alteration is not often sufficiently appreciated. I have referred to this point before, and shall return to it again in connection with the poroplastic case.

Patient's condition and comfort are to be watched during the process of applying the jacket. If the head-gear gets uncomfortable or painful, it is often impossible to improve it without letting the patient down. As to do so would probably ruin the case, there is nothing to be done but to hurry on with the application. It is, therefore, most important to see that the patient is thoroughly comfortable before commencing. Children can be lifted up by the arms till the head-gear is re-adjusted. Some adults may be allowed to swing themselves by their own arms while the head-gear is set right. But, in permitting this, the effect on the case so far as it has been applied must be cautiously watched. If the patient look like fainting, take her down on the truck or plank at once, and, after a short rest, swing her up again and recommence. In doing so, exactly reverse the steps of the above-given directions for taking down. If a patient with angular curvature should complain of pain in the back or side, lower him gently till he says the pain is relieved.

The patient sometimes tends to swing round and round in an awkward way. The operator should employ one hand to steady him whilst rubbing in the bandages with the other.

Tins.—Professor Sayre has himself given up the use of these; and they certainly are open to two objections. First, even when bent and fitted with the greatest carefulness they have a tendency to prevent the case from moulding itself with perfect accuracy to the body. Secondly, they destroy the homogeneity of the case. Still I must confess to using them occasionally myself, though very exceptionally, and to thinking that the above-mentioned objections are not universally paramount. The tins should, as a rule, be placed perpendicularly and in the flanks. As the part of the case most likely to give way is either before or behind, if the tins be placed in the flanks, they resist any such breakage with all the great force necessary to bend a flat metal plate in a plane with its own surface. To obtain this effect the superjacent layers of bandage must be so rubbed and moulded to the tins as to fix them in absolutely firm position. To help this fixation the tins are perforated here and there. Each tin should be about five-eighths of an inch wide, and not quite so long as the case. It is good to give the actual extremity of each tin the slightest possible turn inwards. As the tins should not be worked in till the jersey is completely and thoroughly covered with plaster bandage, there need be no fear of this causing the patient discomfort; while, if the ends of the tins are ever so little everted, they will probably work through the superjacent bandages and tear the patient's clothes. Four tins are enough for any case—two on each side, with, perhaps, a half-tin or two in any great concavity. They should be moulded to fit their destined places with the greatest accuracy.

I have sometimes been tempted to use the elasticity of the tins in such a way as to exert some active influence on the patient's deformity. In this way it is very easy to give to any segment of the case a tendency to compress the part beneath it or to pull away from it. If the steel spinal instruments effect anything at all with their screws and pressure pads (on a future occasion I hope to give proofs that they do not), an elastic continuous pressure, such as can be given by metal strips moulded and worked into a plaster case, should be more effectual, because the case itself gives them a real *point d'appui*, whereas the pelvic girdle of the spinal instrument is little better than a sham when used for the attachment of any contrivance pressing horizontally or nearly so.

If the end of a tin should work, or threaten to work, its way out, a small piece of cotton-wool should be fixed over it by a long strip of adhesive plaster. This is quite effectual.

The Jury-mast.—This is made by the instrument-maker according to measurements which he usually knows how to take himself, but which can be taken by the surgeon in the following way. Make two ink-marks on the patient's back, representing respectively the level of the upper and lower margins of the plaster jacket which is to carry the jury-mast. In a case of upper dorsal disease the upper mark should not be higher than the boss. Then, with the patient standing in as erect a position as he can assume, and with his head well up, apply a narrow strip of lead from the lower ink-mark to the upper, taking a correct tracing along the spine, thence perpendicularly up to the occiput, and lastly curving forward close to the head as far as the vertex or a little farther. This is only the tracing of the patient's outline. The working tracing for the jury-mast is made by carrying the first tracing back from the occiput 1 inch and above the head 2 inches. Otherwise the jury-mast, which always settles down a little, will compress the head, aggravating what it is intended to relieve. The material for the jury-mast is iron soft enough to be bent across the knee without difficulty, so that any error in fit may be easily corrected. The cervico-dorsal part is double, so that a bar runs along each side of the spine. From this several strips of perforated tin run outwards, to act as stays when worked into the plaster jacket. Buckles are riveted to the apex, to which the head-gear straps are afterwards attached.

Fixing the Jury-mast.—The jury-mast should be tried on the patient before commencing the jacket. Remember, in arranging the patient, that no cervical case should be *suspended* by the head. The head-gear may be used, not to sustain the patient's weight, but merely to support the head itself in good position. The patient should not be pulled off his heels. A child should be supported by an assistant with his hands in the axillæ, assisted by the arm loops on the suspension bar. An adult should extend himself. I am assuming that almost every patient with cervical caries and fit to wear a jury-mast can stand and is entirely, or almost entirely, free from paraplegia. The plaster case should be nearly half made before the jury-mast is put in place. The mast should be fixed into the plaster jacket a little higher up than what is destined to be its ultimate position, so as to allow for settling. This precaution is especially necessary in the case of young children. If the mast should be found not to be in a proper position with regard to the head when it has been bandaged on, nothing should be done with it till the case is quite dry and hard. Then its curve may be altered anywhere by means of two hand-vices.

The head-gear should not be put on till the jacket is dry, and then it should be comfortably fitted, so that the patient's chin may neither be too much tipped up nor too little supported. The comfort of the patient is the thing to be aimed at.

Broken Jackets: when and how they can be advantageously mended.—When a jacket breaks, even though it does so in one place only, there are two reasons for making a new case rather than repairing the old one. The fracture being almost always transverse, the jacket may now be regarded as consisting of two pieces, one above, the other below, the fracture. These two pieces approach one another, and no amount of extension applied to the patient merely will separate them. Extension must be applied directly to the jacket itself, and that is sometimes both troublesome and difficult. The second objection to mending a broken jacket is that the additional plaster and bandages are apt to make the jacket look clumsy, and that in a region where it is especially desired to be slender.

Still, mending is sometimes preferable to remaking a jacket. It is mainly in dealing with lateral curvatures that it becomes very important to re-extend the jacket to its original shape. This is effected in the following manner. Two holes are bored near the lower edge of the jacket, one in front, the other behind. These are connected by a loop of strong cord passing downwards between the patient's legs to another loop which passes beneath his heels or insteps. These loops should be just tight when the patient's knees are slightly bent. He can himself, by a very small effort indeed, keep the lower edge of his case dragged down. Or an assistant may, with the aid of the cords, pull the lower part of the jacket down.

The V Cut.—When a patient with lateral curvature has worn a plaster jacket for some time—say two months—and has diligently and regularly suspended himself every day or twice daily, it is generally the practice to put on a new jacket. Professor Sayre at one time, instead of making a new jacket, cut a V-shaped piece out of the dorsal convexity of the old one, and, the patient being suspended as if for the application of a new jacket, plaster bandages were passed round the case in such a way as to cover over the gap produced by the V cut. I gave this V cut a considerable trial, and found it useless.

It is based on an exaggerated idea of the value of practising 'self-suspension.'

II. The Felt or Poroplastic Jacket

Without going here into a complete inquiry into the value of prepared felt as a material with which to carry out Sayre's treatment, and without delaying to make a complete critical comparison of the plaster-of-Paris and the poroplastic jacket, I shall premise that I prefer to use the latter in many cases, mainly for the following reasons:

1. It is economical of time.
2. In the case of adult or adolescent females the felt jacket is more shapely, *i.e.* smaller in the waist, than the plaster jacket.
3. It is more easy to protect the breasts against pressure from a felt than from a plaster jacket.

The cases best fitted for the poroplastic jacket are those of not too severe lateral curvature, and those of angular curvature in the dorsal region. There are many cases which the most experienced person would be ill-advised to treat with felt instead of plaster. And it should never be forgotten that to do justice to the poroplastic jacket requires as much care and skill on the part of the surgeon as are required to make a good plaster-of-Paris jacket. In the case also of the felt jacket the surgeon can very easily deceive himself into thinking he has put on an admirable jacket, when in reality he has merely put on a thing which from its stiff qualities retains a shape, elegant perhaps, but not at all that of the patient beneath, and therefore not supporting him and not doing him any good. Patients are themselves often so vain and so little conscious of the serious nature of their own illness that they will assist the surgeon to deceive himself into thinking a merely handsome felt jacket to be a good one. I have repeatedly seen, in cases of lateral curvature, felt jackets pronounced by surgeon and patient to be admirable fits where no increase in height had been gained by the application, and where, at the points where the jacket ought to fit closest, it was possible to thrust in the blade of a penknife up to the hilt without touching the patient's skin.

The apparatus required for suspension, the jersey worn, and the preliminary preparations up to the moment of applying either the plaster-of-Paris or the poroplastic jacket, are almost exactly the same in the case of both. These have been already described.

But it is not the custom to use a dinner pad beneath the felt jacket. With regard to this matter, I am not sure that the pad is necessary even when the jacket is to be of plaster of Paris. Indeed, I now seldom use it at all. I will, at all events, go so far as to say that when a plaster-of-Paris jacket is applied to a case of severe lateral curvature in which cure is out of the question, the dinner pad is not necessary, provided the breast pads be made rather large, and extended downwards to a few inches below the nipple.

The only special apparatus required for applying the poroplastic case is

The Heater or *Oven*, a high cylindrical vessel of tinned or of 'galvanised' iron. It has a perforated and loose false bottom, to keep the felt jacket high and dry above the thin layer of water which should lie beneath. The whole is heated over a stove of some description, usually a gas stove, until the water boils.

When a special heater is not at hand the jacket can, though less conveniently, be softened before a large fire, or in an ordinary oven. The jackets are made at Plymouth by the representatives of the late Mr. Cocking, the patentee. Their price varies, with the amount of pains taken to finish them off, from about 10*s.* 6*d.* for the roughest quality, upwards. The 10*s.* 6*d.* jacket is good enough for practical purposes, and is the kind in use at hospitals. Of late years this price has tended to rise.

The necessary measurements should be taken by the surgeon. He cannot bestow too much pains on them. If the measurements are well taken, I feel it only due to the workmen at Plymouth to say that it is wonderful how accurately and intelligently they usually work up to them.

I always supplement my measurements with careful diagrams or sketches, and I strongly recommend every one to do the same. No great faculty of drawing is required.

The following rules of procedure may be given :

1. Your patient should stand in a good light several yards away.

2. His back should be towards you.

3. The back should be absolutely nude down to the level of just below the middle of the sacrum. (In treating a female with spinal disease false modesty is as much out of place as it would be in the case of an ovariotomy.)

4. He should stand square, with head erect, knees straight, and eyes looking straight forward.

5. If the affection is lateral curvature, it is best to suspend the patient, or rather to cause him to suspend himself, with arms extended upwards.

6. Make as accurate a drawing of the patient's outline as you can, from the axillæ down to the great trochanters. *Without care you are certain to exaggerate every curve.* As the felt makers have also a tendency to exaggerate still further, special trouble should be taken to avoid doing so yourself. If you look at your sketch and at the patient's back simultaneously in a little hand mirror, you will see them both, of course, reversed, and will have no difficulty in detecting your exaggeration. Correct it. You can sketch first with pencil, and, after correction, ink in.

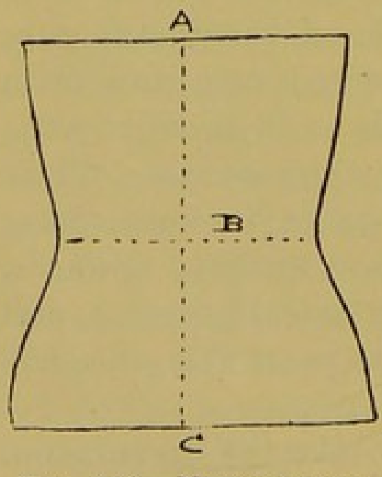


FIG. 245.—MEASUREMENT SKETCH FOR FELT JACKET.

7. Having got now an outline something like this, for example, take the girth of the patient at A, B, and C, A being well over the scapulæ in males and over the breasts in females, B being round the waist, C round the pelvis just above the trochanters.

8. In the mid-dorsal line make three ink-marks : one at A, *i.e.* about 2 inches above the level of the inferior angles of the scapula ; the second below the waist but just above the level of the highest parts of the iliac crests ; and the third at C.

The reason for placing the second mark below the level of the waist is that the jacket, being applied soft and then tightened on, makes a kind of artificial waist which is slightly below the natural one, and whose exact position is determined by that of the iliac crest.

9. Measure the intervals between the three marks.

We now have five measurements, three horizontal and two perpendicular; and if the patient's figure be very simple and commonplace, these measurements, together with the sketch, suffice.

But in the case of all females above twelve, of all cases of angular curvature, of all cases of severe lateral curvature, and of certain individual peculiarities, other data should be given to the felt-maker.

In the case of females above twelve send the height of the nipples above the waist, and the length of a line carried from nipple to nipple round the back, over the scapulæ, adding whether the mammæ be small, medium-sized, large, or very large.

When lateral curvatures are very severe a plaster jacket should be applied, and, when dry, cut off to use as a cast. The patient should be suspended when a cast is being taken for the felt-maker's use.

In the case of angular curvature the patient should be suspended and a tracing taken of the spine from the upper to the lower border of the jacket, or rather between two points which are meant to correspond to these borders, and which may be marked on the skin with ink.

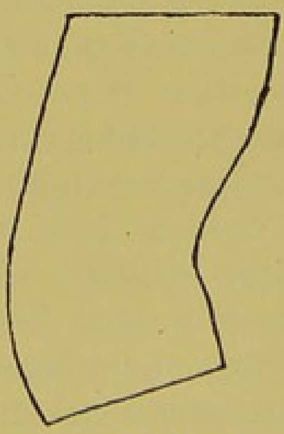


Fig. 246.—Wrong Outline.

When the abdomen is very prominent an anterior longitudinal measurement should be sent, lest the jacket should be made too short below, an accident which causes the hypogastrium to swell out below the lower edge of the jacket in an unsatisfactory manner. Often, in such cases, a lateral sketch is useful. Be particularly careful not to exaggerate in this sketch. Fig. 246 shows the kind of thing *not* to send.

The poroplastic jacket as sent back from the makers is open in front and provided with buckles and webbing straps. There should never be less than four buckles, even to a child's jacket.

The Application of the Poroplastic Jacket.—The rules for suspending the patient and the circumstances which may contra-indicate suspension are essentially the same in the case of both plaster-of-Paris and poroplastic jackets. (Refer to pp. 496 and 502).

The patient being all ready, see that the buckles on the jacket are open, that the webbing straps are tucked up out of the way of the wet, and that there is water in the pan of the oven. Then place the jacket in the oven and close the door. Keep the jacket in until it is soft. It never becomes really plastic. A period of two or three minutes usually suffices for this; but the door of the oven may be opened two or three times to see if the jacket is ready.

An assistant is useful to help in the application of the jacket. There are several different ways in which the surgeon and assistant can work together. I usually proceed as follows:—To commence with, I sit in front of the patient, and place my thumbs below the anterior superior iliac spines. My assistant now takes the jacket out of the oven, and applies it from behind in such a way that its lower margins just rest on my thumbs. He holds the jacket in this position while I take hold of the upper middle buckle and the corresponding strap. He then holds the jacket in position by pressing the lower part of it firmly against the hips, while I, as quickly as possible, fasten the buckles and straps, not tightening any much until all are buckled. Then I tighten them one after another, two or three times over, little by little. To tighten each strap to the utmost at first would either break or wrinkle the jacket. Next, with the palms of my hands and the balls of my thumbs, I press and mould the jacket to the iliac crests, and attempt to mould the jacket also to the ribs, sometimes using my right or left fore-arm to give counter-pressure. But (and this is one of the great defects of the felt jacket, due to its not being plastic, being, indeed, little more than pliable and extensile) pressure from without has not a perfect effect in moulding the poroplastic jacket. If any part of the jacket is too large for the form beneath it, so it usually remains, unless the extensile nature of the felt can be made use of to improve the fit. I have sometimes felt justified in purposely making a fold in the jacket. Then the fold should always be made parallel with the line of greatest pressure at the situation in question, so that the fold may act as a buttress rather than be a source of weakness. The buckle and strap nearest to the lower border of the jacket should be well tightened, so as to get a good fit round the hips. But the chest buckles should not be tighter than will admit of free and full inspiration ; otherwise they will have to be loosened afterwards, and this will disturb the fit of the whole jacket,

Sometimes I apply a double-headed roller bandage over the whole jacket while it is still soft, and I am inclined to think that this is the best method of attempting to mould the jacket by pressure. By it pressure is applied everywhere at once—a great advantage in moulding pseudo-plastic material, which is apt to bulge out at one spot while it is being moulded and pressed in at another. This plan I learnt from Mr. Willett.

Mr. Swayne uses the pressure of a wide girdle of soft felt.

Be careful not to squeeze the mammæ over or half over the upper margin of the jacket by tightening it too much.

If the case be one of angular curvature, mould the jacket carefully to the boss.

In a few minutes the jacket is cool, dry, and hard, and the patient may be gently let down ; but he should maintain the horizontal position for half an hour.

It is because the 'poroplastic' jacket is not plastic, even when warm, but only ductile and flexible, that I have emphasised the importance of not exaggerating the prominences and curves in sending measurements to Plymouth. *For years I have made a point of understating them.* It is easier to stretch out a simple cylinder of felt to fit the body than to press in an elegant felt jacket of exaggerated shape. I also now generally take the jacket out of the steamer myself, swing it quickly round the patient, press it well down on the hips, and tighten the upper middle buckle, doing all this in as quick succession as I can. With this plan an assistant is unnecessary.

Early After-management of the Poroplastic Jacket. At once find out (1) if the jacket is too high in the armpits, (2) if it permits free respiration; (3) if it is too tight anywhere at all; (4) in the case of a female, if there is room for the breasts. The breast pads should be removed at once in the case of a felt jacket, and not left *in situ* for twenty-four hours as with the plaster jacket. Also (5) see if any part of the upper margin of the jacket projects unduly, either anteriorly or posteriorly. If so, you must correct this either by cutting or remoulding. In nine cases cut of ten a little cutting suffices. Very unsightly is the high rim of a felt jacket sticking out under the dress far away from the chest or back beneath it. When the jacket is too high in the armpits, cut a semilunar piece out, 4 or 5 inches long; often a depth of about an inch suffices. The patient's comfort will guide you. Hold his arm to his side whilst determining the exact place where you mean to cut out the semilunar piece. If you have not left room for the breasts, you had better suspend your patient again, pad her breasts thicker than before, resoften and remould the jacket, taking care not to draw the upper two buckles overtight. The management of the mammæ is usually much neglected in applying spinal apparatus of any kind. This is the more disgraceful because the amount of improvement to be effected by the instrument is often neither great nor certain. Thus it comes about that after a time the surgeon finds what he calls his patient's figure, namely, her spine, not improved, and she finds what she calls her 'figure,' namely, her breasts, entirely spoilt, flattened back, pendulous, atrophied.

If the jacket extends too low, and prevents the thighs from being flexed on the abdomen, cut it away charily, on no consideration getting quite as high as the anterior superior iliac spines. Moreover, if it presses or chafes anywhere at the lower edge, remedy it by pads of cotton-wool (see the section on After-management of the Plaster-of-Paris Jacket), and not by cutting away. Remember that the pelvic part of the jacket is the basal, and a most essential, part of the whole structure.

When applied for caries of the spine the jacket should not be removed, as a rule, either night or day, for a month. Forbid the patient to, on any consideration, either loosen or tighten a single strap or buckle, except in your presence. Of course this throws on you the responsibility of seeing that there is room for free respiration before you send the patient away from your house. If it is convenient, you had better see the patient the following day; but at least see him within a week, unless it be a patient on whom you have put several jackets, and who, therefore, has had an opportunity of learning their management. When such persons live far away in the country, I frequently give them leave to stay away for the whole of the first month.

On the first return of the patient after the application, in addition to inquiring into the comfort and fit of the jacket, particularly investigate into whether there be any chafing over the iliac crests, and, in the case of angular curvature, over the boss. Also measure and carefully record the height of patients with lateral curvature. Examine the jacket everywhere to see if it is cracking or tearing at all.

At every succeeding visit attend to the points mentioned in the last paragraph, take care that the jacket is kept in proper repair, as well as securely buckled, and measure the height again from time to time, carefully recording it.

Repairing a torn felt jacket is usually effected by patches of leather fastened to the felt beneath by a double row of large stitches. But when the jacket has *broken or been crushed*, the mischief, if reparable at all, should be repaired by a patch, not of leather, but of strong felt. The leather patches can be put on by a saddler. So also can the felt patches; but these should be previously softened and moulded to the part where they are to be.

Should any part of the felt jacket—e.g., over the anterior superior spines and breasts— be left soft? I am inclined to answer, No, because it is not necessary, and it must tend to lessen the value of the jacket as a uniformly rigid support.

I have sometimes seen jackets which had been treated in this way which were thus rendered really quite useless. Moreover, if a jacket presses on the mammæ *at all*, it is likely to cause atrophy whether the compressing part be soft or hard.

III. How to Judge of the Patient's Progress

Entirely different methods are, of course, required according as the case be one of angular or of lateral curvature. In the case of

Angular Curvature

the surgeon should be content for the first six months of treatment to judge by the patient's general appearance and carriage, and by the account given of his state as regards freedom from pain, amount of appetite, spirits, and the like. If in almost all these points things are satisfactory, the local condition is almost certainly improving. If in any of these points the patient's condition is not as it ought to be, inquiry is demanded. The angle can be watched, if desired, without taking off the case. To facilitate this the patient should bow forward over a stool or over the surgeon's knee, with his head towards the light. The surgeon can then look downwards between the jacket and the spine. Unless the patient has grown thinner or the angle more acute, the space between jacket and skin should, even in this position, be very small. But an increase of the angle, provided the general symptoms be excellent, is more likely to mean cicatricial contraction than progress of disease.

If the carriage is not improved, and there is a continuance or a revival of the pains of caries, most likely the jacket is imperfect either in fit, or length, or consistency. The pains of dorsal and lumbar caries are quite as commonly referred to the stomach, to the belly, or even to the lower extremities, as to the seat of the disease. The cause of pain due to superficial chafing or pressure will be suspected from its locality in the case of children, and will probably be pointed out by an adult patient himself. Such chafing or pressure may affect the general health if neglected, but scarcely appears to affect the course of the caries.[1]

If the jacket has removed the local pains and given strength to the diseased spine, but the patient's general condition remains bad, including his appetite and spirits, what he probably needs is fresh air, and especially sea air. In those melancholy cases among the poor where change of air is not attainable, do not grow impatient and remove the jacket, but first see if it be imperfect anywhere, and, secondly, try to impress upon the poor people concerned the importance of ventilation and light. Neither a plaster nor a poroplastic jacket can be expected to make a London slum as good as Margate.

But I must say that when Sayre's jacket is properly applied, no matter what slum the patient may live in, he generally soon begins to improve in every way. Therefore, when he does not, you have always to first consider whether there may not be some fault in your jacket.

Valuable information can be gained by weighing the patient from time to time. Progressive caries almost always tells on the weight. On the other hand, a steady increase in weight means either arrest or, more generally, retrogression of the disease.

Lateral Curvature

There are three classes of methods by which progress may be judged of in these cases, namely (1) measurements, (2) photographs, (3) casts.

(1) *Measurements.*—It is necessary to take the height of the patient from time to time, always in the stocking feet (or else in the boots, subtracting the height of the heels), and always, if possible, with a regular measuring standard having a spirit-level in the horizontal bar. In the absence of this, approximately accurate results can be obtained by making the

[1] In the case of a child whose father was dead and whose mother's avocation of monthly nurse kept her away from home and her little one, and also prevented her from bringing it to the hospital, chafing led to erysipelas. No medical man was called in, and the poor child died.

patient stand against the wall under a large square book or wooden square, one edge of which should be perpendicular and closely applied to the wall. Then, of course, the lower edge will be horizontal. Lower the bar or book until the patient says he can just feel it touch, and no more. Then move his head from side to side two or three times to see if you have got the right level.

Only a general idea of the progress can be obtained in this way. In perhaps the only cases where any improvement can possibly be expected, namely, before adult age, the measurements are complicated by the effect of growth. Still they give quite sufficient indications of the extent to which the jacket is keeping up extension.

Professor Sayre pointed out to me another mode of measurement, namely, by comparing the distances between the umbilicus and the two nipples respectively. This should furnish a fraction which might be taken as an index of the amount of deformity.

The elaborate and expensive machines for measuring scoliotics by some Continental orthopædists are of doubtful value.

(2) *Photographs.*—These can be obtained quite good enough for practical purposes for about 1*s*. 6*d*. each of the cheap photographers around London. Instructions should be given that the patient should stand erect, with his back to the camera, and looking straight forward, with knees straight, heels together, and hands down. The elbows should be bent rather out than in, or they get in the way of the photographic outline of the patient's flanks.

This outline is perhaps the most valuable indication which a photograph shows of the state of a patient.

In a slight case a photograph may show no alteration at all in the line of spinous processes. Moreover, the outlines of the flanks are almost independent of any accidental arrangement of lights and shadows.

Every hospital should be fitted with its own photographic apparatus, which one of the officers of the institution should have the skill and time to use. I myself use a camera with an Eastman's roll carrier, and send the roll from time to time to be developed by Eastman. Half-plate is a sufficient and a handy size, but a 4 × 5 does very well.

(3) *Casts.*—A succession of plaster-jackets, if preserved, form a series of moulds which can be compared with each other, but they take up a great deal of room and collect dust.

CHAPTER XIX

Acromegaly

In the Clinical Society's 'Transactions' for 1885 Mr. C. A. Ballance and the late Dr. Hadden described fully a case of hypertrophy of the face, hands, and feet. In the following year ('Revue de Méd.' April 1886) M. Marie described a morbid state, of which Ballance's case was evidently an example, and gave to it the name of acromegaly. Marie showed that it had been noticed as far back as 1772 by Saucerotte. Sir Samuel Wilks also had a case, in 1864–70 (Fagge's 'Medicine,' vol. i. p. 757). But Ballance's and Marie's writings seem to have been mainly instrumental in calling attention to the disease.

It attacks both sexes. The cases recorded have ranged in age from fifteen to sixty. In females the catamenia tend to disappear at the onset. In males virility is sometimes diminished. Occasionally there is a history of rheumatism or gout. Blindness may come on. Nettleship's report on Ballance's case is that there was blue-white atrophy of the optic disc.

More than one member of the same family may be attacked.

The remarkable symptoms are the enlargement, sometimes almost gigantic, of the hands and feet and of the features of the face. *E.g.*, a patient originally wearing '4' boots has to gradually increase the size to '8,' and has gloves in proportion. The face lengthens, the lower jaw and chin become massive, the teeth spread out, the under lip thickens and projects, the lower or cartilaginous part of the nose thickens, the eyelids hypertrophy, as also do the ears.

But the skin does not alter, nor is the speech thickened, so the condition cannot be confounded with myxœdema. The cranium is natural and the long bones do not curve—marked distinctions from osteitis deformans; although dorsal kyphosis, and even scoliosis, may occur.

FIG. 247.—ACROMEGALY. A patient of Dr. J. Barry Ball's.[1]

In many cases coincident abnormality of the thyroid gland has been noted. *E.g.*, in Godlee's there was a large bronchocele ('Clin. Soc. Trans.' 1888, p. 196).

And in at least three—a considerable proportion of those

[1] *West Lond. Med. Journ.* 1898.

in which a post-mortem examination was made—marked enlargement of the pituitary body was discovered. Hence, probably, the frequency of blindness. Enlargement of the thymus has also been noticed.

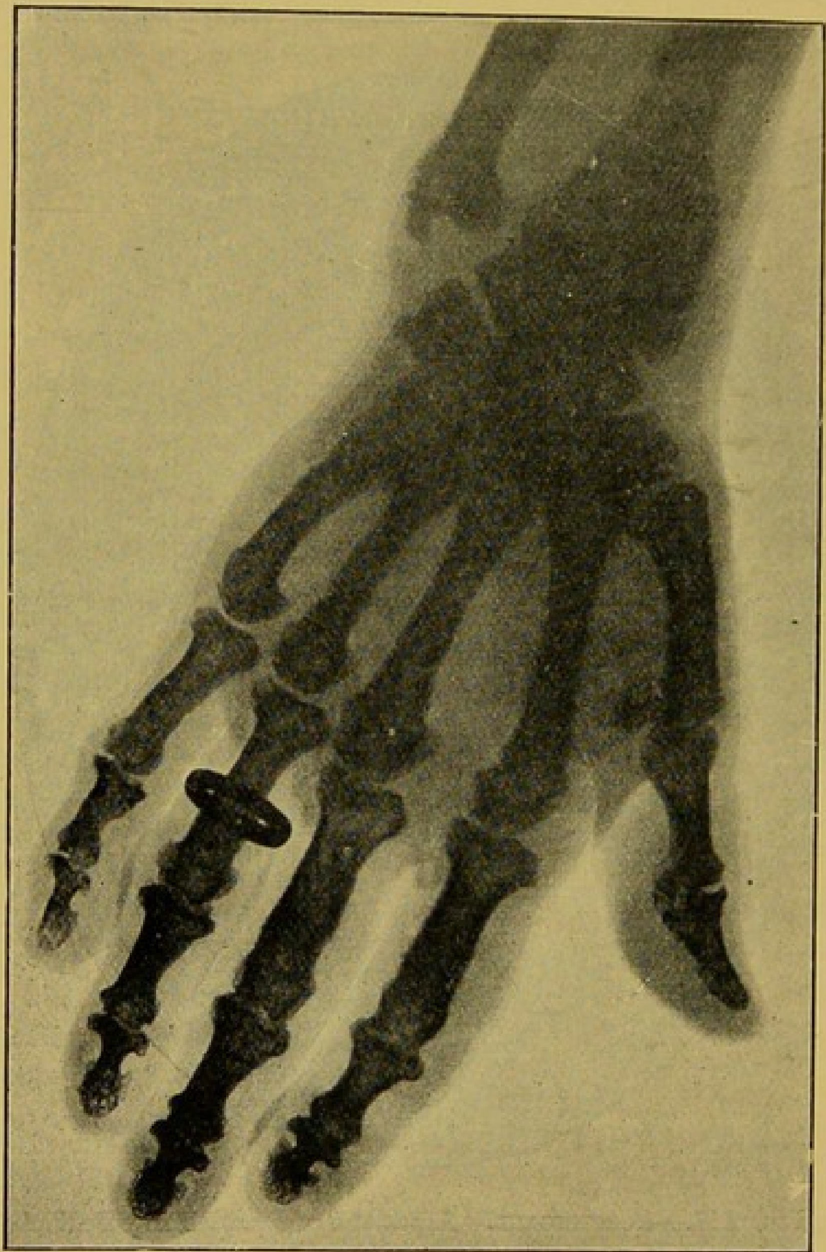


FIG. 248.—SKIAGRAM OF HAND OF DR. BALL'S CASE OF ACROMEGALY.

The hypertrophy, though mainly affecting the parts already mentioned, is not absolutely confined to them. The orbital margins and cheek-bones, and even the bones of the wrist and the iliac crests and spines, are sometimes affected, as well as the larynx (Barry Ball). The clavicles, upper ribs, and bony prominences of the scapulæ enlarge. Osteophytes grow. They differ from those of arthritis deformans in being wholly extra-articular. Taste and smell may suffer. In some cases there have been slight albuminuria and glycosuria. The skin of parts of the face is apt to be rather coarse and the sebaceous glands enlarged. Ball's case bore children several years after the catamenia ceased.

No treatment appears to have been efficacious. Pituitary tabloids have been suggested.

Dwarfish Growth with Atrophy of Hair, Skin, and Nails, and with Large Knees

Cases presenting these peculiarities have been described (1) by Mr. Jonathan Hutchinson (' Roy. Med. and Chir. Trans.' 1886) and (2) by Mr. Hastings Gilford (*ibid.* 1897). Mr. Gilford's paper is very full and detailed, in fact a model of observation and description. He regards the condition as being one ' of mixed premature and immature development,' allied to acromegaly in origin, and he suggests for it the name of ' micromegaly.'

Both cases had aural discharge from infancy, and, when examined, cardiac murmurs, which in one case were found after death to depend on atheroma of the valves. Both presented the appearance of old men, were bald, stiff in gait, stooping, with thin legs set wide apart ; and what little hair they had was colourless. The skin was thin and withered, and tight over the head, the cutaneous veins large, the nails long and thin, the nipples small or absent, the sight hypermetropic, the voice piping, the reflexes lessened or absent. The gape of the jaws was limited ; the teeth, in one case at least, irregular ; the anterior fontanelles open, even at the fourteenth year ; the clavicles very puny ; but some of the epiphyses, especially the femoral epiphyses at the knees, very large. In both the nose was beaked, the lips thin, the eyes protruding and the lower jaw ill-developed, the skin of the trunk and neck spotted and pigmented. The intelligence was at least up to the average and the character amiable. Neither grew to a greater height than about 3 feet 3 inches.

FIG. 249.—DR. HASTINGS GILFORD'S CASE OF DWARFISH GROWTH WITH ATROPHY OF HAIR, &C., AT AGE OF 1½ YEARS.

Could these cases have been examples of that form of 'congenital rickets' the fœtal examples of which have been described under the name of 'chondrodystrophia hyperplastica'? (see fig. 37, p. 73).

Gilford compares the features of the disease with those not only of acromegaly, but also dwarfism and gigantism, and

FIG. 250.—DR. GILFORD'S CASE AT AGE OF 12.

thinks all may be of similar origin, varied only by the time of life at which the disease commences.

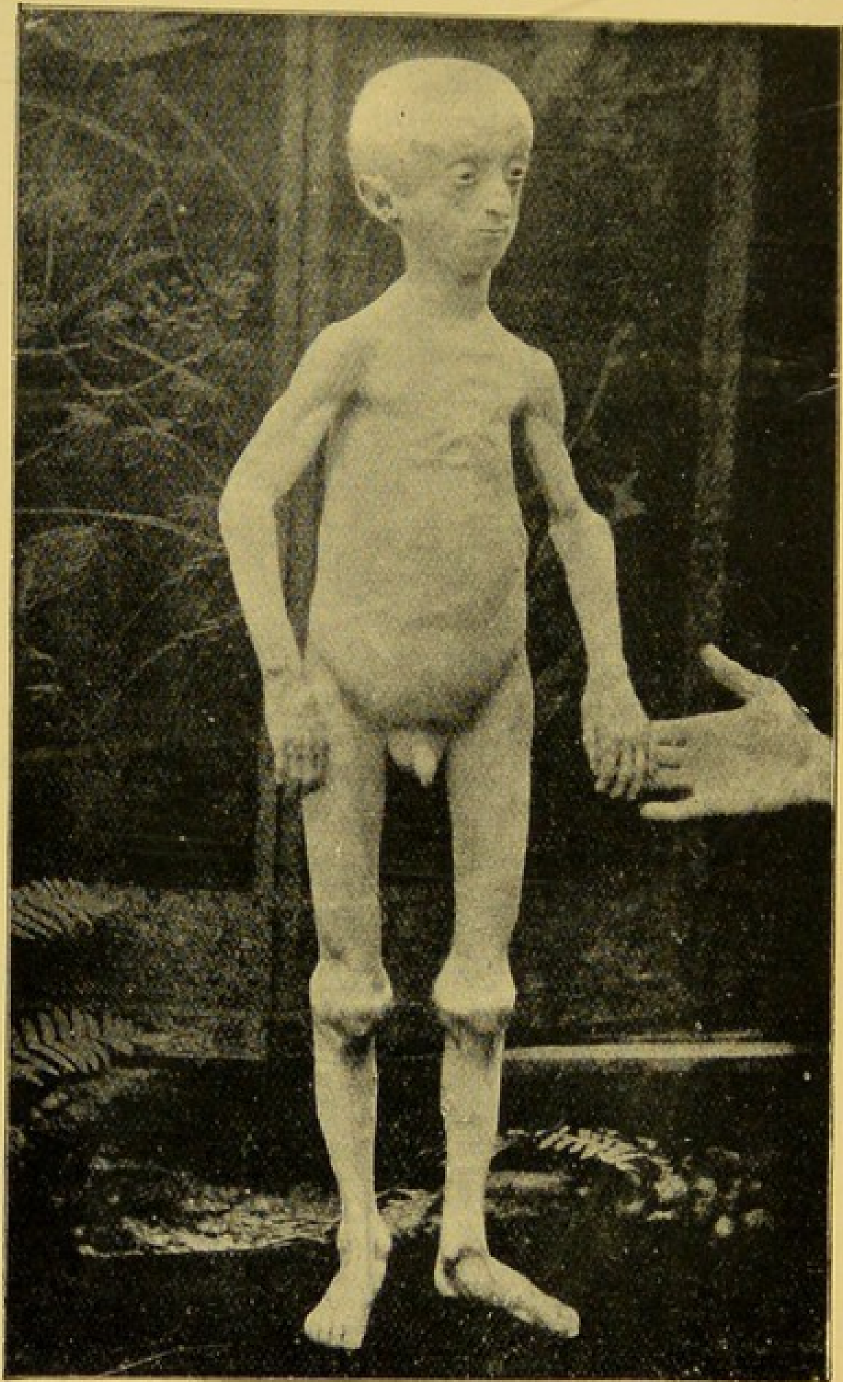


FIG. 251.—DR. GILFORD'S CASE AT AGE OF 17. Normal hand introduced to show relative size.

SPONDYLOLISTHESIS

The fifth lumbar vertebra sometimes is the subject of a pathological dislocation forwards carrying with it all the superjacent part of the spinal column. The origin of this deformity may be congenital or traumatic, or some acquired disease of the bone or neighbouring joints. Its chief interest is obstetrical, on account of the resulting encroachment on the pelvic inlet. The symptom is extreme lordosis, with shortening of the measurements between the thorax and the pelvis.

CONGENITAL UPWARD DISPLACEMENT OF SCAPULA

In 1891 (Langenbeck's 'Archiv,' xlii. p. 545), Sprengel of Dresden described a congenital elevation of the scapula, reporting four cases. Since then many have been reported, and seven years before then I myself made a sketch of one

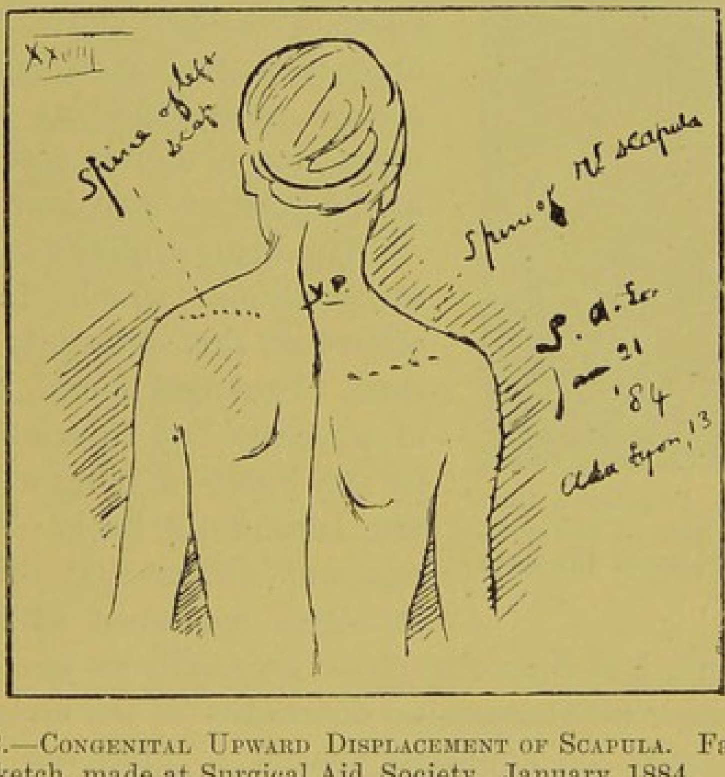


FIG. 252.—CONGENITAL UPWARD DISPLACEMENT OF SCAPULA. Facsimile of sketch made at Surgical Aid Society, January 1884. Patient had also been seen by Mr. Reeves. The notes of this case state that the condition had existed from birth, that the muscles attached to the superior posterior angle of scapula were short, and that the deformity was *not* due to spinal curvature.

at the Surgical Aid Society, but did not publish it. Another presented itself some years ago at the West London Hospital.

Almost always the affection is confined to one side, generally the left. The shoulder-blade looks as if pushed upwards an inch or more. Its lower angle approaches the vertebra, its own spine is tilted upwards at the inner end. Its neck muscles are, of course, shortened; in fact, all the muscles are adapted to the abnormal position of the shoulder-blade. Neither in Sprengel's cases nor in mine were the mobility and strength of the limb materially impaired, but that is not always the case.

Occasionally a slight degree of spinal curvature with the convexity towards the side of the normal scapula is seen. In one of my cases the row of vertebral spinous processes was perfectly straight and perpendicular, except that about three or four just above the mid-dorsal level formed a very short, sharp, lateral curve, with right convexity, and an obscure feeling as if some of the spines were bifid—as if, indeed, there was a double row of spines in the position mentioned.

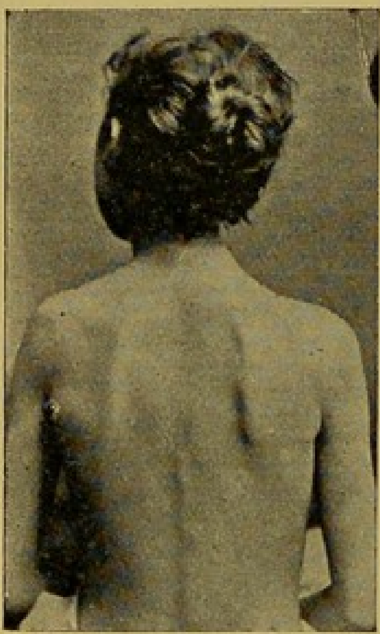


Fig. 253.—Possibly a less-marked case of the same kind. Notes of this case mislaid.

The history of the hypothetical explanations which have been offered of this deformity is significant. Sprengel found that some of his cases had from infancy been in the habit of lying with the left arm behind the back. The deduction was drawn that this position in utero, combined with deficient liquor amnii, had been the cause, especially as one child had an elder sister with congenital dislocation of the hip; although there is really no sufficient reason to attribute congenital dislocation of the hip to deficiency of liquor amnii. Then cases were observed in which the face was asymmetrical, and even in one case one radius was totally absent (Hoffa). Other coexistent defects have been noticed; *e.g.*, the peculiar spinal one in my case. And now it is argued that congenital elevation of the shoulder-blade must be a primary deformity of the bone itself (Kirmisson), or due to shortening of the neck muscles associated with asymmetry of the skull (Schlange, quoted by Hoffa). Unfortunately, speculation about such matters is so easy, demonstration so difficult.

Most cases require no treatment. Where movement has been limited, Hoffa reports cases in one of which, with benefit, he divided the muscles ascending from the scapula through an open incision ; while in the other he chiselled away the upper angle of the scapula, which interfered with abduction by jamming against the vertebral transverse processes.

Bat's-wing Deformity

In certain rare cases a fold of skin extends along the flexor aspect of the lower extremity, and limits the extensibility of the knee-joint. J. Wolff has illustrated and described such a case. In it there were other grave defects, including syndactyly, talipes, and a pendulous dorsal lipoma, as well as absence of the patella. The fold of skin contained no structure of importance, and things were greatly improved by a plastic operation.

APPENDIX

Operation for Contraction of Fore-arm and Hand due to Infantile Hemiplegia

The following ingenious and successful procedure was described by Tubby in the 'British Medical Journal' for August 19, 1899. A three-inch incision is made as if for tying radial artery in middle of fore-arm. Supinator longus and radial artery and nerve are drawn inwards, and distal part of pronator teres separated from surrounding muscle and fascia. Its tendon is then removed from the radial attachment, leaving all periosteum. The pronator teres is then passed through an opening made in the interosseous membrane and carried round the back of the radius till it reaches its original insertion, where it is fixed by suture.

The superficial tendons on the palmar aspect of the wrist are now divided through a transverse incision. They include the flexor carpi radialis, sublimis, carpi ulnaris, and the palmaris longus. The flexor longus pollicis is divided if the thumb is strongly flexed and abducted.

The limb is put up with elbow extended, the fore-arm supinated, and well flexed for eight days. From then till the sixth week the angle of flexion at the wrist is gradually opened out. Afterwards the straight limb is supported on a splint, while the extensors and supinators are massaged and faradised.

The result is to weaken the flexors and pronators and to strengthen the extensors and supinators.

Notes on Dr. Bromet's Case of Congenital Rickets, illustrated by fig. 36 at p. 72

No fractures were noticed at birth. Three weeks afterwards arm broke while nurse 'raised it (the arm) from side.' Eleven other fractures occurred between the age of three weeks and five years, viz.: scapula 1, right arm 7, right thigh 2, left thigh 1.

Cannot stand or walk (age now 6). Bones feel firmer now, and are growing.

Mental condition good; talks well. Internal organs apparently healthy.

INDEX OF SUBJECTS

INDEX OF NAMES

Spottiswoode & Co. Printers, New-street Square, London