TUBERCULOUS DISEASE OF THE BONES AND JOINTS

SIR W. WATSON CHEYNE, BT., F.R.S.

SECOND EDITION

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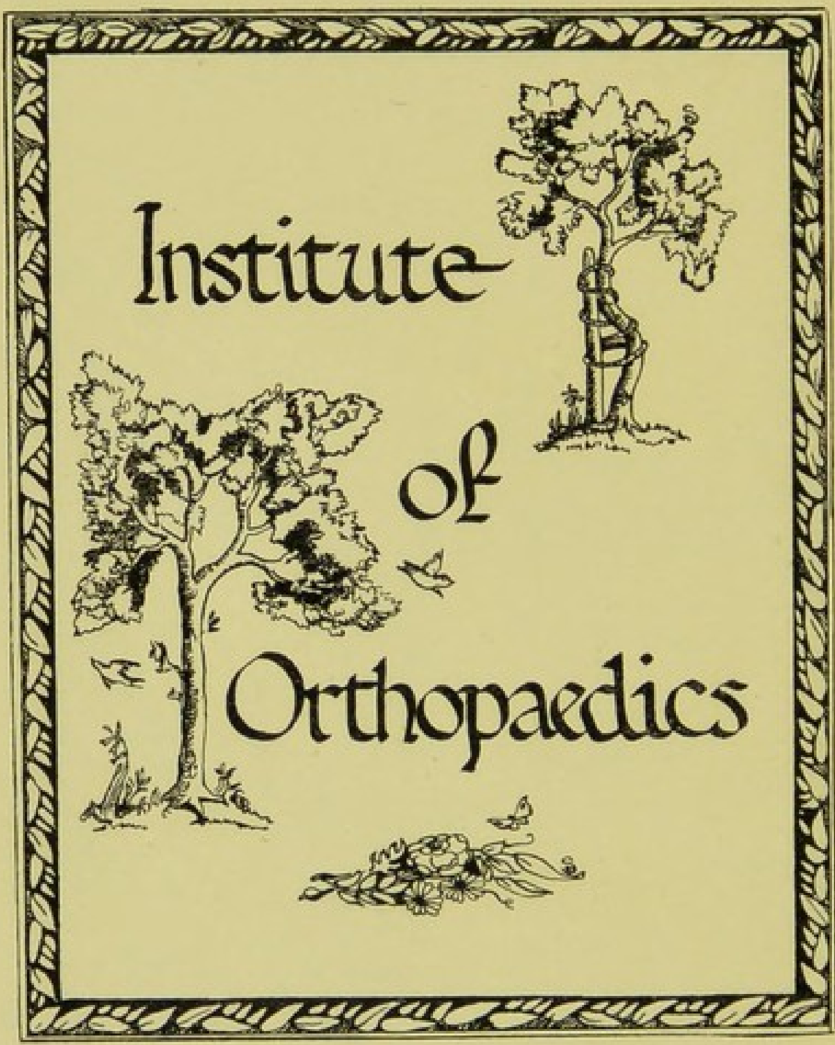

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TUBERCULOUS DISEASES OF BONES AND JOINTS

THEIR PATHOLOGY, SYMPTOMS, AND TREATMENT

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PREFACE

In preparing a second edition of my book on tuberculous diseases of bones and joints, I have been much struck by the alteration which has been taking place in connexion with the question of operative treatment. While there is very little to alter or add as regards the morbid anatomy and pathology of these diseases, there is no question that operative interference is very much less frequently employed at present than it was at the time when the first edition was published. When the tuberculous nature of these diseases was first demonstrated, the views as to the prognosis of tuberculosis were much more gloomy than they are at the present time; hence operation was very largely carried out with the view of attempting to eradicate the disease, as well as to obtain a good functional result. Since that time, however, experience has been accumulating, and has shown that, with careful hygienic and local treatment, the outlook of tuberculosis, especially of the forms met with by the surgeon, is more favourable than was at that time thought, and the frequency of operations, especially at the early period of the disease, and in the absence of suppuration, has been steadily diminishing. Indeed, the pendulum is tending to swing rather too far in the conservative direction, and

I have attempted, in re-writing the part of this book dealing with treatment, to take as far as possible a reasonable position between excessive operation on the one hand, and prolonged perseverance in conservative treatment on the other.

W. WATSON CHEYNE.

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SECTION I

PATHOLOGY, ETIOLOGY, AND TREATMENT OF TUBERCULOUS DISEASES OF BONES AND JOINTS

TUBERCULOUS DISEASES OF BONES AND JOINTS

CHAPTER I

DEFINITION OF THE TERMS 'TUBERCLE' AND 'TUBERCULOUS TISSUE'

THE term 'tubercle of bone' is a very old one, but it did not till comparatively recently bear the significance which is now assigned to it. At first it was applied to almost any nodule in bone, and thus included cancerous, syphilitic, tuberculous, and other deposits. It was not till the time of Bayle and Laennec that more attention was paid to the miliary tubercle, and that the term acquired a more definite meaning, and was to some extent restricted to a definite specific disease of the same nature as tubercle in the lungs. The earlier works on tubercle of bones mainly dealt with Pott's disease of the vertebræ, and Delpech, in 1816, was the first to assert the close analogy of that disease with pulmonary phthisis, and he stated that tuberculosis was the only cause of that deformity which is called Pott's disease of the spine, and that therefore this affection should be termed tuberculous disease of the vertebræ. The real starting-point of the study of tubercle in bone was, however, Nichet's work on *Pott's Disease*, published in 1835, and more especially Nelaton's work on *Tubercular Diseases of Bone*, published in 1837. According to Nelaton, tubercle of bone, like tubercle of the lungs, occurs under two forms to which he gives the names of 'encysted tubercle' and 'tubercular infiltration'. In his opinion the encysted tubercle begins as a deposit of grey miliary tubercles in the cancellous spaces of bone, leading to absorption of the intervening bony septa and the formation of a space containing caseating tubercles surrounded by a more or less well-developed fibrous wall. In the other form there is at first a transparent greyish or reddish infiltration of the bony tissue followed by the formation of pus, and chiefly affecting the spongy bones. In Germany this subject was discussed by Meinel, Rokitansky, Virchow, and others, who all adopted somewhat similar views, though with slight modifications.

It is unnecessary to follow all the phases in the development of the views on tubercle of bone ; they varied according to variations in opinion on the subject of tuberculosis generally. Nor need we dwell on the discussions as to how far these caseous deposits were, on the one hand, the results of the development of tubercle, or, on the other, only dried up and otherwise altered pus, and not the consequence but the forerunner, and, to some extent, the cause of tuberculous development. Up till quite recently the diagnosis was made only by the naked eye, and thus only cases where distinct miliary tubercles or larger caseous masses were present were included under this heading. Hence, on the one hand, it was by no means always possible to exclude gummata and other affections of bone from the group of tuberculous affections ; and, on the other hand, it was only when distinct miliary tubercles or larger caseous masses were present that the disease was diagnosed. Consequently, till the histological side of the question was brought into prominence, the opinion of most surgeons was that, while tubercles were undoubtedly found in bones, they were comparatively rarely present, and that there was no necessary relation between the well-known strumous diseases of bones and joints and tuberculosis ; at any rate, no identity of origin. Even Volkmann, who has since done so much to establish the tuberculous nature of scrofulous diseases of bones and joints, was at first (*Handbuch von Pitha Billroth, II*) inclined to think that in many cases it was only when the constitution had been lowered by the local joint affection that the patient became scrofulous or tuberculous. Although, however, there were these difficulties in diagnosis, the idea seems to have entered the minds of several pathologists that many cases of so-called scrofulous diseases of joints, in which no tubercles were present to the naked eye, were probably of a tuberculous nature, and that their pathology was closely allied to that of tuberculous disease of the lungs.

With the development of histological and pathological research, attention was directed to the histology of these affections, and a new era was opened up as regards their pathology. At first efforts were made to find some histological structure characteristic of tubercle, and as the result of the observations of Langhans on the almost constant presence of giant cells in miliary tubercles, of Schüppel on the epithelioid cells, and of Schüppel and E. Wagner on the presence of a fine reticulum, a definite structure was demonstrated and proved of great value in further histological work, although it must be admitted that at that time no single and definite histological characteristic of tubercle had been obtained. Köster, in 1869, was the first to study these diseases of joints histologically, and to recognize fully their tuberculous nature. He examined the synovial membrane in several cases of white swelling of joints, and found in all of them nodules of the size and character of miliary tubercles having one or more giant cells in their centre, lymphoid elements in their periphery, and a greater or less tendency to fatty degeneration, and he pointed out that so long as the conception of the term 'miliary tubercle' was a histological one, so long must these miliary nodules in the swollen synovial membrane be looked on as true tubercles. Numerous investigations on this subject, and on the subject of tubercles in other parts of the body, followed in rapid succession till the discovery of the tubercle bacillus by Koch, and its demonstration in the synovial membrane and bones in these diseases placed the tuberculous theory of their origin on a very sure basis. Among those who have become leaders in this matter may be mentioned Volkmann, König, and Lannelongue, who, taking into account the naked eye appearances, the microscopical characters, and the clinical features of scrofulous diseases of bones and joints, have worked out the subject so thoroughly that the view of the tuberculous nature of these affections and of their intimate connexion with tuberculosis elsewhere is now very generally accepted.

A thorough knowledge of the morbid anatomy of tuberculous diseases of bones and joints and of the mode of spread of the disease in the affected parts is very necessary, especially from the point of view which when employed at the present time aims at thorough removal of the disease along with as small an amount of the unaffected tissues as possible, as distinguished from the older methods where certain rule of thumb operations were performed with but little reference to the extent or distribution of the affected tissue. I shall therefore, in the first instance, endeavour to show the distribution of the disease and its relation to surrounding parts as gathered from a study of complete thin sections of the affected bones and joints. I do not intend to go minutely into all the pathological points but only to discuss those matters a knowledge of which is of essential importance for the satisfactory treatment of these affections.

Before entering on the special pathology of tuberculous diseases of bones and joints, I must say a few words as to the meaning of the terms 'tubercle' and 'tuberculous tissue', and point out what are the essential elements in the tubercle, what its mode of origin, what its life history, and what the cause of its production.

The general idea with regard to tuberculous tissue is that it is a tissue containing tubercles, that is to say, containing more or less well-defined nodules, and if no tubercles are found in a part it is concluded that that part is not the seat of tuberculous disease. This view is, however, I am satisfied, too narrow, and its adoption has been one of the chief obstacles in the way of the early and general admission of the tuberculous nature of these diseases of bones and joints. Tuberculous tissue, as a matter of fact, presents two chief forms; it may be a tissue containing well-marked tubercles, or it may be, and frequently is in these joint diseases, a tissue which does not show any well-defined tubercles, but which is nevertheless infiltrated with the essential tuberculous elements, a condition which we may term shortly 'tuberculous infiltration'. Both of these forms of tuberculous tissue, viz. tubercles and tuberculous infiltration, are found in tuberculous diseases of bones and joints, and it is by no means uncommon to find at one part of a specimen a number of discrete tubercles and at another part a tuberculous infiltration.

The 'tubercle' occurs in the form of a small microscopic nodule, circular or oval in shape, and usually a number of these nodules are aggregated together and have frequently coalesced with each other. In sections stained with various dyes, such as methylene blue, and examined under a low power, we generally see that the nodules consist of two parts, a central portion, the larger, faintly stained, and an external part, much narrower and usually more deeply stained. The central portion is the essential part of the tubercle, and the external part is merely an adventitious wall. This wall may be either mainly cellular or mainly fibrous. Perhaps in most cases the wall is composed of a mass of small, round, deeply stained nuclei, the nuclei of lymphocytes, which form a barrier around the tubercle (see Fig. 1). In other cases, there is a considerable amount of fibrous tissue in the wall; in some instances, indeed, the wall may be almost entirely fibrous. As I shall presently point out, I believe that most of these tubercles with fibrous walls are formed in the interior of blood-vessels, and that the fibrous wall is the remains of the vessel wall. In the central portion, the cells are much larger than those outside; their nuclei do not take on the stain so well, they are somewhat flattened, and from their resemblance to endothelium and some forms of epithelium, they are termed 'epithelioid cells'. Among these epithelioid cells we sometimes find a few lymphocytes, recognized by their small, round, densely stained nuclei, but these cells are few in number as compared with the epithelioid cells, and are frequently entirely absent. The nuclei of the epithelioid cells are large, oval or elongated, granular and more faintly stained than those of the external wall. These cells have usually only one nucleus, but not uncommonly two or more are present.

The most striking thing in most tubercles is the large giant cells which are so frequently present. These cells are by no

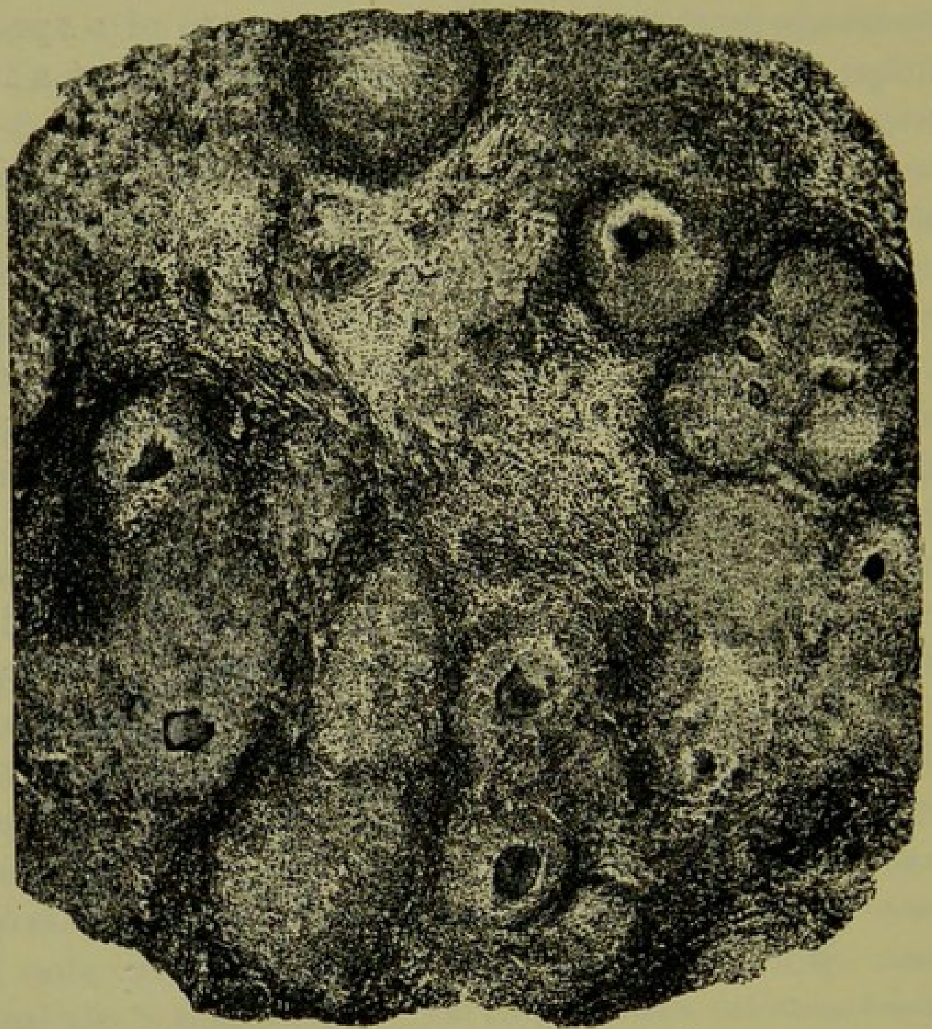


FIG. 1.—Section of tuberculous synovial membrane, showing a mass of tubercles under a low power. The majority of them contain a giant cell. The epithelioid cells which make up the main mass of the tubercle are indicated by the paler centre, as contrasted with the dark rim around, which is made up of a dense mass of granulation cells.

means constantly found, and are therefore not an essential part of the tubercle. They usually lie somewhat eccentrically, and consist of large masses of protoplasm of irregular shape, containing large numbers of nuclei presenting the same characters as those of the epithelioid cells. These nuclei may be distributed irregularly throughout the cell, but perhaps most commonly they are arranged in the form of a complete or incomplete circle around its margin, or are collected together in a mass at one end.

As a rule, only one giant cell is present in each tubercle, but sometimes two are found, and we not uncommonly see that several of the epithelioid cells contain more than one nucleus.

Processes frequently pass out from one or both ends of the giant cells ; in some cases, in the form of one or more broad protoplasmic bands, or of a number of finer threads. These processes, when present, may either join the protoplasm of the epithelioid cells or ramify among these cells, often extending as far as the wall.

The presence of a reticulum, resembling that of lymphatic glands, and ramifying between the epithelioid cells, has been often described, but though I have for years directed special attention to this point, I have never been able to demonstrate to my satisfaction a reticulum in any way comparable to that of lymphatic glands, and I believe that what has been looked on as reticulum has been partly these processes of the giant cells, partly bands of fibrous tissue in connexion with the wall of the tubercle, and partly, and probably chiefly, diffraction appearances due to bad illumination of the specimens.

I would therefore describe a tubercle histologically as a microscopic nodule, generally round or oval in shape, composed of a central portion made up of epithelioid cells and sometimes giant cells, surrounded by a wall consisting of cells of inflammatory origin, or of more completely formed fibrous tissue.

As I have already said, tuberculous tissue does not always present the nodular form ; indeed, in the case of bone and joint disease, it is very common to find, either along with or without the nodular form, a condition of what I have termed 'tuberculous infiltration'. In this condition, which it is most important to recognize, the epithelioid cells are not collected in small masses, but either run through the tissue in broad tracts or simply scattered irregularly among the other tissue elements. Giant cells are also frequently found in this peculiar mixed tissue. The tissue which is the seat of this infiltration presents two chief types, viz. granulation tissue or young fibrous tissue.

In the cellular form, we find a mass of cells like those of granulation tissue, among which are numerous epithelioid and frequently giant cells. In Fig. 7 we see very well the mixture of cells and the absence of nodular form, while in other parts of the same section well-defined tubercles were present. This is the kind of tissue which is generally found at those parts of the synovial membrane where caseation is going on, and it also precedes the formation of a chronic abscess. Where we find this tissue, we generally also find that the disease is extending rapidly.

The fibrous form of tuberculous infiltration is best seen in sclerosis of bone, in certain cases of caries, in caries sicca, in strumous dactylitis, &c. In this form we find more or less well-developed fibrous tissue infiltrated with cells chiefly of an epithelioid type, and having also a tendency, though less than in the preceding form, to break down and caseate.

The question next arises whether there is any histological element which is characteristic of tubercle, and if so what it is. This is a question which has been much discussed, which has received various answers, and as to which there is by no means unanimity of opinion even at the present time. Small granules or irregular fragments of cells, giant cells, epithelioid cells, lymphoid cells, a fine reticulum, or several of these in combination, have been at different times put forward as the essential and characteristic elements of the tubercle. In my opinion, the epithelioid cell is the characteristic element, and I think that when we find small collections of epithelioid cells, or larger tracts of them, and when they present the life history to be presently mentioned, we have to do with tuberculous tissue. In the first place, the epithelioid cells are constantly present in tubercles and tuberculous tissue. However uncertain the presence of giant cells, their processes, &c., the epithelioid cells, characterized by their size, appearance, and reaction with suitable staining reagents, are constantly found. In the second place, they are not only always present, but they also bear a constant relation to the tuberculous virus—the tubercle bacillus. What first directed my special attention to these epithelioid cells, and what first convinced me that they were the characteristic histological elements of tubercle, was the peculiar distribution of the tubercle bacilli in the tuberculous tissue. If we examine a tubercle stained to show tubercle bacilli, we find that the organisms are located either in or among the epithelioid cells, most usually, I think, in them, while they are not found at all among the inflammatory cells beyond the tuberculous growth. In the epithelioid cells they are frequently closely applied to the nucleus. In cases where there is tuberculous infiltration rather than definite tubercles we see the same thing; the bacilli are chiefly found in connexion with the epithelioid cells. So constant and marked is this relation that I have found it best, when searching for tubercle bacilli in tissues where these organisms are few in number, to look with a low power for tracts of epithelioid cells, and then search for the bacilli among these cells. If one does not do this much time may be lost in examining portions of tissue in which these bacilli are not present, and when few in number the organisms may be entirely missed. If giant cells are present the bacilli are generally found in their interior in largest numbers, and when the bacilli are few in number they may be found only in giant cells. In giant cells with marginal nuclei the bacilli frequently form a ring around the margin lying among the nuclei (see Fig. 2).

The conclusion that the epithelioid cells are the essential histological elements of tubercle has also been arrived at by Baumgarten from the study of the elements in tubercle in which karyokinetic processes occur. Baumgarten has found that in tuberculous tissue nuclear division occurs only in the epithelioid cells, and in the cells from which they are derived, and hence he comes to the conclusion that these epithelioid cells are the essential histological elements.

Various authors have attempted to minimize the importance of epithelioid and giant cells in the diagnosis of tubercle by asserting that these cells are found in other and non-tuberculous tissues. No doubt cells of an epithelioid type do occur in various pathological tissues, for example, in gummata, but there they are not so numerous, and they are never arranged in the characteristic nodules above described. Where nodules of the above character are present, and where their life history is that to be presently mentioned, there can be no question that we have to do with true tubercles ; the

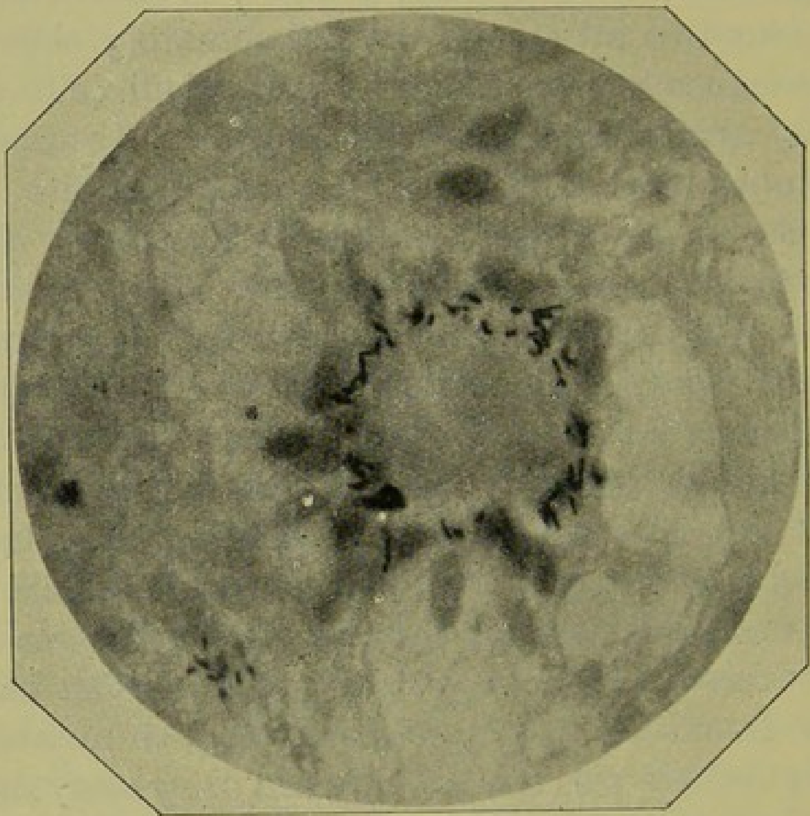


FIG. 2.—Large giant cell from tubercle, with a ring of bacilli lying among the nuclei.

great difficulty in diagnosis is between tuberculous *infiltration* and some forms of granulation tissue, especially those where retrogressive changes are occurring. Here, however, a careful comparison shows marked differences between the two forms of tissue, more especially in the presence of large numbers of epithelioid cells in the tuberculous form, and the diagnosis is made in the latter by the tendency to caseation—a point to which I shall immediately allude. It is often asserted that giant cells, like those of tubercle, are present in ordinary granulations. For my own part I cannot confirm this. I have examined much granulation tissue, and have never seen giant cells at all resembling those found in tubercles, and I suspect that the observations in which they have been found have been made on strumous ulcers, or on sinuses after chronic abscesses, where tuberculous giant cells are actually present. The ordinary myeloid cells of bone are much smaller than tuberculous giant cells, and only have three or four nuclei, generally in the centre of the cell,

FIG. 3.—Caseating tubercle. Where caseation is more or less complete the bacilli will be found scattered through the cheesy material, very often arranged in circles representing degenerated giant cells.

and the only large cells in bone resembling tuberculous giant cells are the osteoclasts, and the diagnosis is readily made by examination of the surrounding tissue. In any case, as I shall presently state, I should never depend for the diagnosis simply on the histological elements present, I should also take into consideration the life history of the new growth, more especially as shown under the microscope.

The source of these epithelioid cells is in all probability manifold, and varies according to the situation of the tubercle; they may be derived from epithelium, as in the lung, from the endothelium of blood or lymphatic vessels, from tissue cells, and very probably also from the plasma cells. In the tissues they are probably most often derived from the endothelium of blood-vessels, though this is by no means an absolute rule. There has also been much dispute about the origin of the giant cells. They have been supposed to represent plugs in lymphatic vessels, with hypertrophy of the endothelium around, the contents of the vessel forming the apparent protoplasm, and the ring of nuclei representing the nuclei of the original endothelial cells; or a similar process in the blood-vessels; or hypertrophied or coalesced endothelial cells, &c. My own opinion is that they are derived from the epithelioid cells either by hypertrophy of individual cells or by coalescence of neighbouring cells.

The discussion of the origin of these cells is, however, not essential, and I shall therefore not go into the matter, but as the vascular origin of tubercles is of great interest, I may say that I have, in several cases, been able to demonstrate the direct development of the endothelial cells of blood-vessels into the epithelioid cells of tubercle, and have found all stages in the formation of tubercles in the interior of blood-vessels. Fig. 4 shows another relation to the blood-vessel, and in it we see the development of a tubercle in the substance of the internal coat of a blood-vessel, the lumen of the vessel being still patent.

The life history of the tubercle is an important element in its diagnosis, and there are two points in its life history which we must take into consideration—viz. (1) the fate of the individual tubercle, and (2) the tendency to the formation of fresh tubercles.

Beginning in hypertrophy and new formation of cells, the nodule rapidly grows or the tuberculous infiltration rapidly extends till it has attained, so to speak, its normal size or extent, and then retrogressive changes occur. We may roughly divide these changes into three great classes—viz. (1) simple atrophy and disappearance of the tubercle;

(2) rapid caseation and breaking down, often leading to what is termed suppuration; and (3) slower degenerative changes generally ending in some degree of calcification.

Simple atrophy of the cells of the tubercle, accompanied no doubt by more or less fatty degeneration or fibrous formation, probably frequently occurs in cases where healing

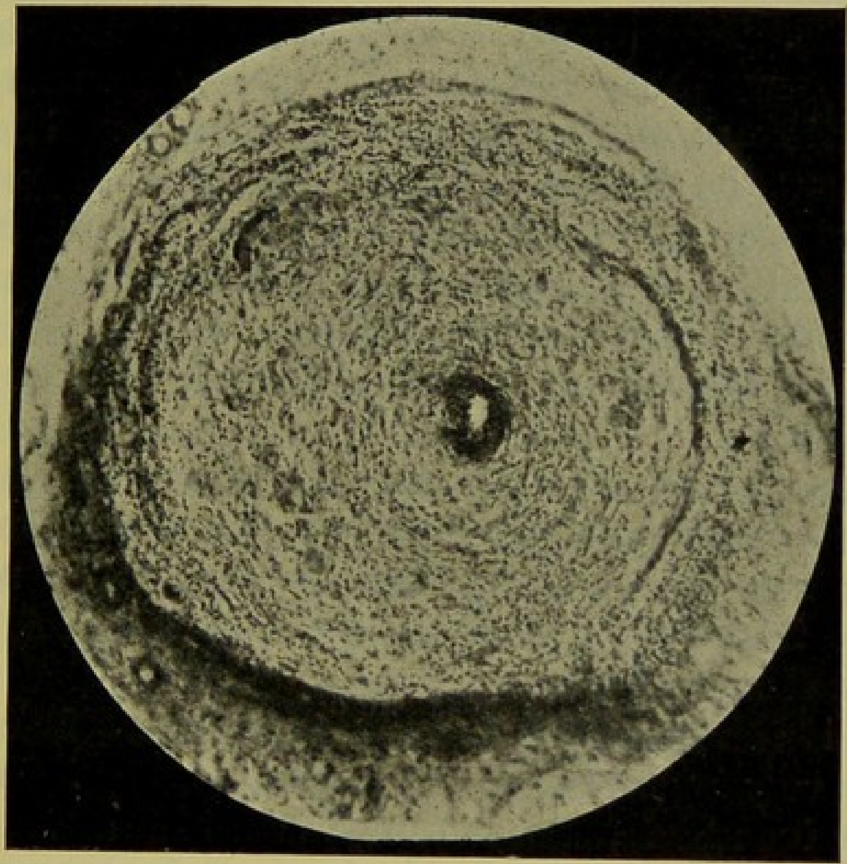


FIG. 4.—Section of a tubercle from tuberculous synovial membrane, showing its development in the substance of the internal coat of a blood-vessel, the lumen of the vessel being still patent. In the particular tissue from which this was taken (a case of synovial disease of the ankle-joint), almost all the tubercles were apparently developed in this way.

takes place. I need not, however, go into a theoretical description of the process, but whatever it be it seems certain that during recovery from tuberculous disease many tubercles disappear completely or undergo fibrous transformation, and that they do not all become encapsuled or calcified, as seems to be the belief of many writers.

Perhaps the most frequent change which occurs is caseation of the tubercle, and where the tubercles are very numerous or where tuberculous infiltration is present the caseation may be rapid, and we have the process termed 'chronic suppuration'. The process of caseation, especially when it is extensive, as in joints, is generally preceded by coalescence of tubercles and formation of the condition of tuberculous infiltration. It frequently commences in the protoplasm of the epithelioid cells, but perhaps most often in the intercellular substance and in the processes of the giant cells. The protoplasm loses its homogeneous or finely granular appearance and becomes coarsely granular, while the nuclei break up into fragments which become distributed throughout the caseous material. The general appearance of the caseous material is seen in Fig. 6. The giant cell is one of the last structures to disappear, and we sometimes see that the caseous material extends up to and becomes continuous with the protoplasm of the cell, while the nuclei are still alive.

Lastly, in some cases the tubercle neither atrophies nor caseates rapidly as above described, but the degenerative changes occur more slowly, and the degenerated material becomes infiltrated with calcareous salts and can still be recognized even after many years.

This is the life history of the individual tubercle, but another very important point in its life history is that it is an infective nodule, that is to say, that it does not remain single, but that once a tubercle develops, fresh ones spring up around the primary one. Indeed it is in this way that the tuberculous process spreads, the new tubercles coalescing with the old and fresh ones appearing in the tissue around. And not only is the tubercle locally infective, it is also generally infective, a tuberculous deposit in one part of the body being very apt to lead to tuberculous growth elsewhere. The tuberculous process is also infective from man to man, and from man to the lower animals, and from the lower animals to man. A large number of cases of infection of wounds in man with tuberculous material have now been published, and I need not therefore go into this matter. Nor need I go into the question of the infective agent in tuberculous material; that has been conclusively shown by Koch and others to be the tubercle bacillus.

A further and very important point in the history of tubercles is that they are very irritating structures, and that the tissue in which they lie becomes the seat of simple inflammatory changes which extend far beyond the limits of the tuberculous disease and produce very marked and destructive effects.

To sum up we see that tuberculosis is an infective disease due to the growth in the tissues of a parasitic micro-organism —the tubercle bacillus. It is characterized by the production of a special form of tissue which may either present the form of nodules or of a more diffuse infiltration, the characteristic element of this tissue being the epithelioid cells. This tissue shows a great tendency to undergo a peculiar form of degeneration termed caseation, and it also excites and keeps up a condition of inflammation in the tissues around. The primary nodule does not remain single but leads to fresh development of nodules both in the immediate vicinity and also frequently in distant parts. It is only by taking into consideration the histological characters of the tissue, the tendency to caseation, the presence of bacilli, the multiplicity of the nodules, &c., that we can come to a definite conclusion as to the tuberculous nature of a disease.

Of the various points which I have mentioned those which I consider most important are the *presence of epithelioid cells, the multiplicity of the nodules or the extent of the epithelioid infiltration, and the subsequent caseation.* When we have numerous and evidently spreading tubercles or large tracts of tuberculous infiltration, and where caseation is occurring, I know of nothing else which this can indicate but tuberculous disease. Limited collections of epithelioid and giant cells may occur around parasites of various kinds, but there is no tendency to extension of the process or to the formation of fresh epithelioid collections at a distance, while the constant tendency to multiplication is a characteristic of the tuberculous process. I attach but little importance to the demonstration of tubercle bacilli as a means of diagnosis in these bone and joint diseases: the above mentioned histological characteristics are sufficient to enable the diagnosis to be made without the aid of the tubercle bacillus.

We have thus arrived at a definite conception as to the histological structure of tubercle, and we may conclude that when we find tissue with the characteristics described above, we have to do with tuberculous disease.

CHAPTER II

CHANGES IN THE SYNOVIAL MEMBRANE

In discussing the morbid anatomy of tuberculous diseases of bones and joints, we shall study in the first instance the changes which occur in the synovial membrane, and in the second place those which occur in the bones. The disease may be primary or secondary in either of these tissues, and the character of the changes which take place varies accordingly.

We may divide the changes which occur in the synovial membrane into four main groups :—(1) Various forms of diffuse thickening of the synovial membrane ; (2) limited thickening of the synovial membrane, more especially the formation of one or more fairly limited nodules ; (3) acute miliary tuberculosis of the synovial membrane ; and (4) a form where there is not much thickening of the capsule at first, but where there is hydrops or pyarthrosis, a condition described by König, and termed by him 'tuberculous hydrops and tuberculous empyema of joints'.

1. The most important of these forms, and that which comes under our notice by far the most frequently, is the diffuse thickening of the synovial membrane.

Here we find a great variety of conditions, and all sorts of transition stages, but if we examine the state of matters at an early period in the disease, we find that the changes may be divided into three great types.

A frequent condition is that in which there is moderate thickening of the synovial membrane, which may be roughly divided into two parts—an internal layer, where the tissue is soft and at an early stage villous and later caseating at the surface, and an external layer of firmer consistence and of a glistening character, without caseation. The soft tissue on the surface has a gelatinous appearance and can be frequently rubbed off with very slight pressure. In some cases, this soft material is not present over the whole surface of the thickened membrane, and in any case, it is usually distributed irregularly as regards its quantity, and is generally in largest amount at the reflection of the synovial membrane on to the bone or cartilage, or in the neighbourhood of any osseous deposit. What I have just described may be looked on as, so to speak, the normal condition in this type of diffuse thickening; but great differences exist as to the relative amount and distribution of the two kinds of material. Thus, in some cases, the soft tissue on the surface forms only a thin layer, the greater part of the thickening being composed of the firmer material, while in others, again, the reverse may be the case, and almost the whole of the thickened part may consist of the soft tissue.

In a second type, we do not find this subdivision into two layers, the thickening being composed essentially of the firmer tissue, but this tissue is dotted over with transparent or opaque yellow spots of varying size, and sometimes shows distinct caseous patches or commencing chronic abscesses.

In a third class of cases we have often very marked thickening of the synovial membrane of the firm œdematous glistening character above described, but without the diffuse speckled appearance due to caseating patches, though it is not uncommon to find these collections here and there, especially over an osseous deposit which has reached the surface outside the joint at the point of reflection of the synovial membrane.

In the first form, the joint generally contains a little serous or purulent fluid, while in the last two types fluid is usually absent.

On studying the microscopical characters of complete sections of the synovial membrane, we find a similar diversity in the appearances, and we see the explanation of the naked-eye characters.

The following drawings represent the condition of matters in the first type of synovial thickening which I have described. They are taken from a case of hip-joint disease in a girl, aged 5, who was admitted with the following history:—Two and a half months before admission, she fell and struck her left hip. She had had no symptoms of hip-joint disease pre-

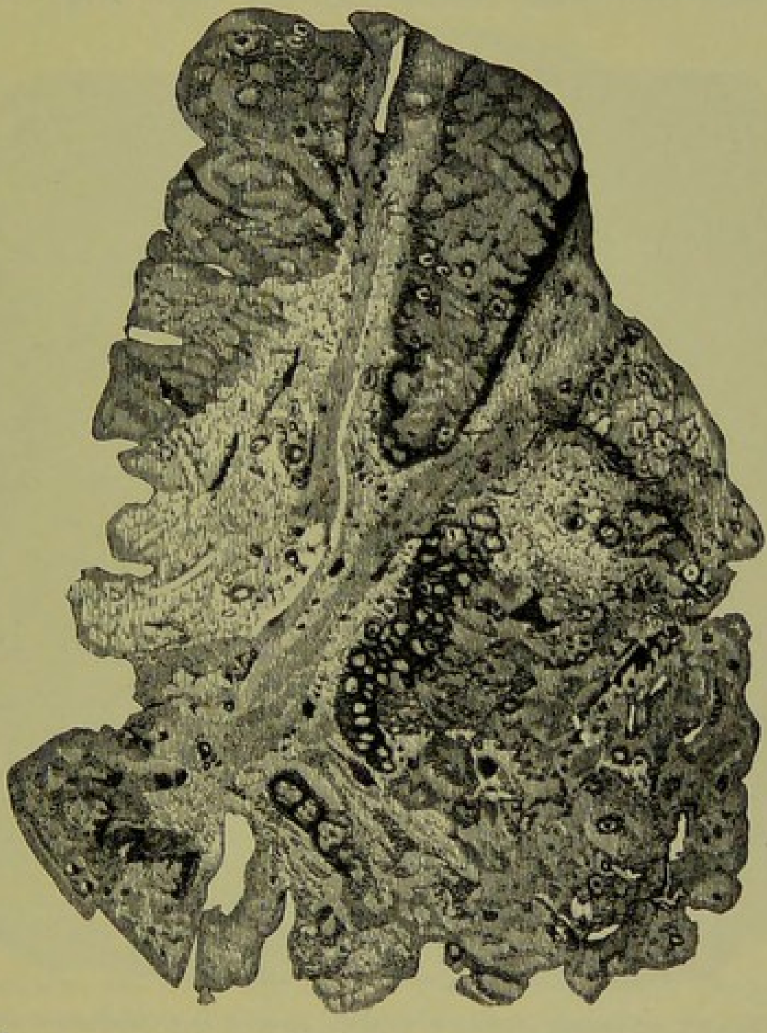


FIG. 5.—Transverse section of the ligamentum teres from a case of tuberculous disease of the hip, magnified 3 diameters. The invasion of the ligament by tuberculous tissue is well seen all round, and the tubercles can actually be made out at the deeper part. The ragged edge is where caseation is actively taking place.

viously, but the parents thought that she had been losing flesh, and she had suffered from cough. Symptoms of hip-joint disease rapidly developed after the accident, and a few days before admission the head of the femur became dislocated forwards and upwards, and there was evidently fluid in the joint. I excised the joint, and clear fluid, containing white flocculent matter, was evacuated, and a dense tuberculous deposit was found at the lower part of the neck of the femur, which was evidently the starting-point of the disease, and which had communicated with the joint. The synovial membrane was covered with villous masses, some of which were caseating on their free surface ; this villous material was soft and easily rubbed off. Fig. 5 is made

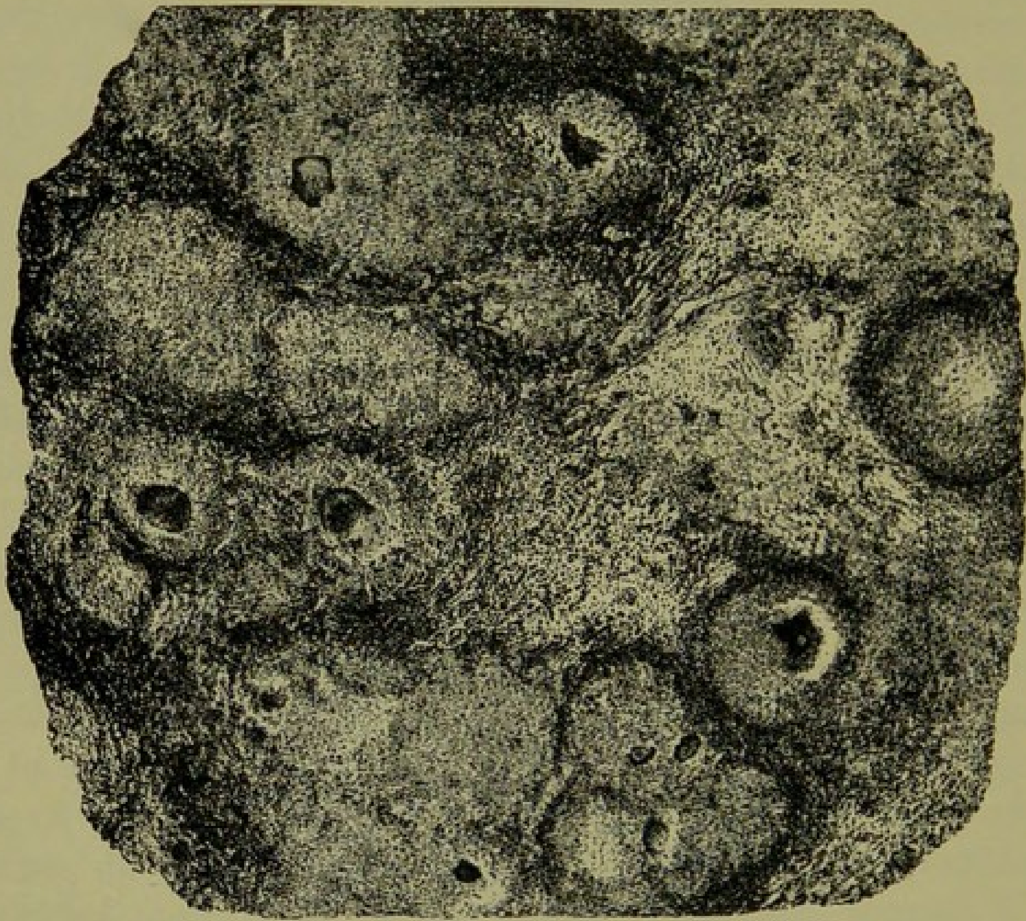


Fig. 6.—Section showing under a higher power the character of the deeper or spreading edge of the tuberculous area. The numerous discrete tubercles are well seen.

from a photograph of a transverse section through the ligamentum teres, magnified about 3 diameters. At one part a small portion of the surface has become detached, but nevertheless we obtain an excellent idea of the state of matters. It will be seen that the section consists of two parts,—a central lighter portion, and an outer darker part. If we look at the outer portion we see that here and there at the edge it is breaking down, but at the innermost part it is composed of closely aggregated circles, with a light centre, dark outline, and often a small dark body in the interior of the circle. This peculiar material is seen to extend pretty completely round the margin, and to penetrate into the interior at various parts, especially between the bands of fibrous tissue.

Figs. 6 and 9 show the appearance under a higher power of the deeper part of this layer, and we see that the tissue

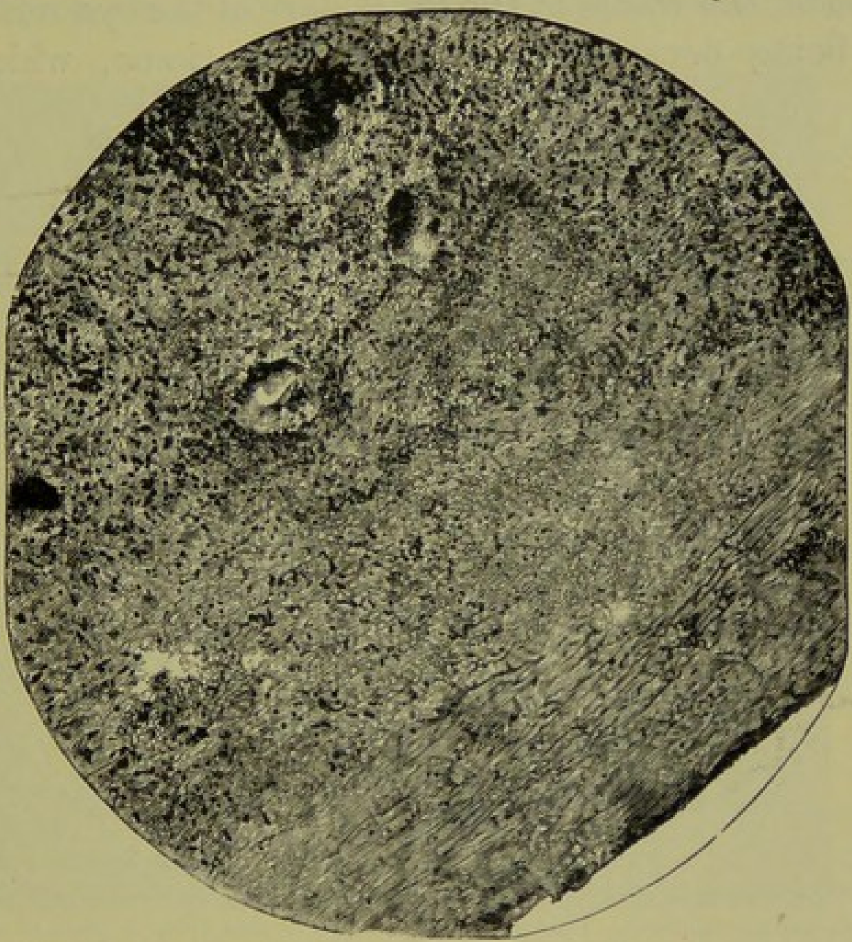


FIG. 7.—Shows the free edge of the same section. Here the tubercles have run together, and the condition of 'tuberculous infiltration' has been produced. Caseation is going on at the edge, and some giant cells can still be seen.

at this part consists of densely packed tubercles, frequently with large giant cells, and surrounded by a ring of leucocytes. Passing now to the free edge (shown in Fig. 7) we no longer see the individual tubercles; they have run together, and we have the condition which I have termed tuberculous infiltration, and quite at the free edge this tissue is undergoing caseation. If, lastly, we study the central tissue (Fig. 8), we find that it is composed of very vascular delicate fibrous tissue, which is much swollen, and contains elongated cells, with processes like myxomatous cells, along with a few lymphocytes. Except in the immediate neighbourhood of the tuberculous masses there are no tubercles among this fibrous tissue. We may retain the old term 'gelatinous infiltration' for this condition.

The sections of the synovial capsule showed exactly the same appearance, except that the tuberculous layer was only at one side, the whole of the inner part of the synovial membrane being occupied by tuberculous tissue, which was

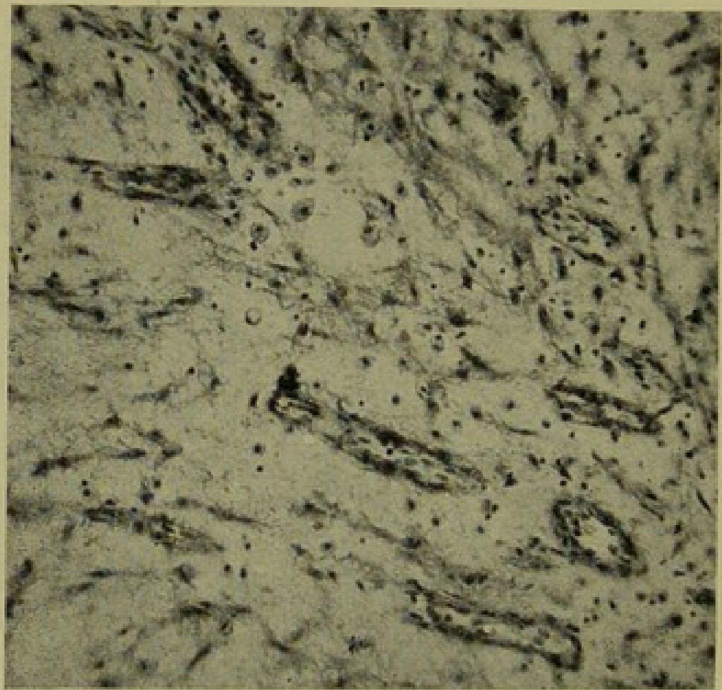


FIG. 8.—Section of the innermost tissue not yet invaded by the tuberculous growth. The tissue is swollen, cellular, with young vessels, in fact in a state of subacute inflammation. This is the structure of the greater part of the tissue which constitutes the swelling of tuberculous joints.

caseating at the free surface, while the outer part was composed of this swollen fibrous tissue.

The sequence of events in these cases is plain. The tuberculous virus, passing into the interior of the joint from the deposit in the neck of the bone, has attacked the surface of the synovial membrane, and spread into its substance. In the ligamentum teres the tuberculous growth is spreading in on all sides, where the tissue is not too dense. The oldest parts of the tuberculous tissue, those next the cavity of the joint, are breaking down and undergoing caseation, and the caseous material is being shed into the joint forming the flakes which were present in the fluid. Further, the fibrous tissue in the outer part of the synovial membrane, or the interior of the ligamentum teres, has become much swollen, is more vascular than normal, and there has no doubt been new formation of tissue.

These specimens represent very well the state of matters in the first form of synovial thickening which I described,

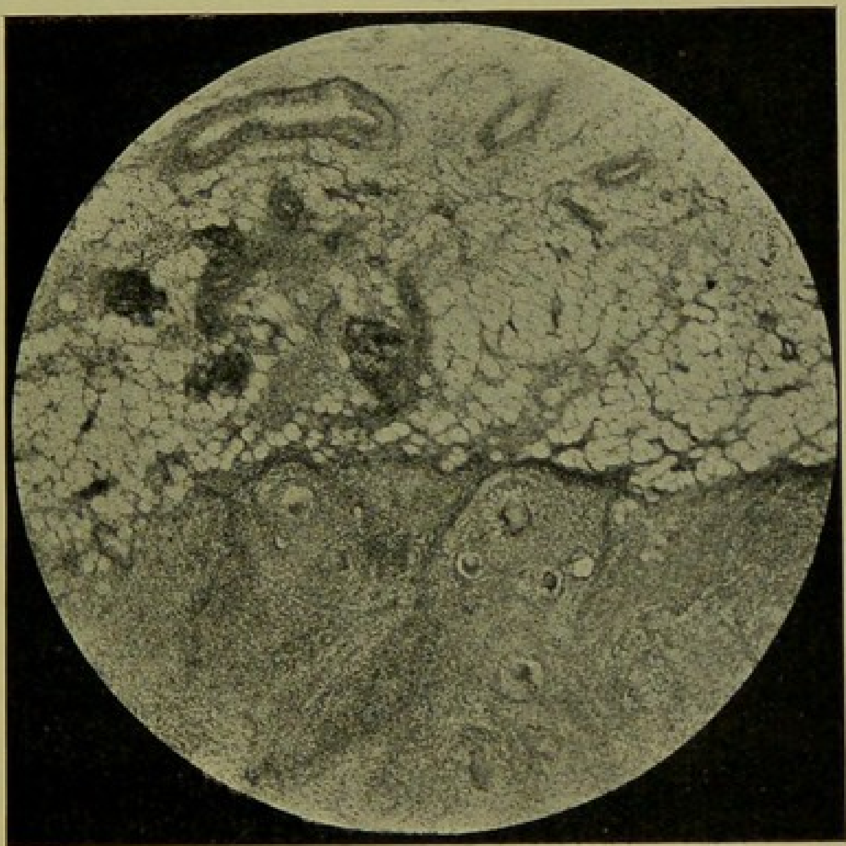


FIG. 9.—Another specimen showing the spreading edge of the tuberculous tissue in a case of tuberculous synovial disease.

where two layers can be made out, viz. an inner, soft and often caseating, and consisting of tuberculous tissue, and an outer, composed of swollen vascular fibrous tissue. This condition most frequently occurs, I think, as the result of infection from the interior of the joint, for example, from the bursting of an osseous deposit into it ; and associated with it, we generally find fluid containing pus cells and caseous material in the joint, due to the caseation of the surface of the tuberculous growth. As time goes on the tuberculous material gradually involves the whole of the synovial membrane, which is then no longer divisible into two layers, but consists entirely of soft caseating tissue with swollen fatty, and fibrous tissue outside.

In the second type of diffuse synovial thickening (Fig. 10) we find that the thickened synovial membrane is not distinctly divisible into two layers, but that it is somewhat tough with small or large transparent or yellow spots scattered through it. In this type the tuberculous growth does not, in the first

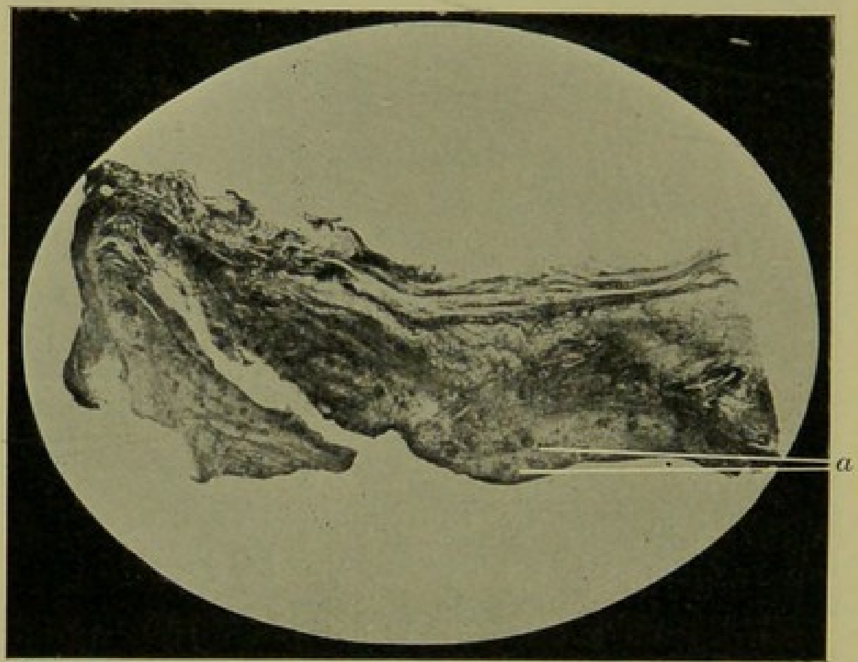


FIG. 10.—Section of synovial membrane from the knee-joint in a case of primary tuberculous disease. The double thickness at the point of reflection of the synovial membrane in the suprapatellar pouch is well seen, and the thickened synovial membrane is interspersed with minute tubercles (a) which are as yet discrete.

instance, form on the surface of the synovial membrane, but in its substance, though generally close to the surface, and the tubercles are generally scattered irregularly throughout the thickened tissue. As time goes on, however, the whole thickness of the synovial membrane becomes involved, and we may ultimately have a condition resembling the first type but differing in that the caseation most commonly occurs, in the first instance, beneath and not at the surface of the synovial membrane, seeing that the oldest tubercles are beneath the surface. Hence the characteristic appearance of yellow specks scattered through the substance of the thickened synovial membrane. In this type of synovial thickening we have generally to do with primary synovial disease.

In the third type of diffuse synovial thickening the great mass of the thickened tissue is composed of the swollen fibrous tissue which is seen outside the tuberculous growth in the first type, and the tubercles are few in number and in parts entirely absent. It is most important to bear in mind the existence of this type of disease, and the fact that there may be very marked thickening of the synovial membrane without any tubercles in it. This condition is either associated with primary disease of the synovial membrane, where the tuberculous deposit is limited to some part of the thickened tissue, or perhaps it most often occurs in connexion with osseous deposits which have not yet reached the surface or have done so at the point of reflection of the synovial membrane, but have been shut off from the joint cavity by the soft tissues over their point of exit.

In cases where we meet with this type of synovial thickening we may have to search a little before we find the tuberculous area which, however, is present. Usually it will be found at some part where there is a large amount of thickening, more especially at the reflection of the synovial membrane, or in some portion of the bone.

To sum up we may say that the diffuse thickening of the synovial membrane may occur as a primary or a secondary lesion. If it occurs primarily the deposit may and usually does commence at one part in the substance of the synovial membrane, and is not diffused over the whole membrane at once. At the point of commencement there is a deposit of tubercles, swelling of the surrounding tissue, and the tuberculous growth soon spreads through the whole of the synovial membrane, being often, however, preceded by thickening of the membrane, due solely to swelling and gelatinous infiltration of the tissue. In these cases of primary disease of the synovial membrane the tuberculous growth commences in its substance or even in the sub-synovial tissue, and these are often the cases in which we have the greatest thickening of the synovial capsule.

Where the diffuse thickening occurs secondarily to deposits in the bone we may have one of two conditions according to the point where the deposit reaches the surface of the bone. (*a*) If it communicates freely with the cavity of the joint there is rapid infection of the whole surface of the synovial membrane, tubercles form in the superficial layers, grow rapidly, and caseate at the free margin, while they also penetrate into its substance. At first the tissue outside becomes swollen from gelatinous infiltration, but subsequently this material is invaded and destroyed by the tuberculous growth. (*b*) In other cases the osseous deposit may reach the surface at the margin of the synovial membrane, which becomes thickened in the first instance, and shuts it off, for a time at any rate, from the joint cavity. This thickened patch is full of tubercles, and these rapidly spread in the substance of the synovial membrane or in the sub-synovial tissue, while the synovial membrane becomes swollen and gelatinous even before the tuberculous deposit has reached it.

At first sight one might be inclined to think that these details as to the various types of diffuse synovial thickening are only of pathological interest, and not of any special practical importance, but in reality their recognition is of great importance in treatment. Thus, suppose that we open a joint with the view of removing the tuberculous disease and find that a primary osseous deposit has burst into the joint, we know from what I have pointed out that the tuberculous disease will be confined, in the first instance, to the superficial layers of the synovial membrane, and that these layers are soft and easily removed, while the outer layers are tougher and composed only of inflamed and swollen fibrous tissue. It is evident, therefore, that in order to remove the tuberculous disease, if we operate at an early period, we need not dissect away the whole of the thickened tissues, destroying ligaments, &c., in our course, but that thorough scraping of the surface will remove the whole of the disease, or at the most, the additional removal of a thin layer of the firmer tissue by knife or scissors will be sufficient.

In this way we leave a strong joint, and may subsequently obtain some movement.

Again, if we have to do with a case of primary synovial disease, we know that the tubercles are scattered irregularly throughout the thickened tissue, as in Fig. 10, which is too tough to yield to the sharp spoon, and if we decide that it is necessary to remove the whole of the tuberculous disease, we can only make sure of doing so by dissecting away the whole of the thickened tissues.

In the third place, as illustrated by the third type, if an osseous deposit has reached the surface at the margin of the synovial membrane and caused thickening at that part, or if there is a localized primary deposit in the synovial membrane at one part, all that is necessary at an early stage may be to remove the primary deposit and a good area of the synovial membrane around without touching the greater part of the synovial membrane, even although it may be somewhat thickened.

2. Limited thickening of the synovial membrane. A comparatively rare condition is that described by König, Riedel, and others, where we have nodular, often polypoid, growths on the synovial membrane; this generally occurs in the knee-joint. In most cases of synovial thickening the surface of the synovial membrane is not smooth, but shows irregular soft projections, but this is not the condition which is here referred to. In the cases to which I allude, we find one or more firm nodules projecting from some part of the capsule, generally in the pouch above the patella, and not unfrequently accompanied by hydrarthrosis. At first there may be no general thickening of the synovial membrane, but if the disease is allowed to progress, the whole of the synovial membrane ultimately becomes swollen and infiltrated with tubercles. Riedel describes the characters of these cases as follows:—the synovial membrane is reddened, often thickened, and shows one or more firm prominences on the surface; the joint frequently contains fluid and rice-like bodies; the nodules contain numerous

tubercles, closely packed together; I have only seen a few instances of this kind.

3. Acute miliary tuberculosis of the synovial membrane. König describes a form of tuberculosis of the synovial membrane in which miliary tubercles are found in the subsynovial tissue, and in which the synovial membrane is not at all altered; there are no symptoms of disease. This condition occurs in acute general tuberculosis and is only of anatomical interest.

4. We have also to consider the condition of the synovial membrane in 'Hydrops tuberculosus' and 'Empyema tuberculosum', described more especially by König and Volkmann. A certain amount of hydrops is not uncommon in connexion with general thickening of the synovial membrane, and more especially with the pendulous growths just described, but the condition to which I refer here is that in which a joint affected with tuberculous disease contains fluid, but where there is no marked thickening of the synovial membrane at first, although the disease is primarily synovial. This is, as a rule, only a temporary condition, and as time goes on the synovial membrane becomes swollen, the swelling generally commencing at the point of reflection of the synovial membrane on the bone, and ultimately the joint assumes the ordinary appearance of a tuberculous joint. These cases are usually diagnosed in the first instance as simple hydrops, and it is not, as a rule, till the thickening of the synovial membrane has occurred that their true nature can be recognized, or that operative interference seems to be called for. König has examined these cases at an early stage and states that there is a formation of a thin layer of tubercles on the surface of the synovial membrane, along with a slight amount of chronic inflammation.

The 'empyema tuberculosum' is a similar condition where, however, there is caseous pus in the joint cavity also without any marked thickening of the synovial membrane in the first instance. The typical cases of this kind are primarily synovial affections, occur especially in old people, and are particularly intractable. A very similar condition may, however, be found in some cases soon after an osseous deposit has opened into a joint. The appearance of the synovial membrane is very similar to that in the previous condition.

CHAPTER III

TUBERCULOUS DEPOSITS IN BONE

THE changes which occur in bone as the result of tuberculous deposit in them, are very various, and to some extent merge into one another. The following are, however, the chief forms :—(1) Miliary tuberculosis of bone ; (2) soft caseating deposits in bone ; (3) tuberculous deposits with sclerosis of bone and necrosis ; (4) superficial tuberculous disease of the articular surfaces of bone, in connexion with which we have to study the changes in the articular cartilage—this form is always secondary to deposits in bone and to disease of the synovial membrane—(5) the condition termed 'caries sicca' ; (6) diffuse condensation of bone, in connexion with tubercuclous disease ; (7) diffuse softening of bone and formation of 'red marrow' ; (8) tuberculous periostitis ; and (9) tuberculous osteomyelitis of the short bones, one form of which is 'spina ventosa'. In connexion with these tuberculous affections of bone we must also study the inflammatory processes which accompany them, and which play a most important part in the destructive changes.

1. MILIARY TUBERCULOSIS OF BONE

Miliary tuberculosis seldom occurs in bone, except in cases of acute general tuberculosis. It is true that we not uncommonly find miliary tubercles in bone in the vicinity of a large tuberculous deposit, but I here refer to diffuse miliary tuberculosis apart from any large deposit. The appearance of the tubercles and the changes associated with them are the same as in other organs ; but as a rule the number of tubercles is not so great, and they are not uncommonly most numerous towards the extremities of the bone. For a long time the occurrence of miliary tuberculosis in bone was entirely denied by some authors, but instances of this kind have been published from time to time. This form being only part of a fatal general disease is, however, of very little practical importance.

Apart from acute general tuberculosis, or large deposits in bone, miliary tuberculosis of individual bones has been described. It is not uncommon to find tubercles, or what look to the naked eye like tubercles, in the sternum, ribs, and even the vertebræ in post-mortem examinations of cases of phthisis, and that although there is no general tuberculosis.

2. Soft Caseating Tuberculous Deposits in Bone

Soft and frequently caseous tuberculous deposits in bone are by no means uncommon as the primary condition in tuberculous joint disease. These deposits vary much in size and situation, but they are as a rule small, and situated in the ends of the bones, usually close to the articular cartilage or the surface of the bone. They also vary in number, but in my experience they are most usually single, though in some cases there may be deposits in more than one of the bones entering into the formation of the joint, or in more than one part of the same bone.

In this specimen (Fig. 11) we have an excellent example of one of these soft caseating deposits in bone. This is a section of the external condyle of the left femur of a child aged 5. Two years before admission an abscess formed on the outer side of the left knee-joint, and burst, leaving a sinus ; the synovial membrane became much thickened, the knee flexed, and fresh abscesses formed. The condition of the joint as seen at the operation was that the synovial membrane was much thickened, the articular cartilage of the patella was destroyed, the internal tuberosity of the tibia was much eroded, and there was a soft caseous deposit in the external condyle of the femur, which communicated with the exterior, and to which the sinuses led.

On examining this deposit (*c*) we see that it is more or less circular in shape, and entirely composed of soft tissue, the osseous trabeculæ having completely disappeared. Towards the central part of the deposit caseation is occurring, around this there is a condition of tuberculous infiltration, and elsewhere a number of tubercles. Immediately around the deposit the trabeculæ of the bone are seen to be considerably

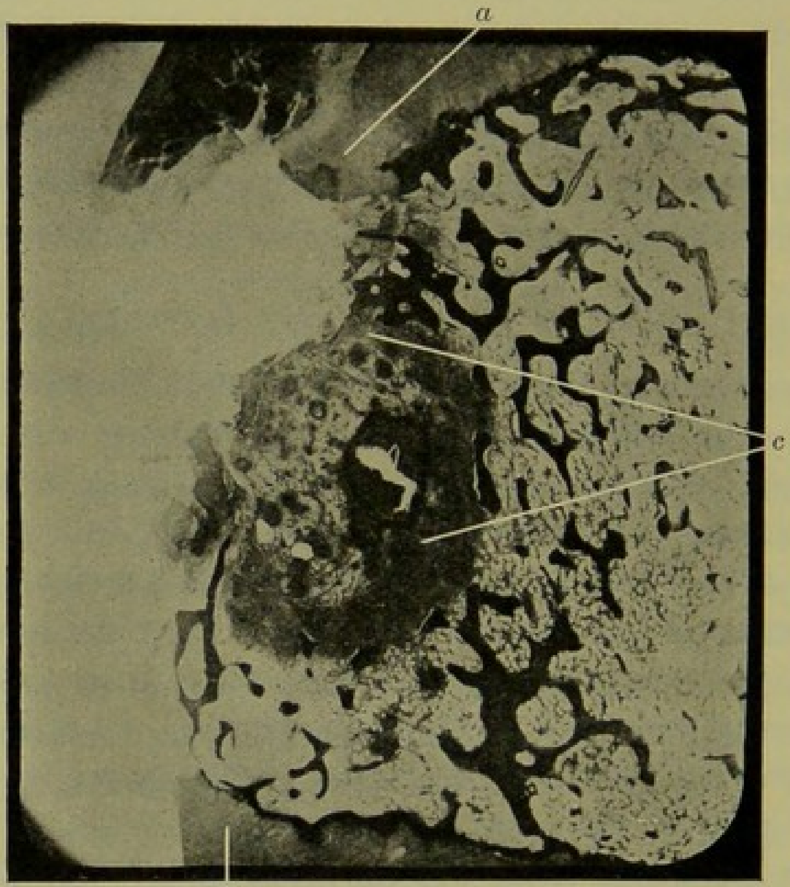


FIG. 11.—Section of the external condyle of the femur, from a case of disease of the knee-joint. Above is the articular cartilage (*a*), below the epiphysial cartilage (*b*), and between them, on the left hand, is a soft tuberculous deposit (*c*). (See Text for description.)

thickened, and more numerous than at some distance from this spot. In the cancelli around the tuberculous mass the normal fatty tissue has disappeared, and its place is taken by a swollen, somewhat fibrous, vascular material, not unlike that seen in gelatinous infiltration of the synovial membrane. Further away from the deposit the tissue in the cancellous spaces presents a fairly normal appearance. Towards the left hand side we see that the deposit has destroyed the surface of the bone, and made its way outwards, leading to abscess formation over it.

In Fig. 12 we have a caseous deposit immediately beneath the articular cartilage of the tibia, close to the spine. Here we have a similar appearance to that seen in the last specimen—viz. a central mass of caseous material without any bony spiculæ in it, surrounded by soft granulation tissue containing tubercles. Surrounding the soft deposit there are a few thickened trabeculæ, as in the previous example,

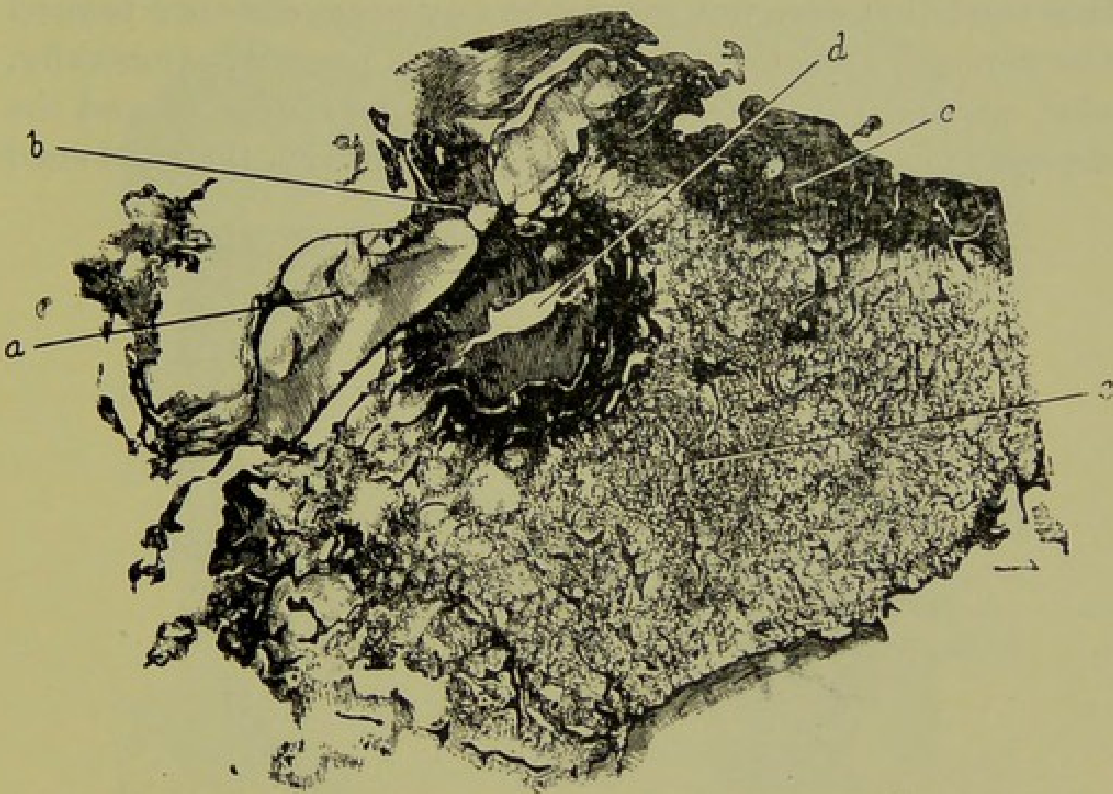


Fig. 12.—Section of the head of the tibia, showing remains of articular cartilage above, and a portion of the epiphysial cartilage below. On the right hand side the surface of the bone is carious. A soft tuberculous deposit is present beneath the remains of the articular cartilage, which was perforated at one part. (See Fig. 29 for explanation of lettering.)

while further away the epiphysis is infiltrated with inflammatory cells, and the osseous trabeculæ are thin and few in number ; in fact, the whole epiphysis is in a state of rarefying osteitis. At one part the deposit has burst through the cartilage, and opened into the joint. On each side of this point some fragments of cartilage are still present on the surface of the bone, but further away the articular surface is destitute of cartilage and carious.

As in the above specimens, these deposits generally undergo caseation in the centre, but in some instances this may not occur for a long time, and sometimes we find a mass of firmer fibrous tissue containing only a few tubercles scattered through it. In these deposits the osseous trabeculæ have usually been completely absorbed, though in some cases fragments of bone may still be seen. Immediately outside the tuberculous growth it is not uncommon to find that the osseous trabeculæ are thicker than normal, but this condition does not extend to any great distance beyond the deposit, and, indeed, is not always present. Generally, also, we find that a few of the cancellous spaces around the deposit, more especially those in relation with the thickened

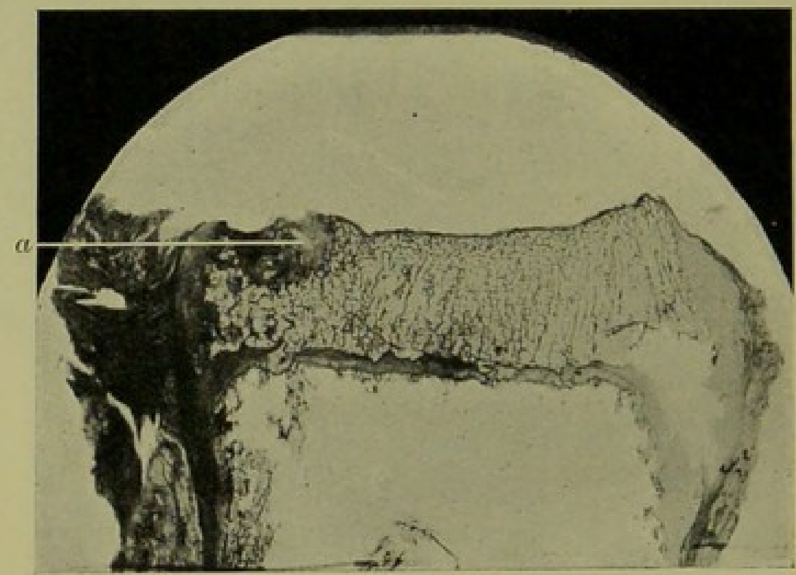


Fig. 13.—Soft deposit (*a*) in the head of the tibia which has burst into the joint. The articular cartilage has been completely destroyed.

trabeculæ, are almost entirely devoid of fat cells, and contain a peculiar swollen semi-fibrous material, not unlike that found in the thickened synovial membrane in the neighbourhood of tuberculous growth. Further away from these soft deposits we usually find a condition of rarefying osteitis. It is noteworthy, however, that here, as in caries, the rarefying osteitis is most marked at some distance from the deposit, the intervening tissue being less affected, and this rarefying osteitis often occurs in patches. Not uncommonly we find new osseous formation from the periosteum outside these deposits, but this is perhaps not so frequent as in the next form of tuberculous bone disease. Fig. 13 shows a soft tuberculous deposit of longer standing in the head of the tibia with complete loss of the articular cartilage.

The process probably progresses somewhat in this way. The tuberculous virus is deposited at some part of the bone, and tubercles form, the tubercles causing irritation, and the formation of a young granulation tissue around them, which attacks the trabeculæ of the bone, and leads to their absorp-

FIG. 14.—Section of a carpal bone, showing the commencement of a tuberculous deposit in the superficial cancelli, destruction of the lamellæ of the bone, &c. (See Text.)

tion. The condition is illustrated in the accompanying drawing (Fig. 14), where we see the formation of tuberculous tissue in neighbouring cancelli, and the lacunar absorption of the bone by the granulation tissue around the tuberculous mass. The tubercles multiply, this granulation tissue extends, and absorption of the trabeculæ progresses, while caseation occurs at the oldest part of the growth. Further away from the tuberculous mass, the irritation is less, and a small amount of young swollen fibrous tissue is formed, accompanied by sclerosis of the trabeculæ. This fibrous material is again invaded by the tuberculous growth, and the thickened trabeculæ are again absorbed, and so the process goes on extending, aided, no doubt, by the rarefying osteitis which is occurring in the neighbourhood, till ultimately the surface of the bone is reached. In some cases the tuberculous growth is more rapid, and time is not afforded for total destruction of the trabeculæ before caseation is complete, and hence we find in these cases portions of osseous trabeculæ in the midst of the caseous material, and the sclerosis of the surrounding bone may be absent.

The further history of the case is as follows :—While the tuberculous deposit is still enclosed in the interior of the bone, there may be only slight clinical evidence of its presence, but once it reaches the surface, various phenomena occur differing according to the point where the deposit has opened. If the deposit opens through the articular cartilage, and communicates directly with the joint, the infective material is distributed over the whole surface of the synovial membrane almost at the same time, and the first type of synovial disease rapidly develops, soon followed in most cases by the occurrence of caseous pus in the joint. In another set of cases the deposit reaches the surface at the point where the synovial membrane is reflected on to the bone, and is thus shut off, for a time at least, from the joint cavity. In this instance thickening of the synovial membrane occurs, usually of the third type, being most marked, especially at first, over the osseous deposit, but gradually extending and involving the whole of the synovial membrane. In a third set of cases, the deposit reaches the surface of the bone quite outside the synovial membrane, and then a chronic abscess usually forms over it, and the joint itself may never become affected.

The sequence of events when the osseous deposit bursts into the joint cavity, is well shown in Fig. 15. This is a complete longitudinal section through the lower end of the radius, the carpus and the proximal end of the second metacarpal bone. At the posterior part of the carpal end of the metacarpal bone (at the lower part of the figure), there is a caseous deposit (*a*) which has opened into the carpo-metacarpal articulation. In this articulation the cartilage is almost entirely destroyed, and the synovial membrane is thickened and villous ; the disease has spread to the articu-

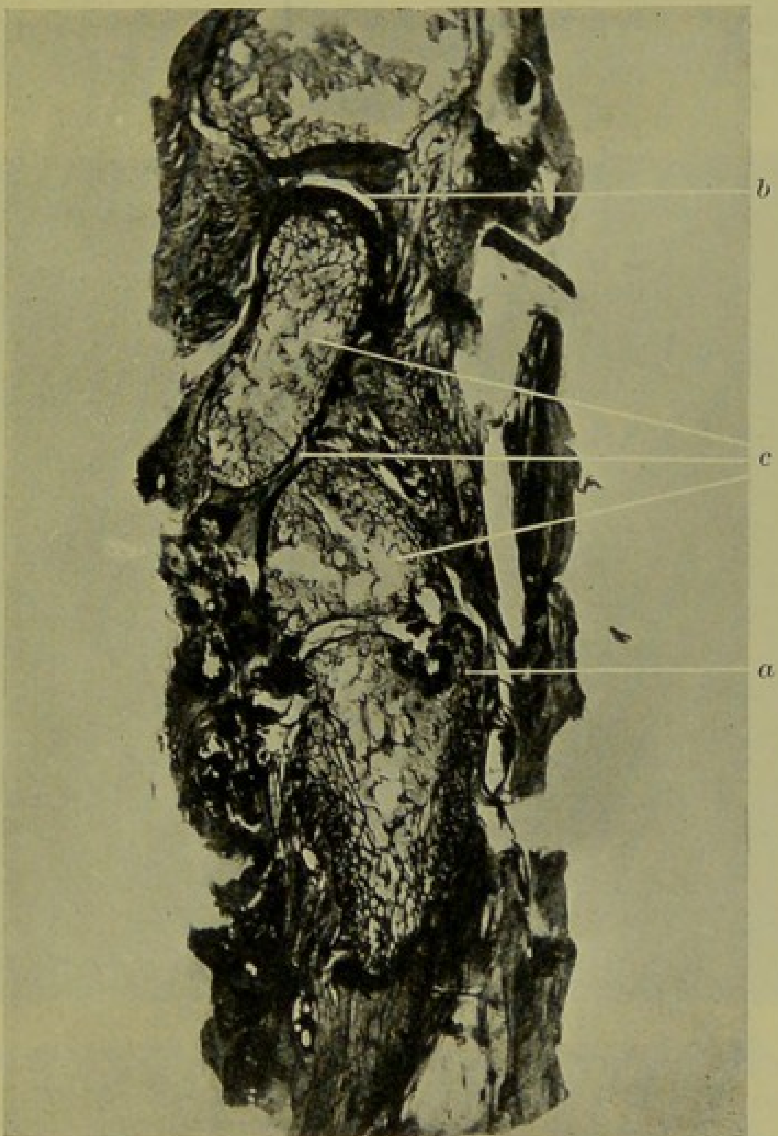


Fig. 15.—Longitudinal section of the wrist-joint from a case of tuberculous disease. At the lower part is the remains of a metacarpal bone, towards the dorsum (right hand side) of which a deposit (*a*) has formed in the bone, which has burst into the joint, and set up the disease. As we pass upwards we see two carpal bones and the radius. (See Text.)

lation between the two carpal bones (*c*), which is filled up with fibrous tissue containing tuberculous tissue, and here also the cartilage has been almost entirely destroyed. The radio-carpal articulation (*b*) is not nearly so much affected, but thickening of the synovial membrane is occurring, and this thickened tissue is creeping over the surface of the cartilage in the manner which I shall describe when I come to speak of the mode of destruction of cartilage. We also see sections of sinuses in the soft parts, with caseating walls, and leading to the joints.

3. Tuberculous Deposits, with Sclerosis of Bone and Necrosis

In marked contrast to the foregoing processes are those in which there is sclerosis of bone and formation of sequestra.

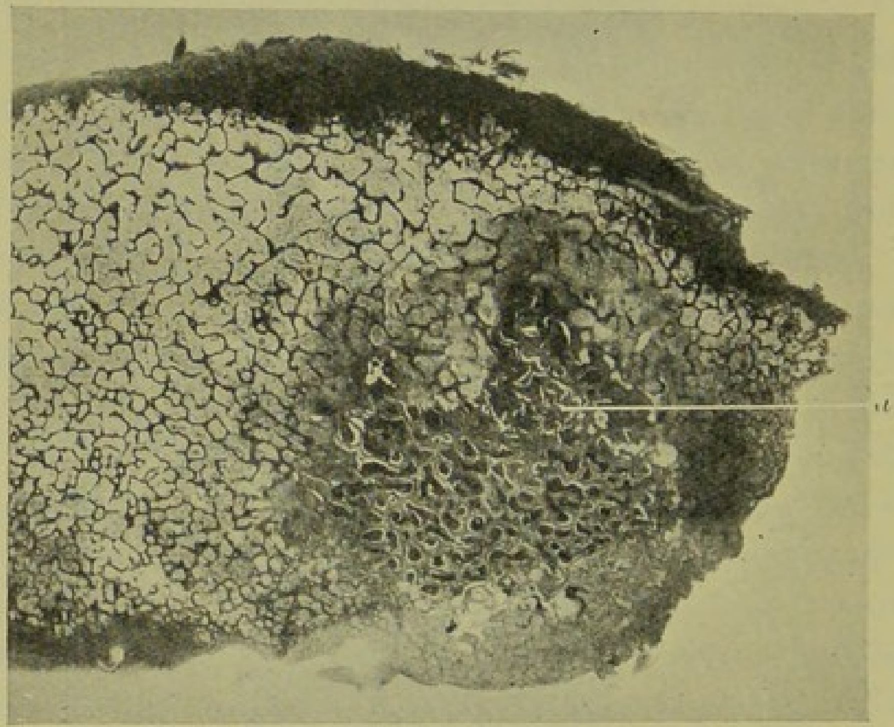


Fig. 16.—Section of patella, showing commencing sequestrum formation at the lower and right hand part (*a*). (See Text.)

This process is very common in tuberculous diseases of bone, varying much, however, in extent and result in different cases.

The early stage of the process is well seen in Fig. 16, which represents a section of the patella from a case of disease of the knee-joint in a female aged sixteen. There was much swelling of the knee, and an abscess on the outer side of the patella ; the disease had commenced spontaneously. The specimen is an excellent example of this form of tuberculous disease, and shows all the stages in the formation and separation of tuberculous sequestra. In the photograph the trabeculæ of the bone which elsewhere are black, come out light in the necrotic area. Bearing this in mind, we see that the trabeculæ in the necrotic area are very much thicker than in the healthy part, showing that a formative process has preceded the necrosis. Around the deposit rarefying osteitis is occurring, and the trabeculæ are becoming destroyed, though this destruction is only complete in a few places : the tissue at

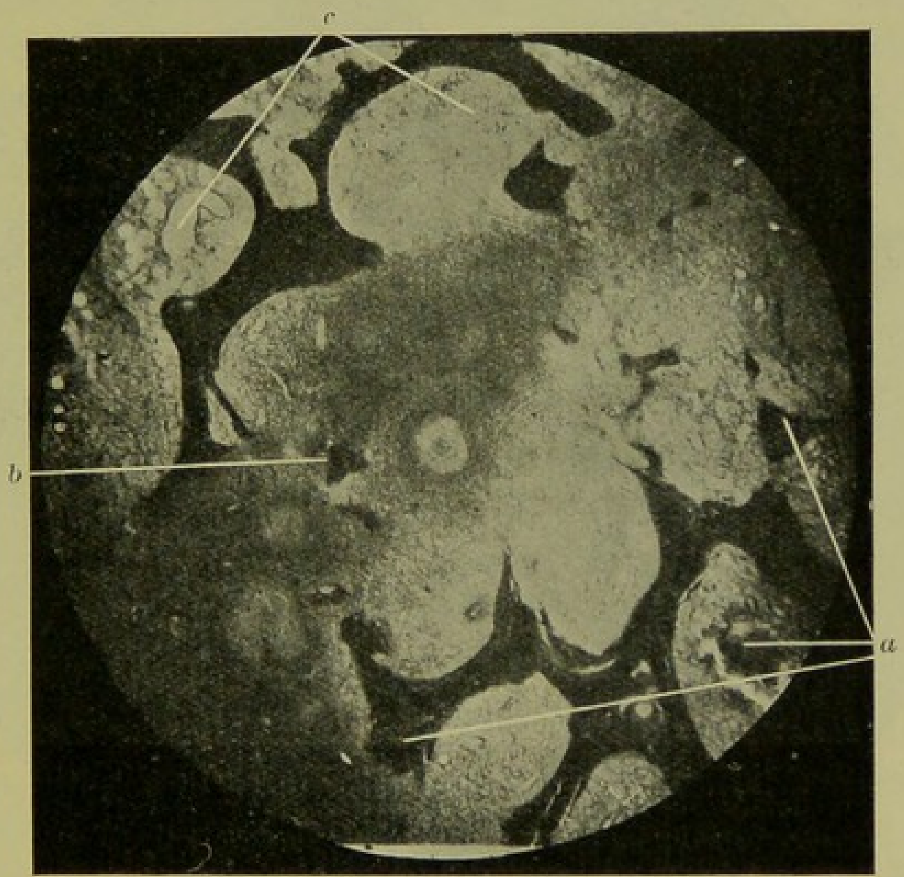


Fig. 17.—Section showing the line of separation of a tuberculous sequestrum (see Fig. 16). The destruction of the trabeculæ by granulation tissue and the formation of a tubercle in this tissue is well seen. (*a*) Sequestrum : (*b*) line of separation : (*c*) living tissue.

these parts contains numerous tubercles. In other parts at the margin, the cancelli contain vascular fibrous tissue, and the trabeculæ are becoming thickened. Nearer the centre tubercles appear in these cancelli, and the thickened trabeculæ are again becoming eroded, and at the centre the contents of the cancellous spaces are caseous material, and the erosion of the trabeculæ has come to a standstill.

Fig. 17 represents the line of separation, and shows the destruction of the trabeculæ and the presence of tubercles in the soft tissue between the dead and the living.

These sequestra vary in density very greatly, being in some cases only slightly denser or even less dense than normal cancellous bone, while in other cases the trabeculæ are

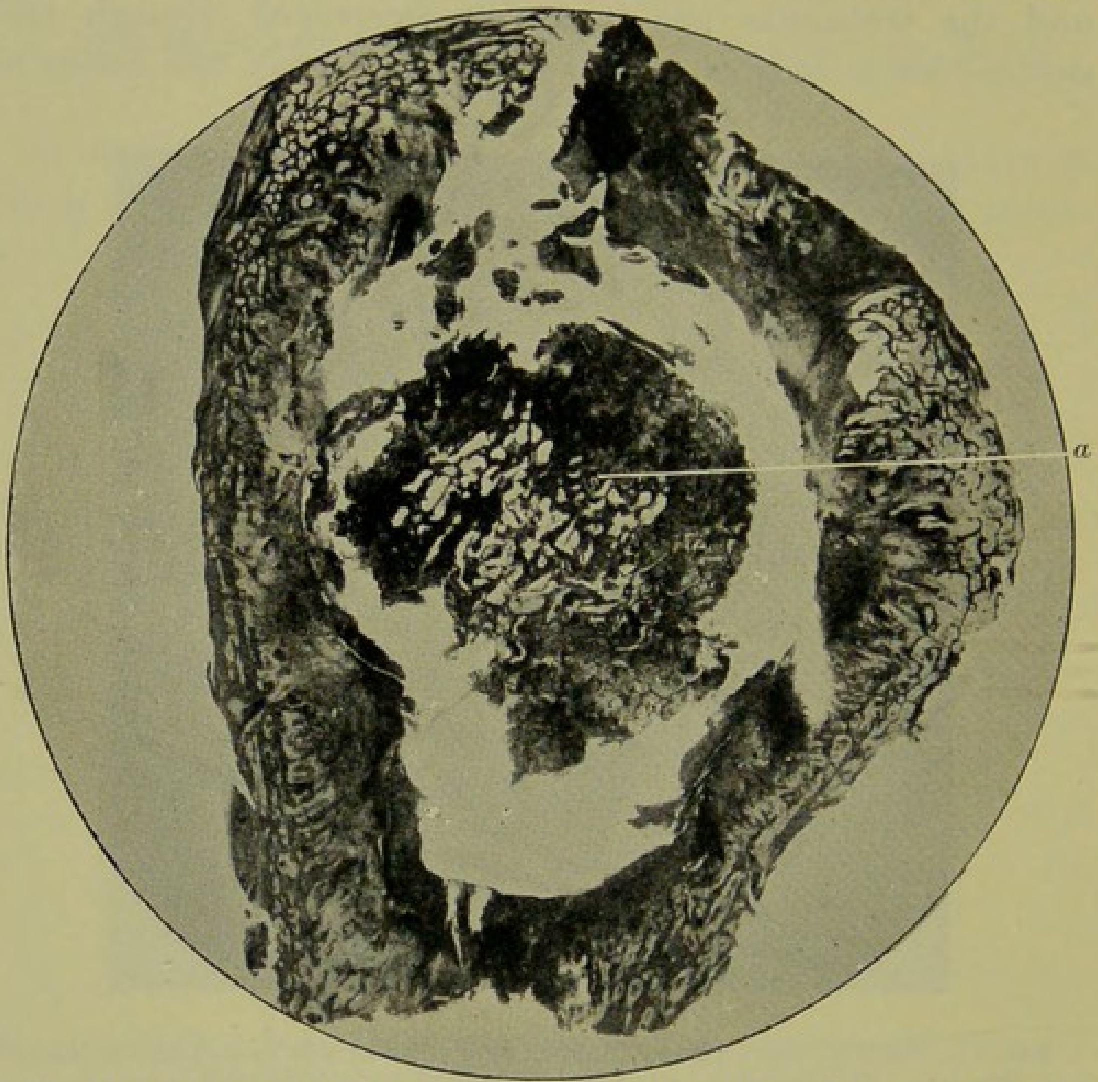


Fig. 18.—Section of head of humerus, showing a tuberculous sequestrum (*a*) completely separated but still *in situ* lying in a cavity in the bone, the wall of the cavity being composed of soft tissue. At the upper part the bone has in parts completely disappeared, and this soft tissue reaches the joint. (From a case excised by Sir William Fergusson many years ago.)

extremely thickened, and the mass resembles the outer shell of a bone rather than cancellous tissue. Further, the sequestrum does not always show the same density throughout. In the patella, from which the preceding figures have been taken, we have an example of the intermediate or what one may term the normal density and character of one of these sequestra (see also Fig. 18).

These tuberculous sequestra are usually larger than the soft tuberculous deposits, but they vary much in size and shape. They are generally quadrilateral or irregular in form, but they are sometimes wedge-shaped, the base of the wedge being directed towards the cavity of the joint (see Fig. 19). In the freshly cut bone they present a dense yellow appearance, and it is very characteristic of the sequestra that they are usually incompletely separated (see Fig. 20). In some cases, the articular cartilage over them is destroyed, and they project into the joint cavity, and, if the joint has still

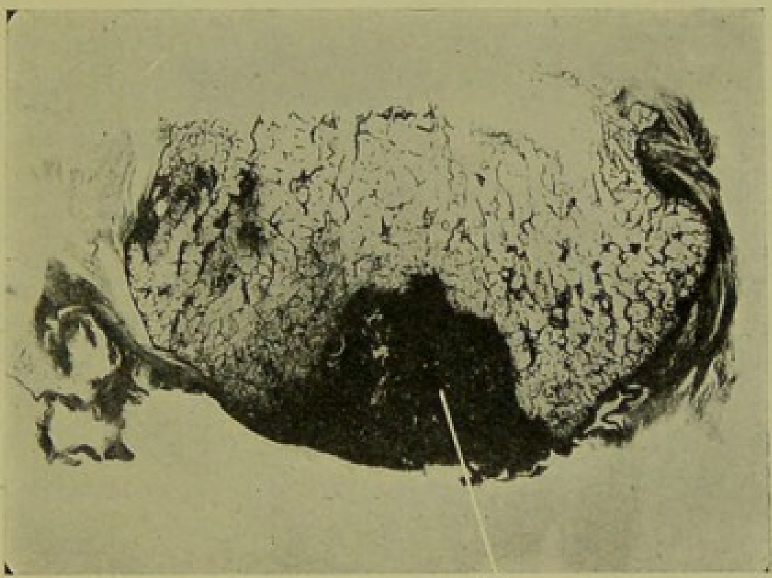


FIG. 19.—Section of one condyle of the femur showing a more or less wedge-shaped sequestrum (a) communicating with the knee-joint.

been used, the surface of the sequestrum may be eburnated. As I have previously said, they vary in density from that of the hardest bone to a friable consistence, but most commonly they are denser than the normal cancellous bone. In most joints they occur close to the articular ends of the bones, and frequently immediately under the cartilage ; in other cases, more especially in the upper end of the femur, they are found just beyond the epiphysial cartilage, or in the substance of the neck of the bone.

When we study these sequestra under the microscope, we find that they are usually composed of much thickened osseous trabeculæ, and also of trabeculæ of new formation. The density of the newly formed bone varies in different cases, and this variation apparently depends on the rapidity and extent of the process. The meshes of the osseous network in these sequestra are filled with fibrous or granulation tissue frequently containing tubercles, or more usually with caseous material; where the sequestrum is very dense the amount of soft material in the meshes of the bone is naturally very small. Frequently, however, even in very dense sequestra, many of the trabeculæ have been a good deal broken up in places by the tuberculous growth before casea-

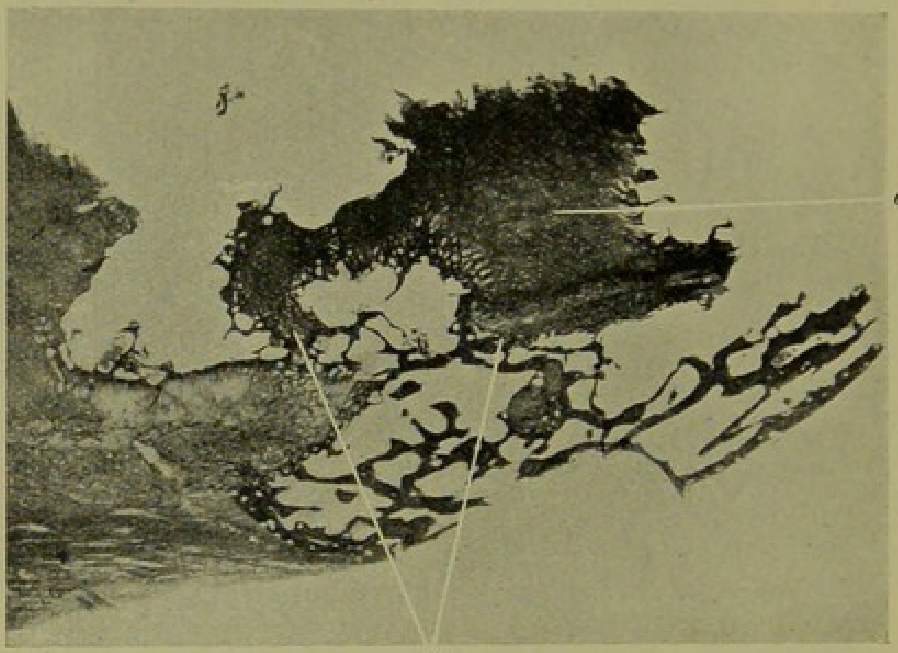


FIG. 20.—Section of the acetabulum showing an old sequestrum (*a*) in which the dead trabeculæ are still continuous with the living ones at (*b*) instead of having become completely separated.

tion is complete, and thus are in a crumbling condition; and usually, though many of the trabeculæ are much thickened, parts of the mass may break down readily under the finger. Surrounding the sequestrum we find a layer of soft and often fibrous tissue, generally containing tubercles or tuberculous infiltration, which is leading in parts to destruction of the trabeculæ connecting the dead and living parts.

The process of sequestrum formation in tuberculous disease is probably shortly the following:—As the result of the deposit of tubercles in a certain part of the bone, there is inflammatory reaction in the neighbourhood, and ultimately the formation of young vascular fibrous tissue in a considerable number of the cancelli of the bone. In these cancelli thickening and new formation of osseous trabeculæ go on, and this process continues to extend at the periphery. While this fibrous formation and sclerosis of the bone are going on, the tuberculous growth is also extending, and, accompanying it, there is reabsorption of the newly formed bone. Caseation of this tuberculous growth occurs, and then the absorption of the bone ceases, and thus we come to have a central patch of sclerosed bone with caseous material in the cancelli, surrounded by very vascular fibrous tissue and denser bone. By and by the process ceases to extend with the same rapidity, and then absorption of the trabeculæ around the tuberculous deposit, and ultimately complete detachment of the sequestrum may take place. The thickness of the osseous trabeculæ in the necrosed fragment depends on the rapidity with which caseation of the tuberculous deposit has occurred, and also on the course taken by that deposit. If caseation has only occurred slowly, there may be considerable thinning and breaking up of the previously sclerosed trabeculæ, while if it has occurred rapidly the thickness of the new bone is not much diminished. The tuberculous growth may not, however, invade the whole of the sclerosed bone, and where it does not extend the sclerosis goes on and very dense bone is formed, this bone being ultimately cut off from the surrounding parts, and composing part or even the whole of the sequestrum. In some cases the tuberculous growth follows a circular or triangular course around bone which has been invaded by it, bone which has become much sclerosed but not invaded, and bone which has not been much affected. We thus see that in the formation of these sequestra we have two processes going hand in hand, viz. growth of vascular fibrous tissue with sclerosis of bone, and growth of tuberculous tissue with rarefaction of bone; and the character of the sequestrum varies according to which of these processes is in excess, according to the rapidity with which the tuberculous tissue extends or caseates, and according to the course taken by the tuberculous growth. Formation of vascular fibrous tissue, with sclerosis of bone, is not uncommon in tuberculous diseases of bones, but this sclerosis may go on to a great extent without ending in death. What determines the formation of a sequestrum is the invasion or encircling of this sclerosed tissue by the tuberculous growth.

Various views have been put forward at different times as to the nature and origin of these sequestra. Some authors have supposed that they are composed mainly or entirely of fibrous tissue, while others have held that their density is due to the deposit of calcareous salts. Without doubt the caseous material in the cancelli in these sequestra is very apt to become infiltrated with calcareous salts, and when this is the case the weight and apparent density of the sequestra are much increased, but, as I have shown, this is not at all the essence of the process. As regards their origin the view which has been most generally accepted is that advocated by König, viz. that these sequestra arise as the result of embolism, and that the vessel being blocked by tuberculous material, the portion of bone supplied by it dies. König lays especial stress on the wedge shape and position of these sequestra as evidence of the accuracy of his opinion, and while he has not failed to observe that the osseous trabeculæ in the sequestra are thicker than in the surrounding bone, he concludes that this is only an apparent sclerosis due to rarefaction of the surrounding bone. There can, however, be no question that the portion of bone which has died has previously been the seat of active growth, a fact quite irreconcilable with the embolic theory, and we see similar evidences of active growth in the bone around the deposit. This being the case, it is quite clear that whatever influence the distribution of the vessels may exert on the direction of spread of the tuberculous tissue, and consequently on the shape of the sequestrum, the formation of the sequestrum is not the result of embolism.

I need not repeat what I have previously said in connexion with soft deposits as to the further progress of the disease when the tuberculous process reaches the surface of the bone.

The progress of events is practically the same in both cases. It does not, however, necessarily follow that once a soft deposit or a tuberculous sequestrum has been formed the disease will continue to progress. I have examined several cases in which disease has evidently come to a standstill, and the deposit has become encapsuled by dense fibrous tissue or bone, or has become infiltrated with calcareous salts ; in some cases, indeed, the tuberculous material has completely disappeared, and a mass of fibrous tissue has been found in its place (see Fig. 46).

CHAPTER IV

TUBERCULOUS CHANGES IN ARTICULAR CARTILAGE AND THE SURFACE OF BONE

The most common tuberculous affection of bone is tuberculous destruction or caries of the surface of the bone. The term caries was originally applied to all destructive or ulcerative changes of the surface of bone, but of late it has been restricted to those changes of the superficial layers of bone which occur in connexion with tuberculous disease, and restricted in this way the term is a very convenient one.

Caries of the articular ends of bones is never, so far as I have seen, the primary tuberculous affection ; it practically always occurs secondarily either to a deposit in the bone or to synovial disease. It is also a curious fact that even in the case of osseous deposits the growth of tubercles in the superficial cancelli of the bone in the neighbourhood of the deposit, and the destruction of the cartilage, only goes on to a comparatively slight extent, and in some cases not at all till the synovial membrane has become affected or the deposit has opened into the cavity of the joint, after which the disease progresses with great rapidity (see Fig. 21). We might have expected that in the case of a deposit immediately beneath the cartilage the tuberculous growth would have spread along under the cartilage and caused its exfoliation from within. This, however, is not the case, at any rate not to any marked extent ; the tuberculous growth seems to be more or less confined within the deposit in the first instance, and not till it has formed a communication with the joint or reached the soft tissues does it seem to be liberated and free to spread over the whole part. As I have already pointed out, when a tuberculous deposit in the bone reaches the articular surface, erosion of the cartilage occurs over it, a communication is formed with the joint, the synovial membrane becomes infected, and then the cartilage is attacked, and it is not as a rule till destruction of the cartilage has progressed to a considerable extent that the surface of the

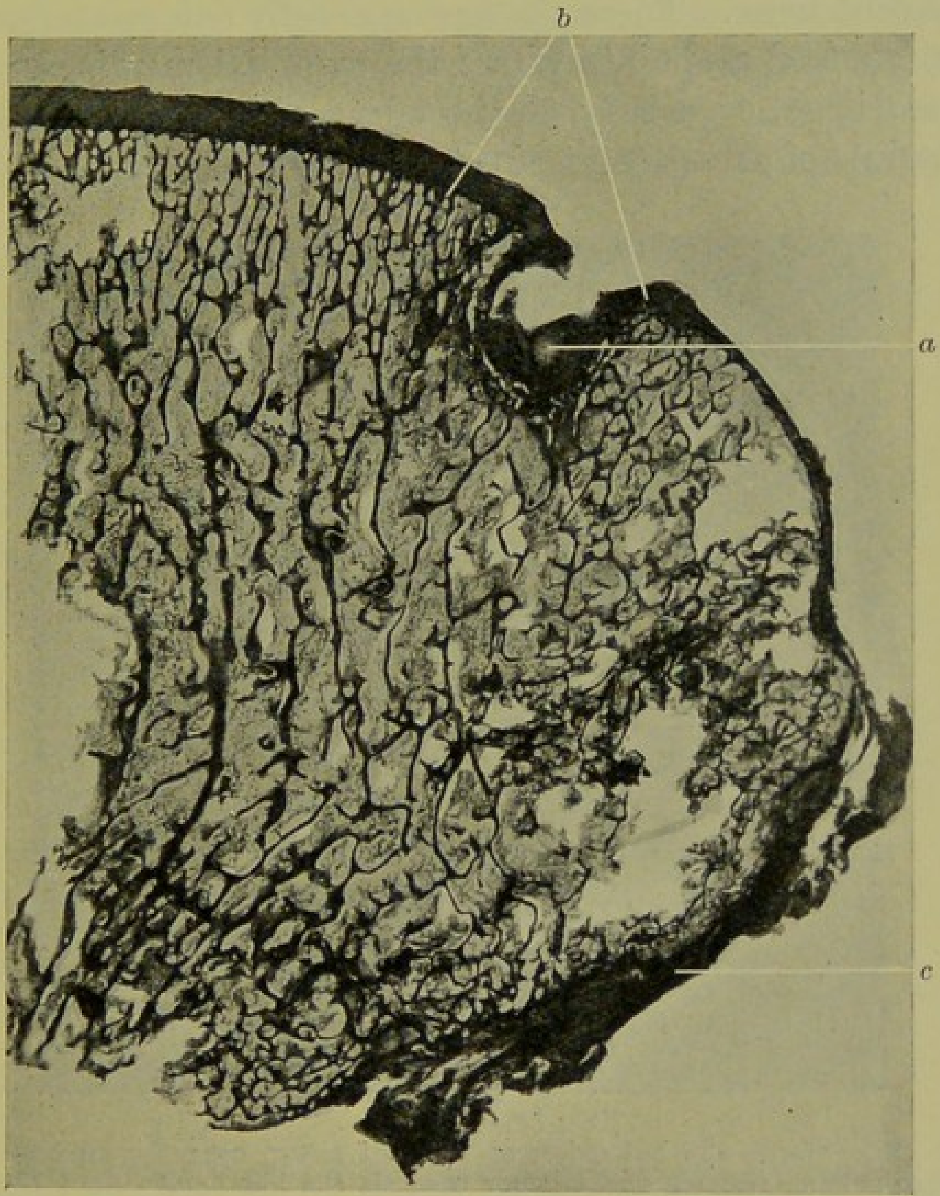


Fig. 21.—Deposit (*a*) beneath the cartilage over the inner condyle of the femur which has burst into the joint. Note that the articular cartilage (*b*) on each side is still fairly intact, and that the deposit has not spread beneath the cartilage. On the other hand, the hyaline cartilage at the side (*c*) near the reflection of the synovial membrane has been destroyed and converted into fibro-cartilage. (See also Fig. 29).

bone is affected. We must, therefore, study the changes which occur in connexion with the cartilage in the first instance.

The naked-eye appearances of the changes in cartilage are well known and consist chiefly in thinning, and complete disappearance of portions of the cartilage, its detachment in the form of thin shreds, often full of holes, or even of thicker masses; in fact in some cases cartilage which shows very little alteration may be partially loose and movable on the subjacent bone. These changes generally commence and are most marked at points where the synovial membrane joins the cartilage, especially at the edges of the cartilage, or at the points of attachment of the crucial ligaments in the knee,

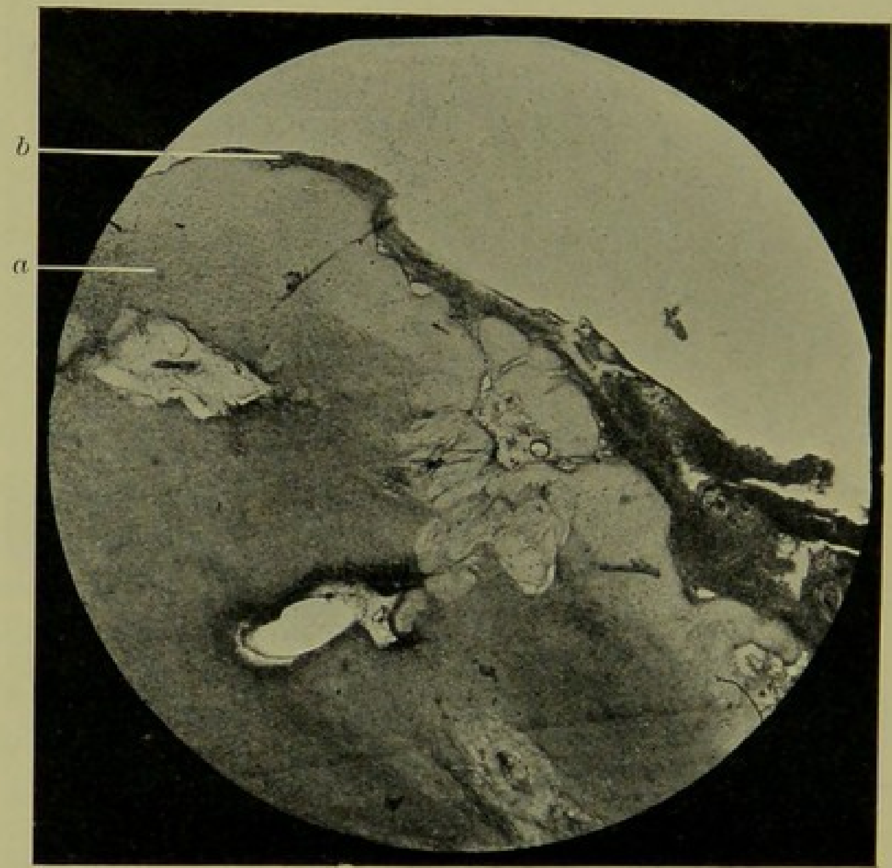


FIG. 22.—Shows the extension of the soft tissue over the surface of the cartilage getting thinner and thinner towards the left hand side, i. e. further from the point of reflection of the synovial membrane. (*a*) cartilage: (*b*) new tissue spreading over it.

in the neighbourhood of the ligamentum teres in the hip, &c. Its destruction may also begin around the point where the tuberculous osseous deposit has opened into the joint, and the thinning of the cartilage is also well marked at points of pressure.

As I have said the early changes in the cartilage are, as a rule, most marked at the points where the synovial membrane is reflected on to the cartilage, and we not unfrequently find that the cartilage is but slightly or not at all affected except at the margins where the soft tissue, continuous with the synovial membrane, is spreading over and destroying it from the surface. This was well seen in the section through the wrist-joint (Fig. 15, p. 39), where the synovial membrane was spreading over the cartilage of the radius and destroying it first at the margins. The first change which occurs is

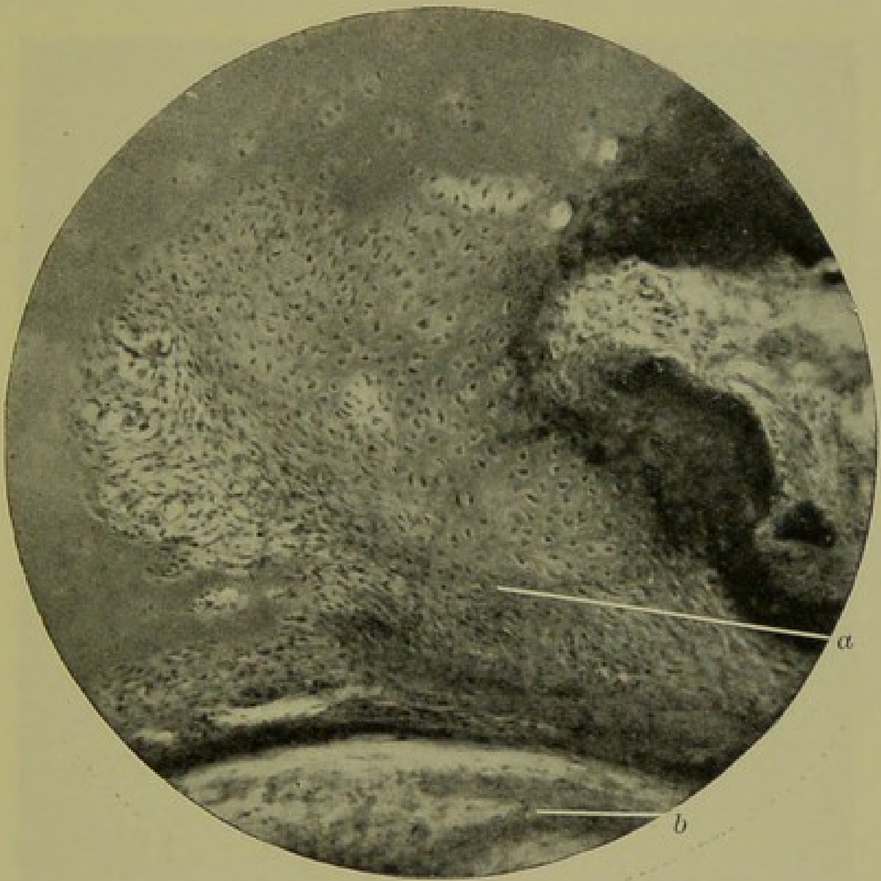


FIG. 23. The deeper part of the hyaline cartilage (*a*) beneath the spreading tuberculous tissue (*b*) showing the enlargement of the cartilage capsules and the changes into fibro-cartilage.

apparently the spread of vascular tissue over the surface of the cartilage, this tissue becoming thinner and thinner as we pass away from the edge. This is seen in Fig. 22, which is a photograph from the margin of the articular cartilage of the head of the femur, showing commencing destruction of cartilage from the surface. Underneath this new tissue the cartilage capsules enlarge, the cells multiply, and ultimately the capsules come to communicate with the surrounding soft tissue (see Fig. 23).

At the same time the intercapsular or intercellular material apparently becomes split up into fibres which are in many cases continuous with the fibres of the connective tissue on the surface, and the nuclei of the cartilage cells become elongated or spindle-shaped, and apparently form some at least of the nuclei of the fibrous tissue. This tissue which, in the first instance, may show no evidence of the presence

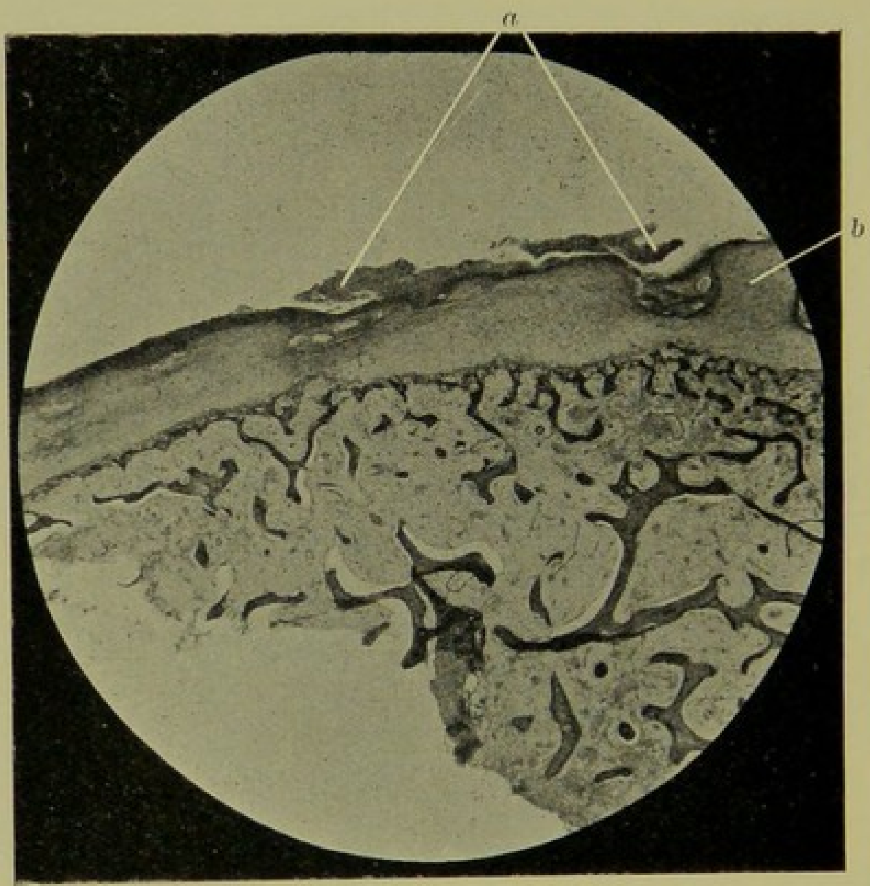


Fig. 24.—Shows the articular cartilage undergoing destruction from the surface, islets of soft tissue (*a*) being formed giving rise to the pitted and sieve-like appearance so often present. (*b*) Articular cartilage undergoing change into fibro-cartilage.

of tubercle, soon presents, in most cases, the character of a tuberculous infiltration, or well-developed tubercles are formed in it.

The process then which takes place at the margin of the cartilage is the extension of the tuberculous tissue in a thin layer over it, followed by changes in the cartilage itself, which lead to its conversion into fibro-cartilage and ultimately into fibrous tissue; the new tissue so formed becomes subsequently infiltrated with the tuberculous growth and undergoes caseation.

If now we study the changes which occur in the cartilage at a greater distance from the edge of the synovial membrane, we find that this extension of the soft tissue goes on for a considerable distance, but, as a whole, in quite a thin layer, while here and there greater growth has occurred, and the previously mentioned changes in the cartilage are taking place, and thus we come to have islets of soft material over

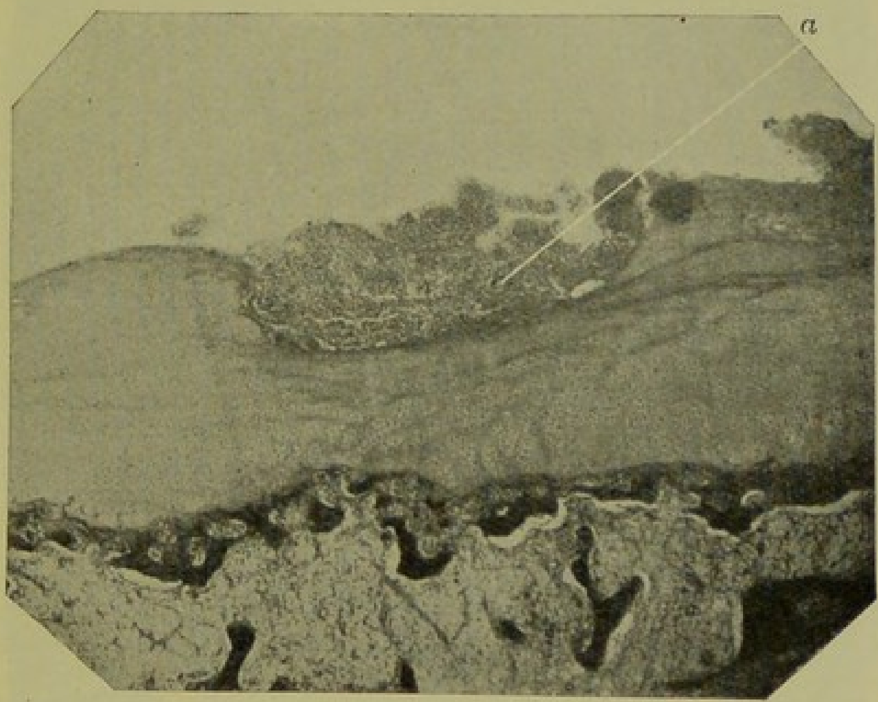


FIG. 25.—One of these islets from the same specimen as Fig. 24 more highly magnified. A giant cell (a) is seen in the granulation tissue lying in the depression.

the surface of the cartilage, separated by patches of but slightly altered cartilage and connected by a thin layer of soft tissue on the surface of the cartilage. This condition is well seen in Fig. 24, where a number of these depressions are present, and in Fig. 25 where one of these islets is more highly magnified. In this way the pitted or completely perforated appearance of the articular cartilage is produced (see Fig. 26).

The chief destruction of the cartilage occurs from the surface in the manner just described, but we not unfrequently also observe somewhat similar changes in the deeper part

(Fig. 27) especially at the margins. In some cases also, osteitis without formation of tubercle occurs in the superficial cancelli of the bone, and a certain, though slight, amount of soft tissue is formed between the bone and the cartilage, and this is what occurs in those cases where the cartilage can be moved over the surface of the bone.

As a rule, when the deeper part is affected one of two things happens, viz. either from the margin of the cartilage

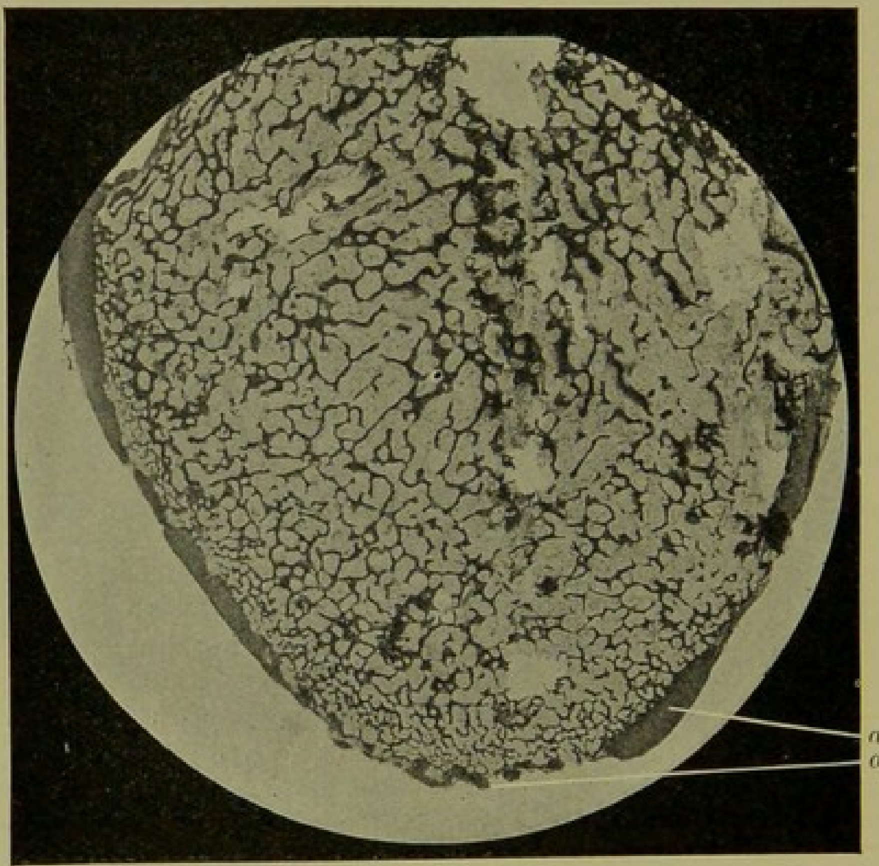


Fig. 26.—Vertical section of the external condyle of the humerus showing the pitted condition of the articular cartilage, bits of cartilage being still adherent to the bone.

or from the bottom of one of the excavations on the surface, the newly formed tissue spreads in between the cartilage and the bone, destroying the deeper part of the cartilage, detaching it, and leading to exfoliation of pieces of as yet unaltered or partially eroded cartilage (see Fig. 27); or tubercles form in the superficial cancelli, destroy the superficial layer of the bone, and lead to erosion of the deeper part of the cartilage. This erosion of the cartilage from the deep surface is, however, usually only seen at the edges of the cartilage, and is neither so common nor so extensive as the destruction from the surface, and it is by no means uncommon to find the greater part of the surface of the cartilage converted into fibrous tissue and portions of unaltered cartilage still firmly adherent to the bone.

This description differs from that generally received in that it assigns the chief changes to the surface of the cartilage; most writers state that the destruction of the cartilage com-

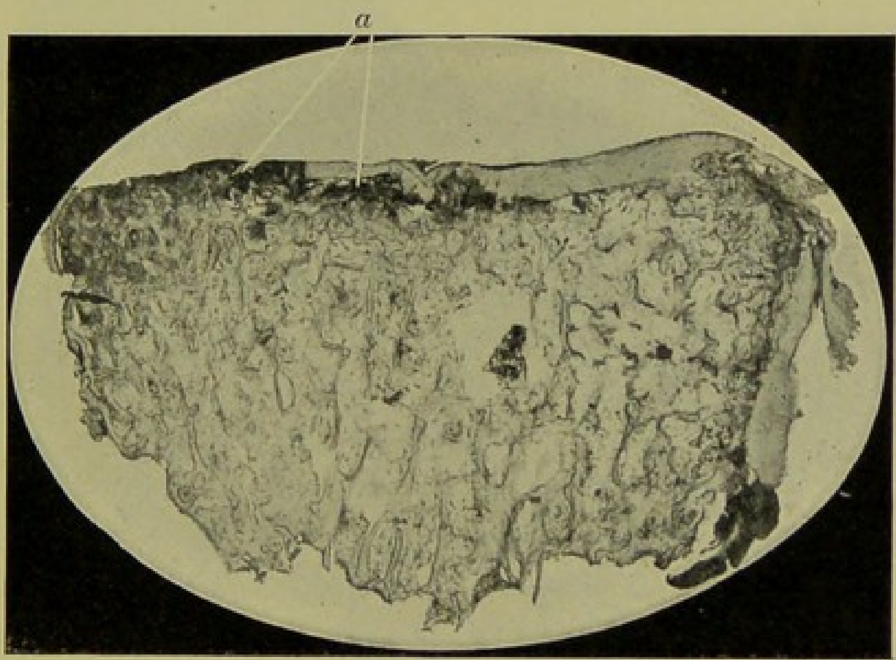


Fig. 27.—Section of the head of the radius showing at (*a*) the spread of the tuberculous tissue underneath the cartilage and the consequent destruction of the cartilage. As a rule this is only seen at the edge of the cartilage, at the point of reflection of the synovial membrane.

mences next the bone, but this is clearly not the case, or else the specimens I have prepared have for the most part been taken from exceptional cases. That is, of course, absurd, and as a matter of fact, one of these complete sections is equal to a great many small ones. No doubt the error has arisen from the examination of the edge of the cartilage, where the process is most marked, and where we frequently see the spread of the soft tissue between the cartilage and the bone ; but when we examine the *whole* cartilage, we see that this deep destruction is very slight as compared with the processes that are taking place at the surface.

Another mode of destruction of cartilage is seen in Fig. 28, which is a portion of a vertical section of the internal condyle of the femur from a case of disease of the knee-joint of six months' duration, in which the disease was primarily synovial, and in which there was great thickening of the synovial membrane. The cartilage was intact, except at the margins, and at one spot towards the centre and anterior

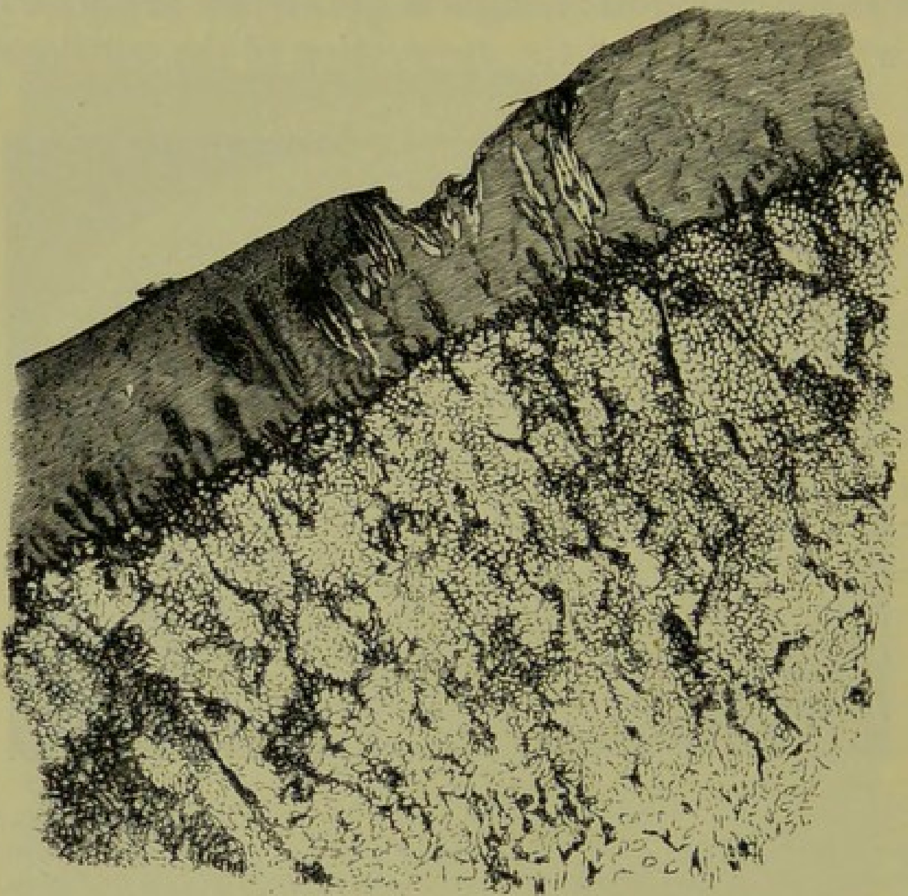


Fig. 28.—Destruction of articular cartilage from the deeper surface, flask-shaped processes containing fibrous tissue shooting into it from the cancellous spaces beneath.

surface of the internal condyle of the femur, where there was a small depression on the surface. The photograph is taken from a vertical section of the end of the bone through this spot. We see that the depression in the cartilage is due to destruction of the cartilage at this point, and before the celloidin was dissolved out one or two small detached fragments of cartilage were seen at the surface, but these have been lost in clearing the specimen. We further see a number of flask-shaped spaces in the cartilage which, under a higher power, are found to be filled with young fibrous tissue. Some of these spaces communicate with the surface of the cartilage, either freely or by narrow channels, while the majority, and perhaps all, are connected with the superficial cancelli of the bone by similar channels. At various other points along the deeper part of the cartilage we see similar flask-like projections communicating with the bone, and where these occur the most superficial cancelli show osteitis. I have not been able to find any tubercles in the bone. In this instance we have undoubtedly destruction of the cartilage commencing from the deeper part in a manner totally different from that which I have previously described as the usual mode, and I have seen indications of a similar process in other specimens, though never to the same extent.

Before leaving the subject of the changes in cartilage, I may refer to the important question whether cartilage can be the primary seat of the disease. As regards hyaline or articular cartilage this may certainly be answered in the negative, but it is still an open question with regard to fibro-cartilage. In the case of the spine it was long thought, and is, I believe, still held by some, that the changes frequently commence in the intervertebral cartilages, but this is clearly not the case. In the knee-joint, however, Kocher has described, under the term ‘ meniscitis fungosa ’, what he believes to be primary tuberculous disease of the semilunar cartilages, but there is no evidence that the disease did not begin in the synovial membrane in the neighbourhood of the cartilage, and spread on to it.

Following the destruction of the cartilages, and in some cases beginning to a slight extent before the cartilages have disappeared we have the carious changes in bone. Roughly speaking, we may say that clinically the articular ends of bones are carious when the cartilages are destroyed, but examination of a number of specimens where the articular cartilages have disappeared, shows that the resulting state of matters varies much, and if we were to limit the term ‘ caries ’ to tuberculous disease of the surface of the bone itself, we should exclude many cases which are clinically reckoned as caries. It will be best, therefore, to study in one group the various conditions which we find when the articular cartilage has disappeared.

In some cases we find that the cartilages are absent, and that their place has been taken by fibrous tissue, but it is seldom that the whole surface is covered simply with fibrous tissue; usually there are tubercles or tuberculous tissue at some part, either at the free surface or in patches in the tissue. We may, however, find extensive tracts of fibrous tissue without any tubercles in it, or in the superficial cancelli of the bone. This is probably an early stage, found only shortly after the destruction of the cartilage, for it is seldom that the process ceases at this stage, or that the new tissue does not become the seat of the development of tubercles, if, indeed, it has not been tuberculous from the first.

In other cases the material which replaces the cartilage is not fibrous, but is composed of young tissue in places undergoing caseation, and this caseation may be of considerable extent, although as yet the superficial shell of bone has not been broken through, and there is no true caries. The following are some of the common appearances met with in true tuberculous caries.

By far the most common type in my experience is that seen in the section of the head of the tibia, shown in Fig. 29. On the right hand side of the surface of the bone (*c*) we see that the superficial cancelli are infiltrated to a depth of about one-quarter of an inch with dense tissue, which, on examination under a higher power, is found to be composed of tubercles and tuberculous infiltration, undergoing caseation at the edge. Lying among this tuberculous tissue we see the trabeculæ of the bone, which are considerably thicker than elsewhere, and have in parts become completely detached, and lie loose in the cheesy material. At some little distance from the tuberculous layer the bone is in a condition of rarefying osteitis (*e*), but immediately beneath it the cancelli contain young fibrous tissue, and it is here that the thickening of the trabeculæ is occurring. The process here is condensation of the superficial trabeculæ, invasion with tuberculous tissue, lacunar absorption and death of the thickened trabeculæ, and rarefying osteitis beyond. It is curious that in most cases this rarefying osteitis occurs at a considerable distance from the surface, and often in patches, while between these patches and the carious surface there may be an interval of comparatively healthy tissue.

Fig. 29.—Section of head of tibia with a soft deposit under the cartilage. To the right of the upper surface the cartilage has disappeared, and the surface of the bone is carious. (See Text). (*a*) Remains of articular cartilage: (*b*) point where the tuberculous osseous deposit perforated the cartilage; (*c*) carious surface of the bone; (*d*) tuberculous osseous deposit; (*e*) bone undergoing rarefying osteitis.

This specimen also bears out very well what I have said about destruction of cartilage in the neighbourhood of tuberculous deposits. I have pointed out that although we might have expected that, in the neighbourhood of tuberculous deposits in the bone, tubercles would readily form in the superficial cancelli of the bone, and destroy the cartilage from beneath, this was not, as a rule, the case. And here we see that the only piece of cartilage left, and the only part of the surface of the bone which has not yet undergone the carious change, is in the immediate neighbourhood of the primary osseous deposit. (See also Fig. 30.)

In other cases, the sclerosis and new formation of bone preceding the tuberculous growth in cases of caries is very well marked, as, for example, in Fig. 31, taken from the internal condyle of the femur. Here we see that there has been extensive destruction of the surface of the bone, which

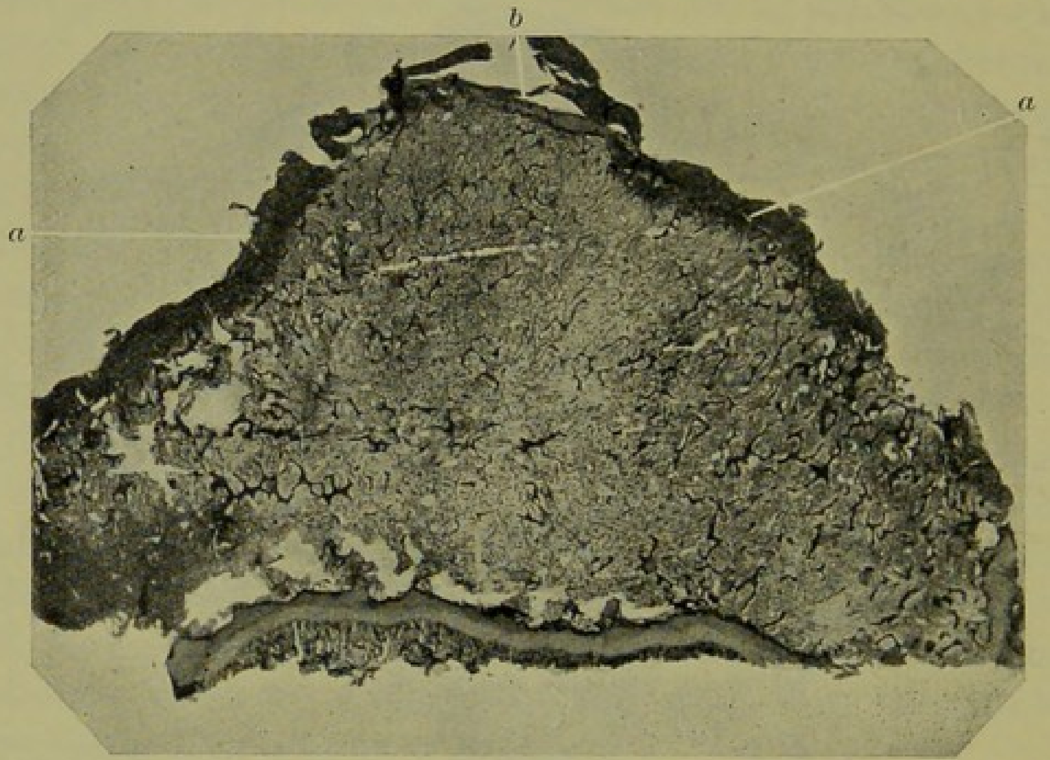


Fig. 30.—Another specimen showing destruction of the cartilage and caries of the bone (*a*, *a*). Section of the internal condyle of the femur from a case of primary synovial disease. Here also the destruction has proceeded from the point of reflexion of the synovial membrane, and the only piece of cartilage left (*b*) is at the centre, the furthest point from the edge of the cartilage.

has been replaced by tuberculous tissue undergoing caseation at the edge. Beneath this layer of soft tissue there is a line of newly formed bone, presenting a reticular appearance, the meshes of which contain young fibrous tissue, not yet invaded by the tuberculous growth.

This sclerosis of bone in connexion with caries sometimes goes on to a very marked extent, but, as a rule, such density of the bone beneath the carious surface is not common in joints except in that form of the disease which is termed caries sicca. It is very rare, however, to find no evidence at all of sclerosis of the affected bone.

The following is, in a few words, what happens in the course of tuberculous disease of the surface of bone. The first changes occur in connexion with the cartilage, though in some cases, but more rarely, the superficial cancelli of the bone first show signs of osteitis, and still more rarely the presence of tubercles. The cartilage disappears in one of the modes formerly described, by far most commonly by

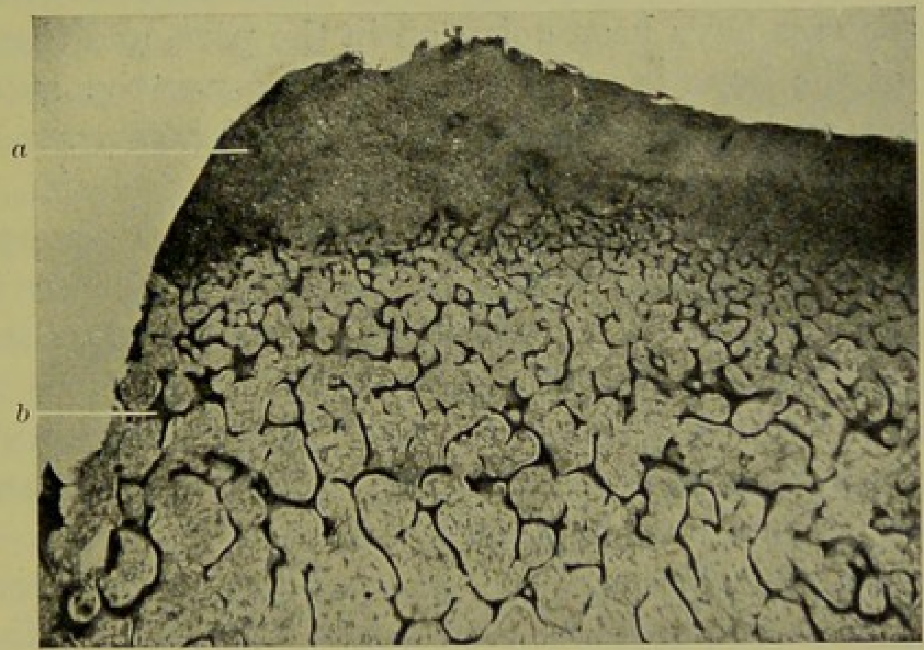


Fig. 31.—Section of the lower end of the femur, showing caries. The cartilage has disappeared, and a quantity of soft tissue containing tubercles is present. Beneath this a network of new bone has been formed. (*a*) Soft tuberculous tissue on the surface; (*b*) thickened trabeculæ.

the spread of granulation tissue over the surface, and then we find the surface of the bone covered with young fibrous tissue containing tubercles, or with very vascular tissue containing tubercles, or with plain fibrous tissue. The tuberculous growth soon extends into the superficial cancelli, and young fibrous tissue is formed beyond it, and sclerosis of the trabeculæ occurs. As the tuberculous invasion extends, portions of these osseous trabeculæ become detached, and caseation takes place. Beneath the tuberculous invasion there is usually a line of condensing osteitis of varying breadth, while further away there may or may not be rarefying osteitis, often in patches. The amount of condensation underneath the carious part varies much in extent and character, the bone being, in rare cases, very dense, and in others not noticeably sclerosed. The sclerosis of the trabeculæ in the carious part varies also in amount, and may even be entirely absent. By the continued extension of these processes, the gradual destruction of the surface of the bone goes on, being naturally most marked at points subject to pressure. The presence of this thickening of the trabeculæ, previous to the tuberculous invasion, shows that active formative processes have been going on in the part, and that the death of the bone is not primarily a degenerative process, as various authors, such as Cornil and Ranvier, have asserted, but usually follows a previous stage of hyperplasia. The detachment of the fragments occurs by lacunar absorption of portions of the trabeculæ, and the reason why these fragments are frequently not absorbed is that, in these cases, caseation occurs too rapidly. Where caseation occurs more slowly, more or less complete absorption may take place, and we may find on the surface a layer of completely caseous material, without any fragments of bone.

Of great clinical importance are the following facts, viz. :—the slight depth to which the actual tuberculous disease extends, seldom more than a quarter of an inch, the tendency to sclerosis immediately beneath it, and the occurrence of rarefying osteitis at some distance away, and often in patches without any tuberculous growth. It is very curious to note, in many cases, that a layer of comparatively normal cancelli separates the carious part from that where the rarefying osteitis is most marked, but of this fact I am unable to offer any rational explanation at present.

CHAPTER V

TUBERCULOUS PERIOSTITIS AND TUBERCULOUS OSTEOMYELITIS

So far I have been speaking of disease of the synovial membrane and the articular ends of bones ; but I must now shortly describe the course of events when the disease attacks bones at a distance from the articular surfaces, and I shall especially refer to disease of the short long bones, and also of the spongy bones. In this instance the disease may either begin on the surface of the bone in connexion with the periosteum, or in the medulla of the bone—that is to say, we may either have a tuberculous periostitis or a tuberculous osteomyelitis.

Tuberculous periostitis as a primary affection occurs most frequently in the ribs and the vertebræ. In the case of the ribs tuberculous disease may commence either in the interior of the bone or in the periosteum, in the latter most commonly. Where tuberculous periostitis affects a rib, the bone at the seat of the disease soon becomes thinner than usual, and presents a worm-eaten appearance. This superficial erosion of the bone steadily progresses till a more or less marked defect in the bone is formed ; indeed, such a bone not uncommonly fractures. (See Fig. 32.) This appearance is due to the fact that the tuberculous new growth, occurring first in the deeper layers of the periosteum, soon spreads into the bone along the Haversian canals, fills up the superficial cancellous spaces, and causes erosion of the bone on the surface and also destruction beneath the surface, while sclerosis occurs in the neighbourhood. The disease spreads along the periosteum, and may involve a considerable extent of the bone, eating into it irregularly at various points.

Perhaps the most common seat of tuberculous periostitis is the vertebræ. Tuberculous disease of the vertebræ commences either in the substance of the bone as a circumscribed tuberculous deposit or a more diffuse tuberculous osteomyelitis, or on the surface as a tuberculous periostitis. The latter is the most common form in adults; it involves a number of bones, curvature is at first absent, and is seldom acute, and chronic abscess very frequently occurs. The character of the disease in this case is the same as that described under caries, and there is the same sclerosis of

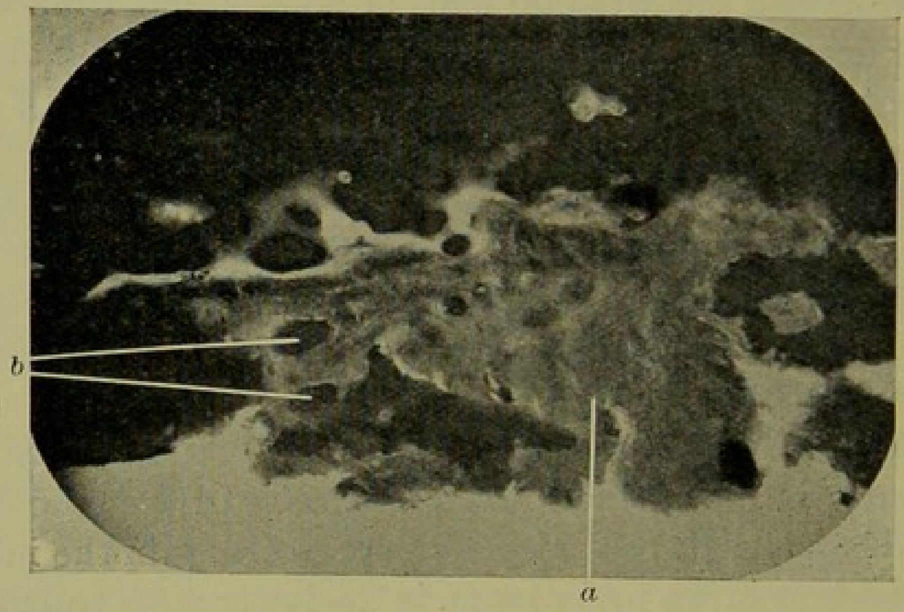


FIG. 32.—Tuberculous periostitis of a rib. At the upper part is the solid bone, at the lower part the soft tuberculous tissue (*a*) is seen eating into the bone and mixed up with the soft tissue there are little necrosed pieces of bone (*b*).

bone beneath. In Fig. 33 the carious condition of the surface, the result of the tuberculous periostitis, and the sclerosis of the bone beneath, are well seen.

In the case of the short long bones, such as the phalanges, with their metacarpal and metatarsal bones, the tuberculous disease generally commences in the interior of the bone in the form of tuberculous osteomyelitis, and it may either cause a general enlargement of the bone, with or without necrosis in the interior, or a more limited and more marked expansion of the bone, the condition typical of strumous dactylitis. The former is more often the case in adults, the latter in children.

The disease in both cases commences in the medulla of the bones, and is very correctly described as a tuberculous osteomyelitis. In some cases it is accompanied by sclerosis and new formation of bone, going on to the production of a sequestrum, but the sequestra in these cases are seldom so entirely dense as those in the ends of the long bones; more

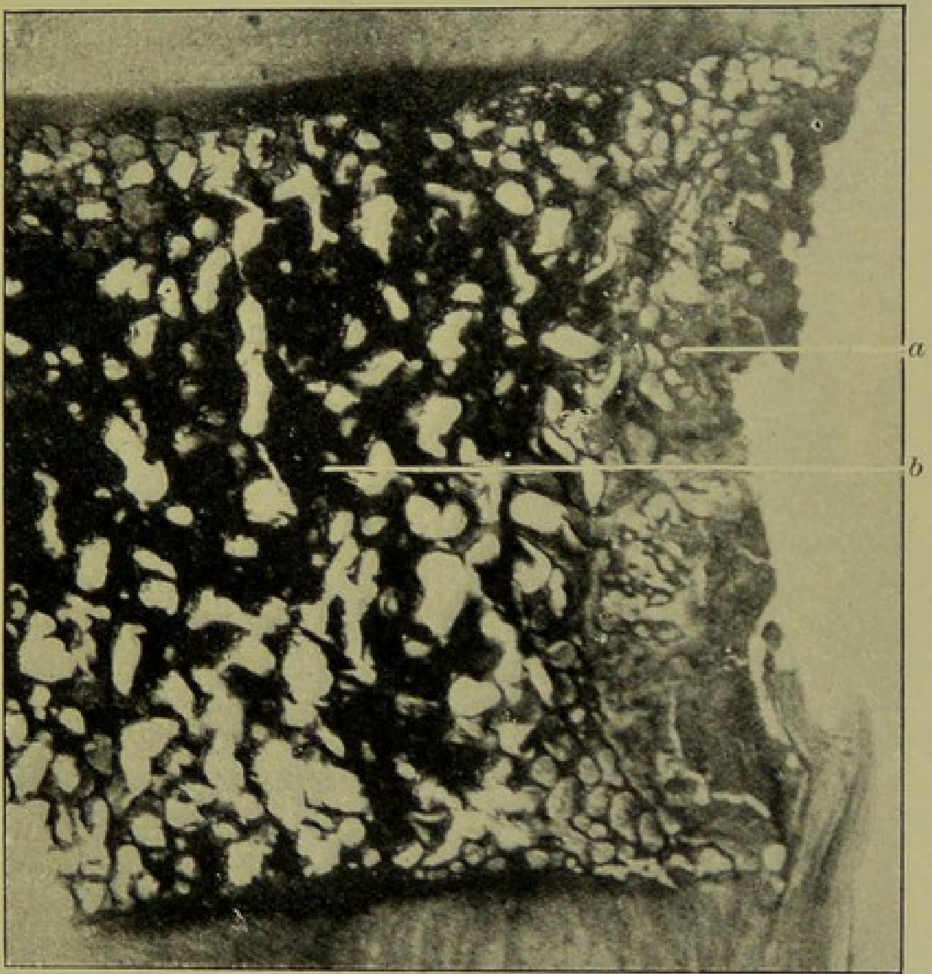


FIG. 33.—Section of the body of a vertebra, showing caries of the surface (right hand side), resulting from a tuberculous periostitis and great sclerosis of the bone beneath. (*a*) Carious surface; (*b*) sclerosis of bone beneath.

usually they have undergone a good deal of absorption, being thus in parts dense and in parts soft.

More often, however, tuberculous osteomyelitis results in the formation of an extensive soft mass in the interior of the bone, which is, nevertheless, not so well circumscribed as the soft deposits in the ends of the long bones which I have previously described, and we frequently find in these cases that the tuberculous growth spreads for a considerable distance along the medulla of the bone, leading to great sclerosis, and sometimes necrosis of the shaft outside. This infiltrating tuberculous growth also occurs in the bodies of the vertebræ, and in the smaller spongy bones, especially in those of the tarsus, but not so often as the circumscribed deposits, while it is rare in the epiphyses of the long bones.

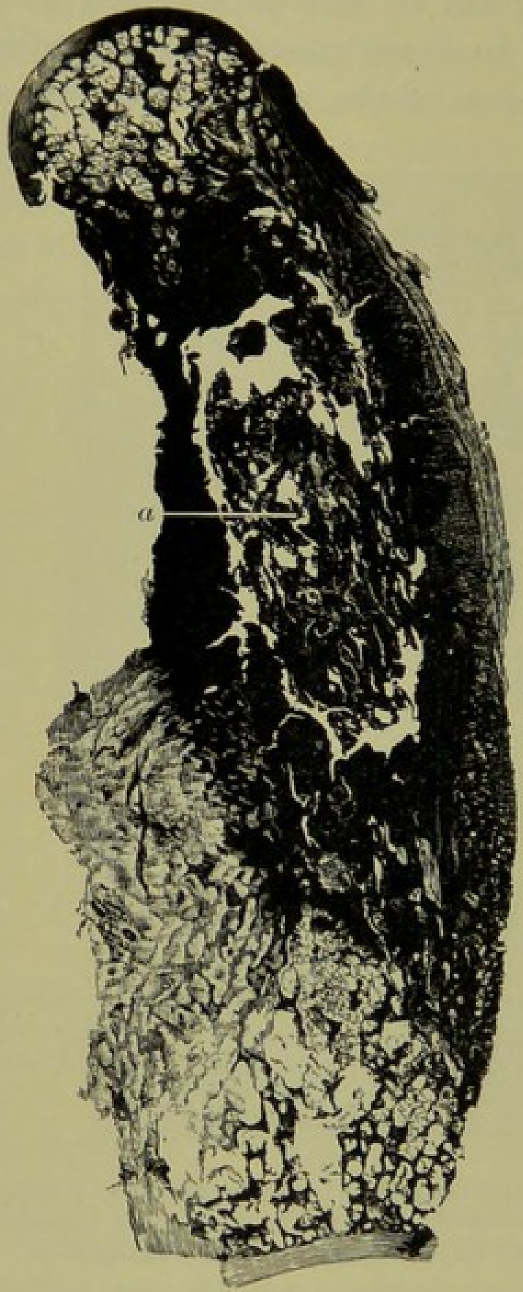


Fig. 34.—Section of a phalanx showing a tuberculous sequestrum (*a*) in the substance of the bone. (See Text.)

Fig. 34 is an excellent example of tuberculous osteomyelitis, with sequestrum formation. It is a complete section through the first phalanx of a finger of a lady, aged 28, who was also suffering from phthisis. There was a sinus on the inner side of the finger leading to the front of the bone. On examining the specimen we see marked enlargement, more especially of the middle of the bone, in the interior of which is a cavity containing cheesy material and a sequestrum. This sequestrum is in parts much thickened, and in other parts partially absorbed, the spaces being filled with caseating material. Surrounding the caseating wall of the cavity is a layer of tissue containing tuberculous tissue either in the form of isolated tubercles or of tuberculous infiltration. Beyond this we have a layer of much thickened trabeculæ, which are becoming eroded on the side towards the cavity by the tuberculous growth. At the proximal end the bony tissue is fairly normal. Towards the distal end of the phalanx there are one or two tubercles in the cancelli, and in some of the sections the tuberculous growth is beginning to creep over the cartilage at the anterior part. This cavity in the bone communicates freely with the surface anteriorly, the bone being entirely

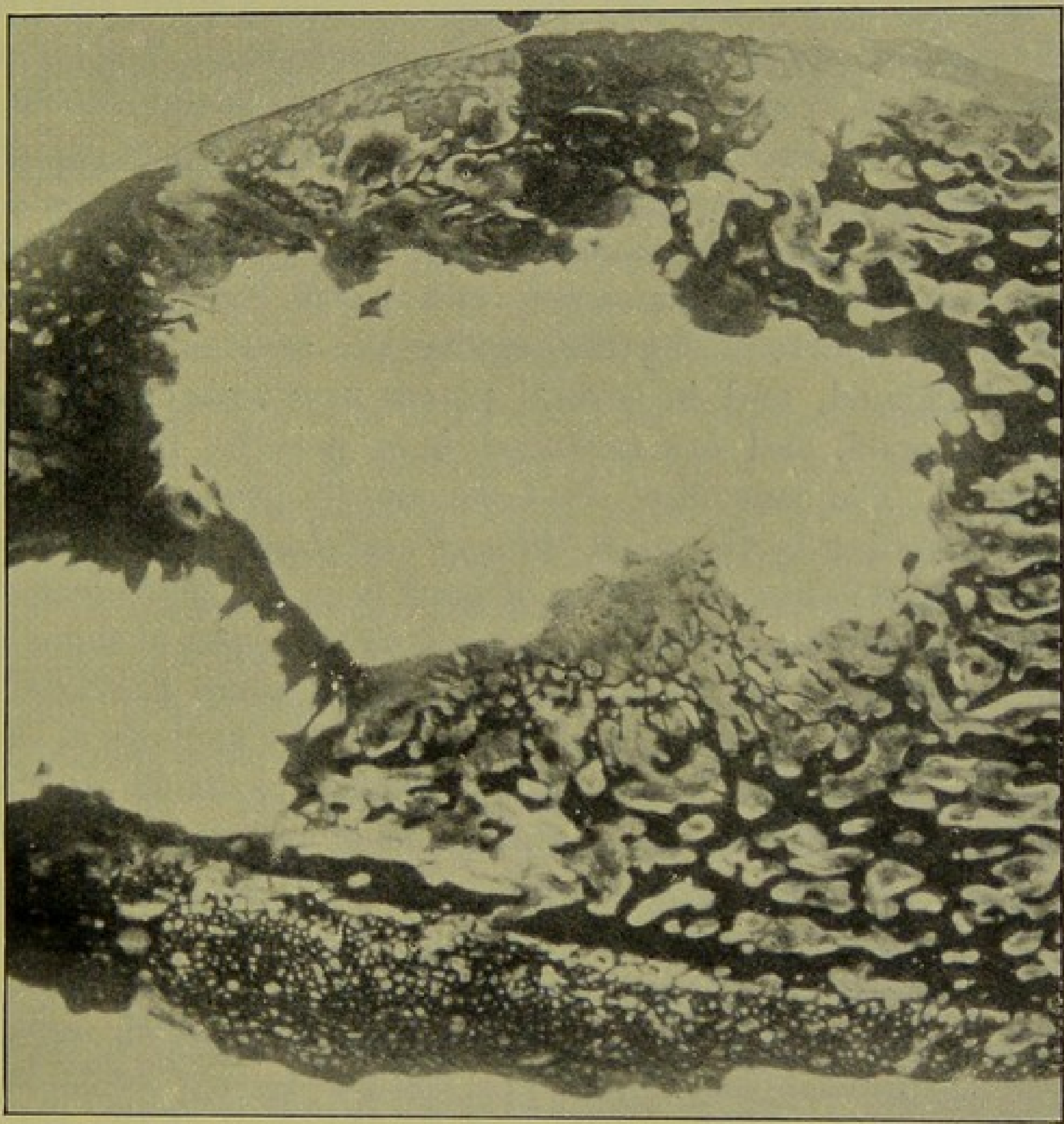


Fig. 35.—Section of the lower end of the uina, showing tuberculous osteomyelitis. The soft tissue in the centre has fallen out. The new bone both in the shaft and on the surface is well seen.

absorbed there, and the tuberculous tissue is infiltrating the soft parts. The posterior part of the bone is also destroyed at one or two places leading to the formation of holes communicating with the soft tissues outside.

The most common form of tuberculous osteomyelitis in young children is seen in strumous dactylitis. We do not usually have the opportunity of examining these cases thoroughly, because amputation is but rarely necessary, and certainly not in the early stage, where the appearances would be most typical. I have, however, obtained a specimen of the lower end of the ulna, which presented this form of the disease (see Fig. 35). The patient was a child, aged 6, who suffered also from disease of the elbow-joint. The lower end of the ulna was much dilated just above its termination, the centre of the bone being filled with soft tissue, which has for the most part fallen out in preparing the sections. We see that lining this cavity there is a layer of soft material which is fibrous in character, and which contains a few tubercles. Surrounding this cavity the osseous trabeculæ are thickened, and in several places new trabeculæ have been formed, and are arranged in a peculiar reticulated manner. The cancelli of the bone contain fibrous material. Corresponding to the most thinned and dilated part of the bone, there is new formation of bone from the periosteum.

The process is essentially the same as that seen in some of the other cases of tuberculous disease of bones previously described, viz. the deposit of tubercles in the medulla of the bone, a formative inflammation around resulting in the production of fibrous tissue, thickening of existing trabeculæ and formation of new trabeculæ, subsequent invasion of this newly formed tissue by the tuberculous growth, and consequent absorption of the trabeculæ. This process is accompanied by great enlargement of the bone which again becomes thinned from the interior, and also by new formation of bone on the surface. By and by the shell of the bone disappears at one or more points and a communication forms externally. This is simply an exaggerated form of the soft deposits in the ends of bones, and just as these are more frequent than necrosis in children so this spina ventosa is more frequent in young children than the form of tuberculous osteomyelitis accompanied by necrosis.

CHAPTER VI

RARER FORMS OF TUBERCULOUS BONE DISEASE

CARIES SICCA ; DIFFUSE CONDENSATION OF BONE IN CONNEXION WITH TUBERCULOUS DISEASE ; DIFFUSE SOFTENING OF BONE AND THE FORMATION OF ' RED MARROW '

1. Caries Sicca

This is a rare form of tuberculous disease of bone which chiefly affects the shoulder-joint, though it sometimes occurs in the hip, and more rarely in the knee. It is seldom accompanied by suppuration, and is characterized by a marked and peculiar atrophy of the bone and by obliteration of the articular cavity.

The term ' caries sicca ' was first used by Carabelli in connexion with disease of the teeth, and was subsequently applied by Wagner to certain diseases of bone. The writer who first brought this type of disease into prominence was, however, Volkmann, who calls it ' an inflammatory atrophy of bone ', and at first he was not inclined to look on it as tuberculous. More careful microscopical examination has, however, shown that the disease is in reality tuberculous, although considerable tracts of the tissue in the bone may not show any tuberculous structure. Tubercle bacilli have been demonstrated in the affected tissue, and a further proof of its tuberculous nature is furnished by the great frequency with which these patients develop tuberculosis elsewhere, especially in the lungs.

I may, in a few words, sketch the clinical history of this type of tuberculous disease, say in the shoulder-joint. The disease, as a rule, develops without any apparent cause in young and frequently healthy individuals ; in some cases, however, it follows a sprain or blow. The earliest symptoms are the occurrence of pain which is often looked on as rheumatic, and diminished range of movement, any attempts at which give rise to pain. The pain usually becomes severe after a time, and not unfrequently extends down the arm in the form of neuralgia. There is no swelling of the part, but on the contrary there is gradually increasing atrophy of the whole of the structures around the shoulder. The acromion projects markedly while the head of the bone becomes so small that it may not be felt. The stiffness of the joint constantly increases, and attempts at movement cause great pain and a crackling sensation. The disease goes on without suppuration or fever till ultimately after one or two years it may cease and leave firm anchylosis of the joint. In some cases chronic abscesses occur, but they are generally of small size and extra-articular, and Volkmann thinks that the cases in which this takes place are those where a sequestrum has formed and projects into the remains of the joint cavity.

If we compare the anatomical structure of caries sicca with the usual appearances in ordinary caries, we find that instead of soft caseous material or luxuriously growing dark red or œdematous granulations on the surface of the bone, and only loosely connected with the underlying tissue we have a small quantity, often only found with difficulty, of a tissue which is very slightly vascular, which at times is almost cartilaginous, and which is so intimately connected with the bone that considerable force is required to detach it.

The process consists essentially in the formation of dense tuberculous tissue which causes erosion of the cartilage and bone, and leads to irregular losses of substance; similar tissue also develops from the synovial membrane, grows inwards between the joint surfaces, and leads to obliteration of the cavity. The peculiarity of the new tissue in this disease is its great tendency to shrink and form firm fibrous tissue.

In addition to the disappearance of the bone as a result of the growth of this dense granulation tissue, there is also a general atrophy of the bone of a concentric character, as Volkmann has pointed out, and the narrowing of the neck of the humerus is sometimes very marked. The disappearance of the bone occurs chiefly under the cartilage, and a considerable tract of cartilage may still be retained over an extensive loss of the substance of the bone. In that case the cartilage generally becomes bent in over the defect, so that instead of a rounded head to the bone the head is irregular and mis-shapen.

2. Diffuse Condensation of Bone in connexion with Tuberculous Disease

These cases are rare, but it sometimes happens, and I have seen it more than once, that on opening up a sinus leading to the shaft of a bone and scraping or gouging away a portion of the bone, we see dense yellow bone extending along the shaft for a considerable distance, and showing no limiting line between healthy and diseased parts. This condition has been looked on as a tuberculous infiltration of the bone and sclerosis, and certainly to the naked eye it looks very much as if the substance of the bone were infiltrated with tuberculous tissue undergoing caseation. This, however, is not, as a rule, the case.

Not long ago I had an excellent example of this form. The patient was a male aged 27, who sprained his knee twelve months before admission, and this was followed by pain and the formation of a chronic abscess. When admitted, the ends of the bones were thickened, there was swelling of the synovial membrane, and sinuses seemed to lead not only to friable bare bone, but also into the joint. Amputation was performed about sixteen months after the commencement of the disease.

On making a section of the bones in a fresh state the greater part of the lower end of the femur, extending well up the shaft and especially towards the outer side, presented a dense yellow appearance. The articular cartilage had disappeared over the front and sides of the femur at the parts where this yellow material reached the surface, but at other parts it was still intact, and there was little or no soft tissue on the surface of the bone. The synovial membrane was firm and only moderately thickened. On the outer side of the external condyle of the femur there was a partially separated sequestrum; this sequestrum was outside the joint and the sinuses led to it. The medulla of the lower end of the femur presented this same dense yellow appearance. Surrounding the necrotic fragment there was a layer of glistening gelatinous material and around this an area of dusky congestion. The head of the tibia was not much affected on the outer side, but in the centre of the internal tuberosity there was a similar yellow patch; the articular cartilage of the tibia was intact. The patella was much atrophied, being about one-half its normal size. A section of the femur showed moderately thickened trabeculæ with caseous material in the meshes. In the bone surrounding the sequestrum were tubercles and tuberculous infiltration to the depth of about one-eighth of an inch. The rest of the shaft showed a certain amount of new formation of trabeculæ and thickening of the older ones, and the meshes were filled with young fibrous tissue which, in most places, was undergoing fatty degeneration. Except in the immediate vicinity of the sequestrum there was no tuberculous tissue in the bone. Towards the periphery of the bone, however, there was distinct rarefaction. There was commencing destruction of the articular cartilage at the edge next the tuberculous deposit.

The sequence of events was, I believe, the following:—A tuberculous deposit formed near the surface of the external condyle of the femur and led to the production of a sequestrum. Around this deposit condensing osteitis occurred and extended over the bone for a considerable distance, but before very long fatty degeneration of the inflammatory products took place and reached an extreme degree, and calcareous salts were also deposited in this fatty material. Where this fatty degeneration extended quite up to the cartilage the latter was deprived of nutritive material and became rubbed or broken away at the surface. The obstinacy of these cases is thus due to the fatty degeneration of the tissue and not to tuberculous infiltration of the bone.

3. Diffuse Softening of Bone and the Formation of 'Red Marrow'

The other diffuse change of bone in connexion with tuberculous disease of the ends of bones is the opposite condition of diffuse softening of the bone. This condition has been described by other authors, and is also rare. In it we find disappearance of the osseous trabeculæ in the epiphyses and medulla of the bone and thinning of the shell of the bone, the medullary cavity being thus much enlarged and filled with red marrow. Several authors who have examined this tissue state that tubercles are frequently found scattered through it in considerable numbers. This is a very bad type of the disease, as a number of bones are usually involved and general tuberculosis is very apt to occur.

CHAPTER VII

PATHOLOGY OF CHRONIC ABSCESS

In what I have previously said, I have retained the terms 'chronic abscess', 'suppuration', and 'pus' in connexion with these tuberculous diseases, although, as a matter of fact, these terms are incorrect; for when we speak of suppuration or chronic abscess in connexion with tuberculous processes, we do not mean the same pathological process as in ordinary suppuration and acute abscess. Nevertheless, the terms are so incorporated with medical literature that it is hardly possible to give them up, more especially as it is by no means easy to find a suitable short word as a substitute. There need, however, be no confusion if we bear in mind their meaning, and in the following pages, when I speak of suppuration and abscess in connexion with tuberculous diseases, I mean the process to be presently described, while if I refer to true suppuration, I speak of it as 'acute' or 'septic suppuration'.

The process of chronic suppuration will be best understood if we trace the development of a chronic abscess in the soft parts. The earliest commencement of these abscesses in the cellular tissue is the formation of a small firm nodule, which steadily, though slowly, increases in size. After a time (when it has attained, for example, the size of a nut or pigeon's egg, sometimes earlier), the centre softens, the swelling increases more rapidly, and the contents become fluid, in fact, a chronic abscess has been formed.

If we examine such a nodule in the early stage, we find that it consists of a mass of tubercles which, at the oldest part, have become confluent. At this period, as seen in Fig. 36, caseation begins, and a collection of caseous material is formed surrounded by tuberculous tissue. This caseous material becomes infiltrated with fluid, and also with some leucocytes, and thus we have a cavity containing fluid, fatty material, fragments of cells and leucocytes, and around this cavity tissue showing tuberculous infiltration, and further away isolated tubercles. At the spreading margin the tuberculous tissue continues to invade the surrounding

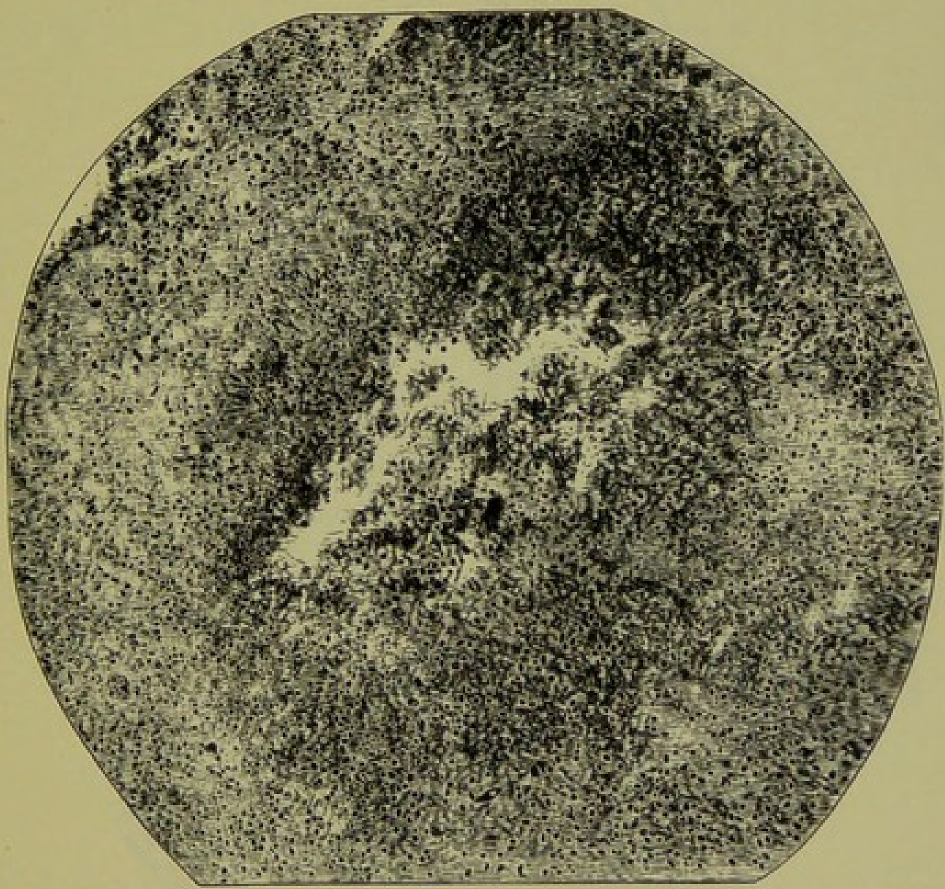


FIG. 36.—Earliest commencement of a chronic abscess. The tubercles have run together, and this tissue is undergoing caseation; fluid is being effused among this caseous material.

structures, while not only does the caseation extend around the original cavity, but it also commences in independent parts of the wall. These fresh caseous centres ultimately communicate with the original cavity, and thus we have produced the ragged appearance of the wall well shown in Fig. 37, which represents a complete section through the wall of a chronic abscess, and in which we see the ragged appearance of the part next the abscess cavity, where the darker portions in the wall, which are numerous, are points where caseation is occurring. As a result of the formation of these isolated caseous deposits in the wall, portions which have not yet completely caseated became detached and fall into the general cavity, forming the flakes and masses so constantly present in chronic abscesses.

These abscesses extend by fresh growth of the tuberculous tissue in the surrounding parts, while caseation goes on in

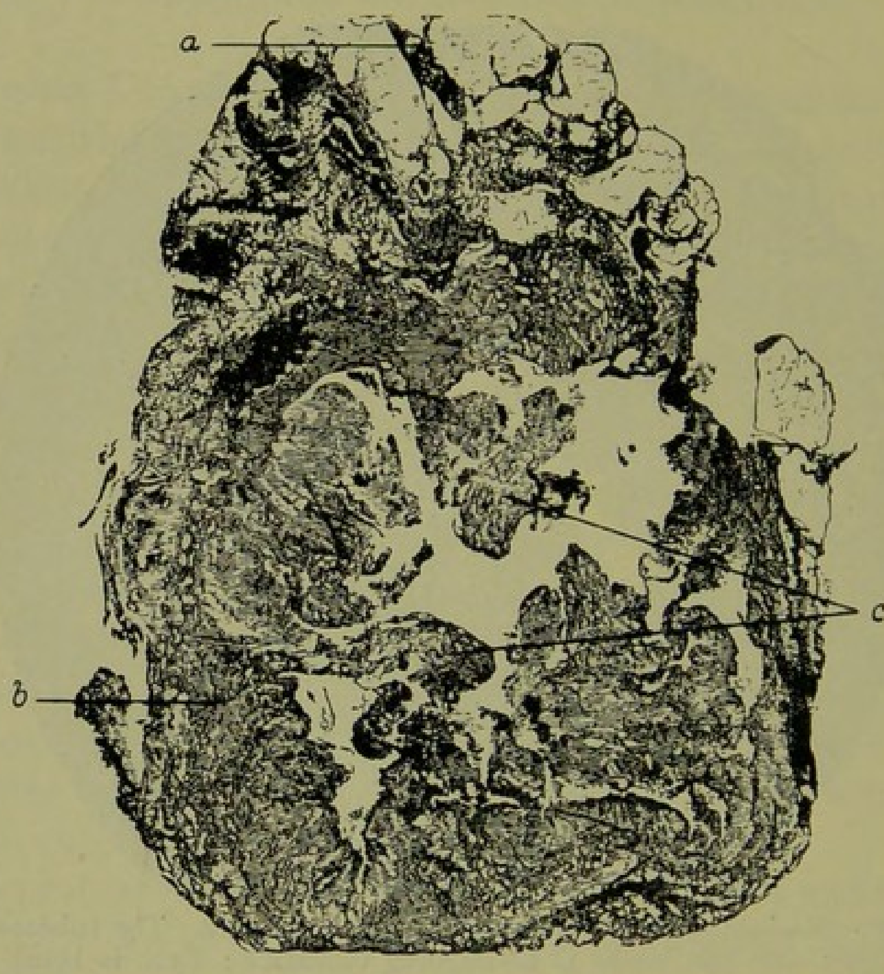


Fig. 37.—Section of a small chronic abscess hardly magnified. (*a*) Healthy fat; (*b*) wall of abscess consisting of tuberculous tissue; (*c*) caseated portions of the wall next the cavity of the abscess. (See Text.)

the centre. Hence, whatever part of the wall of a chronic abscess is examined, caseating tuberculous tissue and frequently isolated tubercles will be found, as seen in Fig. 38, which is taken from the wall of the abscess shown under a low power in Fig. 37. Here we see three tubercles with large giant cells, and the tissue in the neighbourhood is infiltrated with epithelioid and giant cells. When the abscess bursts externally, or is opened, a sinus is left in the wall of which tubercles and tuberculous tissue are present. (See Fig. 39.)

Exactly the same process occurs in connexion with tuberculous disease of bones and joints. When suppuration occurs in a joint in connexion with tuberculous disease the layer of tubercles on the inner surface of the synovial membrane caseates, the caseous material falls into the cavity of the joint, fluid is poured out, and leucocytes also pass out in

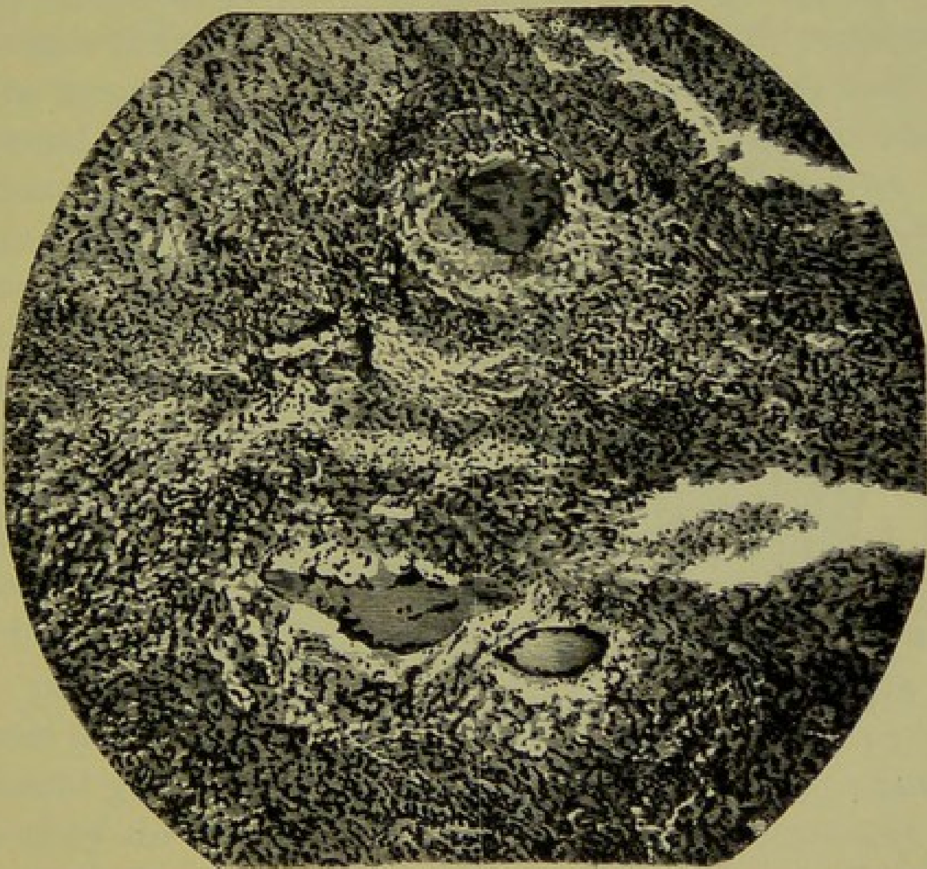


Fig. 38.—Magnified section of the wall of a chronic abscess (Fig. 37), showing the presence of tubercles with large giant cells.

varying numbers. Where the abscess forms in the substance of the synovial membrane a tract of tuberculous tissue caseates, and the abscess spreads in the manner formerly described. Where a tuberculous osseous deposit makes its way to the surface, it infects the periosteum over it, destroys it, and then spreads in the cellular tissue. In such a case part of the wall of the abscess is formed by the carious surface of the bone.

König ascribes an important rôle to fibrin in the formation of the walls of chronic abscesses, and in the thickening of the synovial membrane. He says that fibrin is poured out and coagulates on the free surface of the cavity, that granulation cells spread into this layer, and tubercles appear in the granulation tissue, fresh layers of fibrin are deposited, and thus the process goes on. This pathology will be seen to be quite different from the foregoing, but in my opinion it is erroneous. A careful study of complete sections of diseased

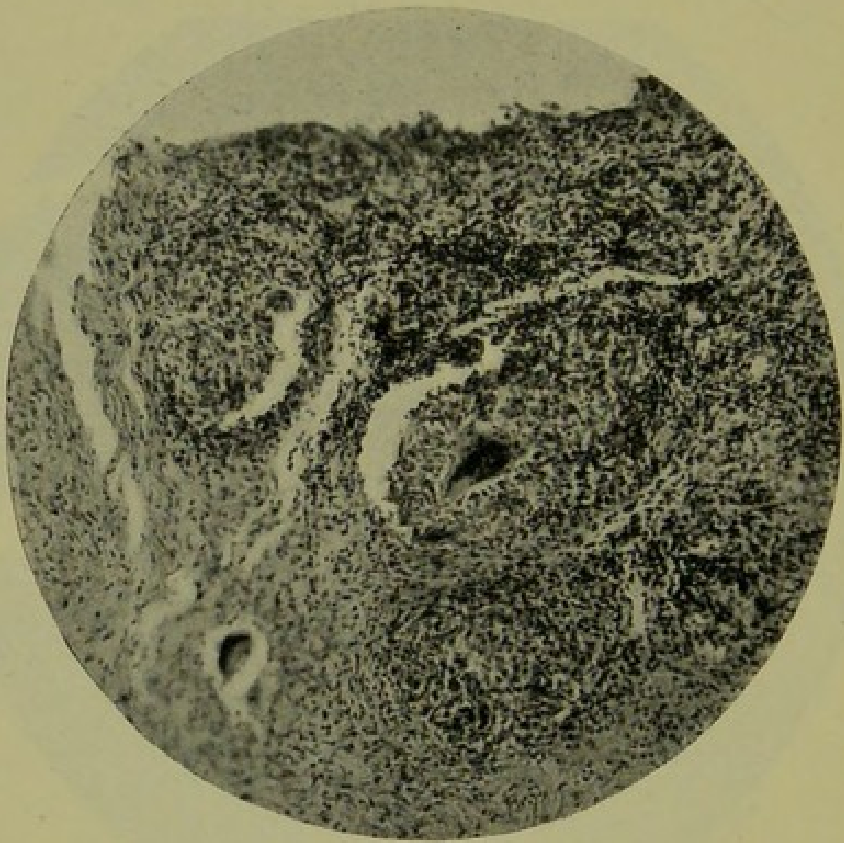


Fig. 39.—Section of the wall of a sinus left after the bursting of a tuberculous abscess connected with bone showing the presence of tubercles in the wall of the sinus.

synovial membrane, and of the walls of chronic abscesses will, I think, show that the description I have given is correct. There can be no mistaking the fact that the granular material on the inner surface of the walls of chronic abscesses and of tuberculous synovial membrane is, in the great majority of the cases, derived from the degeneration of preformed tissue, and is not due solely or even chiefly to fresh deposit of fibrin on the surface, for the whole series of changes can be demonstrated.

While, as we have seen, caseation of the tuberculous growth plays a very important part in the formation of chronic abscess, we must not, therefore, suppose that chronic suppuration is the same thing as caseation, or that these are convertible terms. In chronic abscess we have, in addition to caseation of the affected tissues, effusion of fluid and formation of pus cells, sometimes in very large numbers, in fact, there is more or less acute inflammation, superadded to the tuberculous process. Caseation is a very constant occurrence in tuberculous growths, while chronic suppuration is by no means always present. Hence it is evident that some additional factor must come into play in determining the occurrence of chronic abscess. Some investigators have suggested that they owe their first formation to the ordinary pyogenic cocci which settle in the affected tissue and cause suppuration, and that afterwards these organisms die out. Apart from the fact that the character of the contents of these abscesses differs from that of the contents of acute abscesses, the early symptoms of chronic abscess do not present the acute character which we should expect if the pyogenic organisms were at work, while chronic abscesses have been examined, and I have myself done this, at a very early period, without finding any other organisms than tubercle bacilli. Further, as Garré has pointed out, pyogenic organisms grow luxuriantly in the pus of chronic abscesses, while they do not do so in pus which has previously been the seat of their growth. And further, these cocci do not die so rapidly as we must assume to be the case in order to account for their absence from the contents of these abscesses, for they can retain their vitality for months in the same material. I do not think that we can, at the present time, give any thoroughly satisfactory explanation of the occurrence or absence of chronic abscesses in connexion with tubercular diseases of bones and joints. I believe that it has to do with the constitution of the patient, whatever that term may imply, that is to say, that the factor or factors at work do not come directly from without. These chronic abscesses are most common in patients who have a hereditary tuberculous history, in patients who suffer from multiple tuberculous affections, in patients who have fallen into a low state of health, in patients where there has been exacerbation of the local trouble as the result of injury, &c. Sir Almroth Wright speaks of the development of a ferment as the cause of the breaking down of tuberculous masses, but the presence of a peptic ferment in the contents of chronic abscesses is denied by various observers. The more definite meaning of these facts must be left for future research, but none the less we must bear in mind the tuberculous nature of the abscesses, and the fact that the whole wall is infected and infective, and therefore in treating them we must pay attention to this wall, and, if possible, try in some way or other to render it innocuous.

CHAPTER VIII

EXPERIMENTS DEMONSTRATING THE PRODUCTION OF TUBERCULOUS DISEASE OF JOINTS BY TUBERCLE BACILLI

In the former edition of this book I went into the various points which showed that what were formerly spoken of as 'strumous' diseases were in reality tuberculous, but this view has been so universally adopted now that it is unnecessary to repeat the arguments. I may, however, be permitted to mention again some experiments which I made to show that the typical tuberculous diseases of bones and joints as met with in man can be produced in suitable animals by the introduction of tubercle bacilli.

I have already published an account of these experiments in *The British Medical Journal*, April 1891, and I need not do more here than mention three of them as examples. I may say that the experiments were performed with pure cultivations of tubercle bacilli from man mixed with sterilized water to form an emulsion.

1. *Injection into the knee-joint of a rabbit.*—On January 11, 1888, a small quantity of an emulsion of tubercle bacilli from a cultivation on blood serum was injected into the right knee-joint of a rabbit. A week later there was marked swelling and heat of the knee-joint. The animal was killed on May 10, when the swelling of the knee was still considerable, though not so great as it had been. On post-mortem examination there was marked tuberculosis of the lungs, but in none of the other organs were tubercles visible to the naked eye. The right knee-joint was distended with cheesy material which had burst through the capsule and burrowed down the leg. In the joint there was a large quantity of pus (*d*); more especially above the patella and also behind the joint (see Fig. 40).

On making sections of the bones several small cheesy deposits (*a*) were seen in the femur just above the epiphysial line (*b*), and in front there was a small hole (*c*) in the shell of the bone containing cheesy material and communicating with the cavity of the joint on the one hand, and with these caseous deposits in the interior of the bone on the other. At one part of the epiphysis of the femur just beneath the articular cartilage the bone was yellow and dense. In the head of the tibia there were two small yellow tubercles, and there was pus around the upper part of the shaft of the bone. The cartilage over the head of the tibia had disappeared and its place was taken by soft tissue.

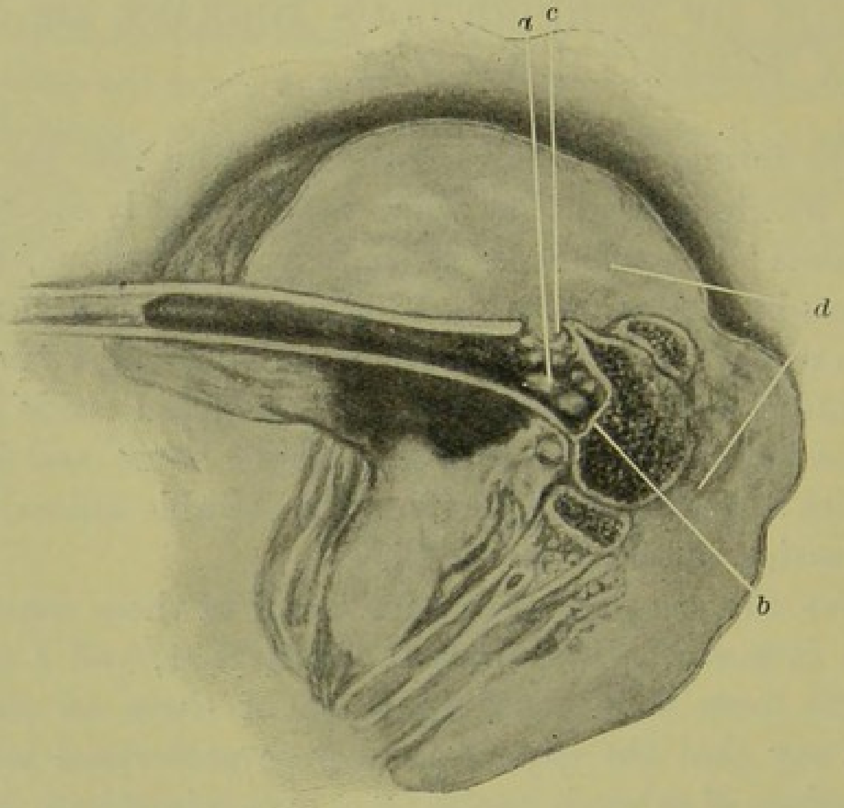


FIG. 40.—Section of the knee-joint of a rabbit after injection of a pure cultivation of tubercle bacilli. (See Text.) (*a*) Tuberculous deposits in diaphysis which have burst through the bone into the joint; (*b*) epiphysial line; (*c*) destruction of the outer shell of the femur by the tuberculous tissue; (*d*) joint cavity distended with pus.

On microscopical examination of sections of the lower end of the femur the articular cartilage was seen to be almost entirely destroyed, the surface being covered with fibrous tuberculous tissue caseating at the edge. Where cartilage was still present it was seen to be undergoing fibrillation and destruction. Over the centre of the end of the bone the tuberculous tissue was penetrating into it, and there were one or two large tuberculous nodules in the cancelli: the trabeculæ were also thickened. Here and there were collections of epithelioid and small giant cells, but the chief form was tuberculous infiltration. In the caseating patches numerous imperfectly stained and fragmentary tubercle bacilli could be made out.

2. *Injection into the nutrient artery of the tibia of a goat.*—This is readily done by exposing the tibial artery just below the origin of the nutrient vessel, injecting upwards against the stream of blood and immediately ligaturing the artery below the nutrient vessel; the result is that the material injected is driven by the circulation into the nutrient artery and its branches. In this experiment the tibial artery was exposed at its upper part in a young goat, and about three minims of an emulsion of tubercle bacilli were injected in the manner above described. The wound was then closed and dressed aseptically.

The animal was somewhat lame for a few days after the operation and then recovered, but after about three weeks the ankle-joint, and somewhat later the metatarso-phalangeal joint, began to swell and the animal limped very much, hardly putting the foot to the ground. The goat died fifty-one days after the operation.

On examining the leg the soft tissues in the neighbourhood of the seat of operation were found to be very much thickened. The ankle-joint, and more especially the metatarso-phalangeal joints, were very much swollen and larger than the corresponding joints on the other side, the thickening apparently affecting the bones as well as the soft tissues. No abscesses or cheesy patches were seen in the muscles or tissues of the leg. The inguinal glands on that side were much enlarged. The lungs were full of minute tubercles, for the most part transparent and not cheesy; a few were seen in the liver but none in the other organs.

This photograph (Fig. 41) is from a drawing made from the fresh section of the bones, and we see that there is a large number of cheesy deposits in the bones, more especially at the lower end of the tibia, and at the lower end of the metatarsal bone; they were also very numerous, but more diffuse throughout the medulla of these bones and in the various tarsal bones. The synovial membrane in both joints, more especially in the metatarso-phalangeal joint, was much swollen and gelatinous. The deposits were not limited to the diaphysis of the tibia but occurred in the epiphysis, though they were not so numerous there.

The following is the result of the microscopical examination:—

In the lungs there were numerous tubercles which in many places had run together and contained numerous tubercle bacilli.

In the medulla of the bone the deposits had evidently been formed in and afterwards around blood-vessels, their centres were caseous, and their periphery composed of tuberculous tissue.

In the lower end of the tibia we see numerous caseating deposits in the bone, not only in the cancellous tissue, but also in the dense bone, in what is apparently newly formed bone, and in the periosteum. (See Fig. 42.) As to the character of these deposits they are roundish or irregular collections of large cells undergoing caseation at the centre, but with no well-formed giant cells. Many of the cancelli are filled with this tuberculous tissue, and the trabeculæ around are eroded and often completely destroyed, several cancelli filled with this material communicating with each other. There is in places new formation of bone from the periosteum. In the epiphysis the deposits are not so numerous. The articular cartilage is almost entirely destroyed, and its place taken by tuberculous tissue with a few small giant cells. Here and there fragments of cartilage are found lying in this tissue. I think that the disease of the joint has been purely synovial in its origin, because in none of the specimens have I found any bone

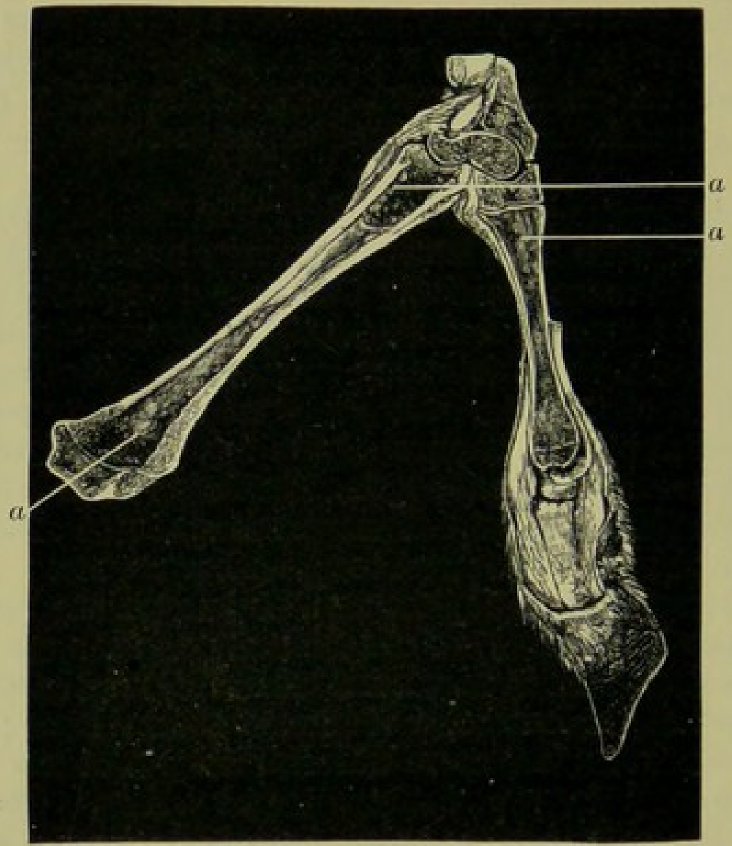


FIG. 41.—Section of the bones of the leg of a goat two months after injection of tubercle bacilli into the nutrient artery of the tibia. Shows numerous tuberculous deposits (*a*) in the various bones. (See Text.)

deposit breaking through the surface of the tibia, and the involvement of the epiphysis is comparatively slight.

The os calcis also contained large numbers of tubercles, especially beneath the epiphysial line ; there were also more giant cells here than I have seen elsewhere. The articular cartilage was almost entirely intact, except at one end where a deposit was seen sprouting out of the bone, destroying the cartilage over it, and spreading over the surface of and eroding the cartilage on each side.

In the astragalus the deposits were fewer, but there were a good many in the cancelli just beneath the surface of the bone. The cartilage had been destroyed in parts, at some places apparently from the surface, at others by the tuberculous deposits beneath it. The changes in connexion with the destruction of the cartilage were precisely the same as those which occur in man.

The lower end of the metatarsal bone showed also a number of tuberculous deposits, very numerous indeed immediately above

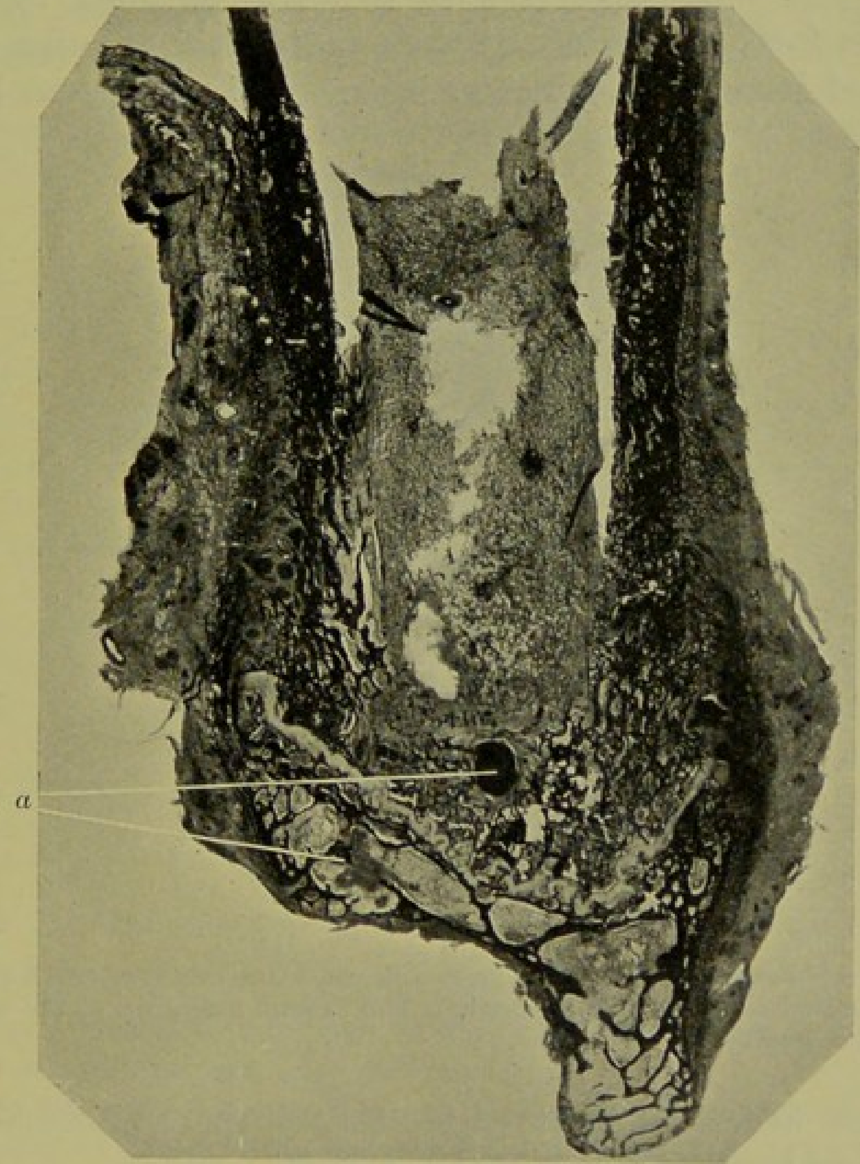


FIG. 42.—Section of the lower end of the tibia of a goat after injection of tubercle bacilli into the nutrient artery of the tibia, showing tuberculous deposits (*a*) in the medullary spaces on each side of the epiphysial line, and roughness and commencing destruction of the articular cartilages.

the epiphysial cartilage, and one or two very large ones in the epiphysis. The synovial membrane in this joint was also much thickened.

Here then we have as the result of the injection of tubercle bacilli into the nutrient artery of the bone, and the deposition of these bacilli in various parts of the bone and periosteum, the formation of caseating tuberculous deposits, destruction of the bone, new formation of bone, both in the interior and from the periosteum, thickening of the synovial membrane, and destruction of the articular cartilages both from the surface and from soft osseous deposits bursting into the joints, in fact, all the changes characteristic of tuberculous disease of bones and joints in man. And as in man in the

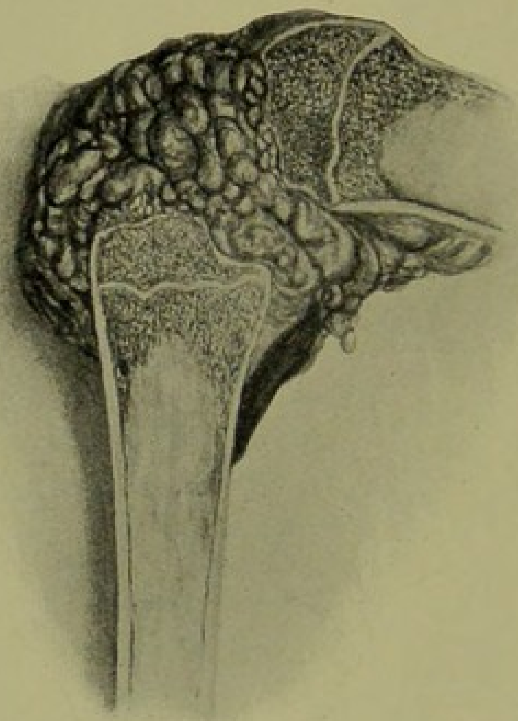


Fig. 43.—Section of knee-joint of goat, after injection of a very small quantity of a pure cultivation of tubercle bacilli. The villous condition of the synovial membrane is well seen.

specimens which I examined for bacilli, the organisms were few in number and imperfectly stained.

3. *Injection into the nutrient artery of the tibia, into the knee-joint, and into the metacarpal bone of a goat.*—Small portions of a very dilute mixture of tubercle bacilli were injected into the nutrient artery of the right tibia in the usual manner, into the left knee-joint, and into the proximal end of the left metacarpal bone through a hole bored with a bradawl. As a result the knee and wrist joints became swollen, but there was no apparent disease in the right hind limb. As the goat was weak and ill, and apparently suffering pain, it was killed forty-seven days after the injection.

On post-mortem examination tubercles were seen in the lungs, spleen, and kidneys, all of small size. The right tibia showed nothing abnormal to the naked eye, and there was no swelling of the joints as in the previous case, but the muscles around the seat of operation were much thickened and infiltrated with tubercles.

There was great thickening of the synovial membrane of the left knee-joint, more especially in the neighbourhood of the crucial ligaments, and the synovial membrane was covered with pendulous villous growths. These growths were most numerous where the synovial membrane joined the bone, and also between the

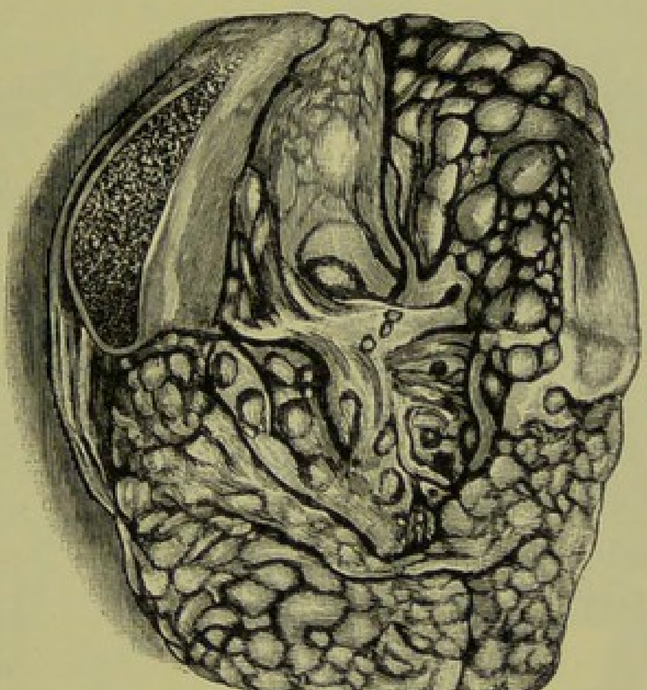


FIG. 44.—The same specimen as Fig. 43, seen from the front. The patella has been turned to one side.

condyles. There was no pus in the joint, and nothing abnormal seen in the bones (see Figs. 43 and 44).

There was also great swelling of the left wrist-joint, and marked thickening of the synovial membrane. In the proximal end of the metacarpal bone there was a large cavity containing soft material, which communicated with the carpo-metacarpal joint. In this joint there were villous projections on the synovial membrane, similar to those in the knee, and when the joint was opened the appearance was exactly similar to that of a carious wrist-joint. The synovial membrane was thickened and highly vascular, and encroached on the articular cartilage and the bone, in fact, very little of the cartilage could be seen. The intercarpal articulation was also affected, but the radiocarpal joint was practically healthy.

Microscopical examination of the various parts gave the following result :—In the lower end of the right tibia two tuberculous deposits were found presenting similar appearances to those in the former case. One of these was situated beneath the epiphysial cartilage, and the other somewhat higher up in the medulla. The articular cartilage was also destroyed at one part. Evidently very few bacilli had been arrested in the vessels in the bone, and disease was just commencing.

The synovial membrane of the left knee-joint was greatly thickened, the new tissue being composed of young granulation tissue with tuberculous infiltration, and a few small giant cells.

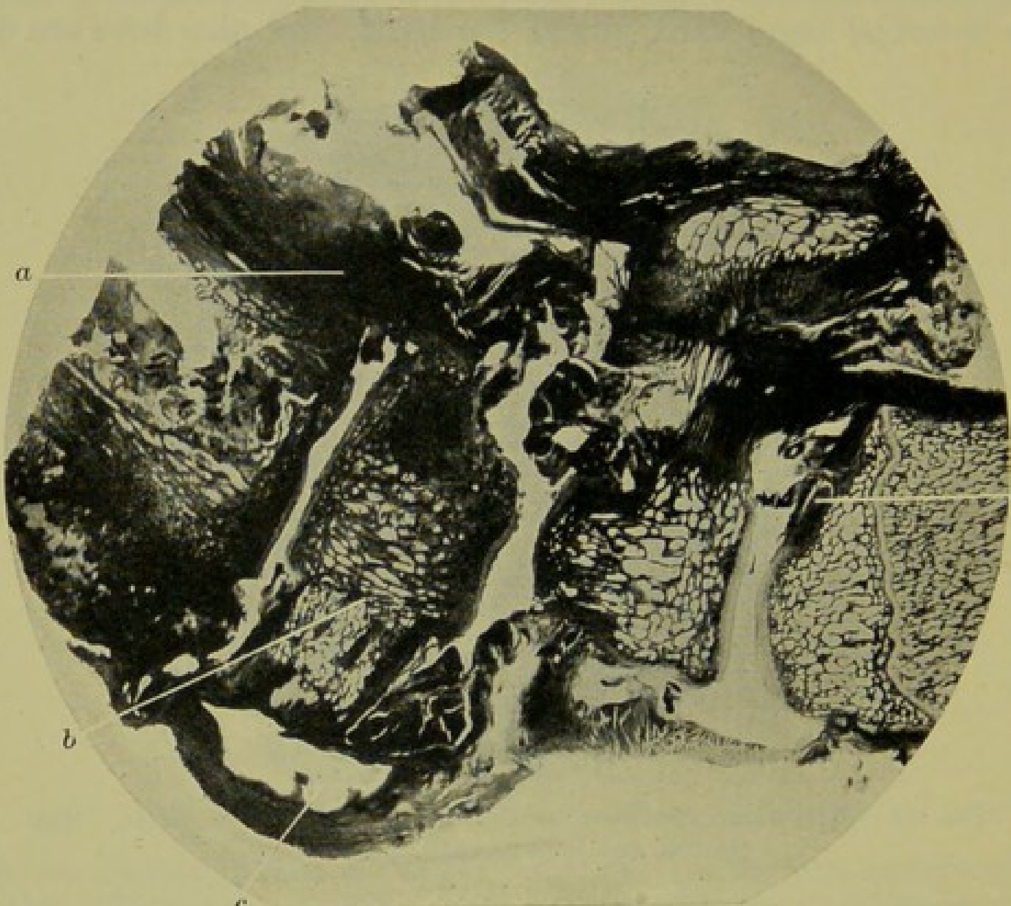


FIG. 45.—Wrist-joint of goat after injection of tubercle bacilli into the end of metacarpal bone. A deposit has formed and opened into the carpal joints, and has set up exactly the same sequence of events as is seen in Fig. 15. (*a*) Deposit in metacarpal bone at the seat of injection bursting into metacarpo-phalangeal joint; (*b*) destruction of carpal bones; (*c*) commencing abscess; (*d*) commencing destruction of the cartilage on the lower end of the radius.

There were no distinct tubercles, but there were here and there patches of caseating tissue exactly as in the wall of a chronic abscess. In some places the collections of epithelioid cells were more limited and almost formed definite tubercles.

The sections of the synovial membrane of the wrist-joint showed tuberculous deposits scattered throughout the fibrous tissue, some of them with commencing caseation. This photograph (Fig. 45) is taken from a complete section of the wrist-joint. Towards the posterior part of the metacarpal bone (*a*) there is a tuberculous deposit at the seat of injection. This deposit has destroyed the bone and the articular cartilage over it, and has thus spread into the joint; a number of the cancelli under the cartilage are also filled with the same material. On the anterior surface of the end of the metacarpal bone there is a considerable amount of new periosteal bone, and the bone around the deposit is much sclerosed. The synovial membrane in the articulation is much thickened and villous both in front and behind, and shows the presence of caseating patches.

The adjacent carpal bone shows destruction of the articular cartilage at the lower and posterior part (*b*), and penetration of the tuberculous tissue into the bone in this situation. There is much new periosteal bone in front, commencing destruction of the bone from the surface at the anterior and lower part, and great sclerosis in other places; in the soft textures behind there is a commencing abscess.

If, now, we examine the middle articulation, we find the same villous thickening of the synovial membrane, and commencing destruction of the cartilage over the upper carpal bone, with sclerosis of the bone in the neighbourhood.

The upper articulation is comparatively healthy, but even there the synovial membrane is beginning to spread over the cartilage at the posterior part of the surface of the radius (*d*), and slight thickening of the synovial membrane is taking place.

Compare this appearance with the section of the wrist-joint (Fig. 15) from the human subject, where the disease has also begun in the end of the metacarpal bone, and we find that the two appearances are practically identical.

These experiments are sufficient to indicate the kind of results obtained, and to establish the causal connexion between the tubercle bacillus and tuberculous diseases of bones and joints, more especially when taken in connexion with the work of other observers. I especially refer to the work done by Tricomi, Müller, and Krause, the work of the latter completing the subject. Professor Krause repeated Schüller's experiments, who injured the joints of animals previously inoculated with tuberculous material; in Krause's work the animals were inoculated with pure cultivations of tubercle bacilli. Like other observers, he has found that severe injuries, such as dislocations, are not nearly so readily followed by tuberculous joint disease, as slighter injuries, like sprains, and he also found that fractures of bones in tuberculous animals heal without any trouble. Of joints which were dislocated or severely injured a few became tuberculous, but of joints which were sprained, the majority ultimately showed evidences of disease. In the great majority of cases the form of the disease was a tuberculous thickening of the synovial membrane resembling primary synovial disease in man. In a few cases he found isolated tubercles in the epiphyses, but in three he found larger caseating tuberculous deposits. He also calls special attention to the difficulty of finding bacilli in these parts, although they were numerous in the tubercles in the internal organs.

CHAPTER IX

ON THE ACCESSORY FACTORS WHICH COME INTO PLAY IN THE PRODUCTION OF TUBERCULOUS DISEASES OF BONES AND JOINTS

Although there can no longer be any doubt that the tubercle bacillus is the ultimate cause of these affections, and although without it they could not occur, the converse does not necessarily hold good, viz. that given the tubercle bacillus in the body tuberculous disease must result. It is a fact to which I need not do more than allude that many persons are exposed to the possibility of tuberculous infection without the development of tuberculosis, and yet we cannot doubt that in many of these individuals the tubercle bacilli have come in contact with various mucous membranes, or have been inhaled into the lungs. This fact proves not that tuberculosis is not a contagious disease, not that the tubercle bacillus is not the essential causal agent of tuberculous diseases, but only that the bacillus cannot act except under favourable conditions—that, in fact, other factors must come into play to enable the bacillus to obtain a foothold and to grow in the animal body. One of the chief problems to which we must direct our attention in the future is the nature of these accessory factors, and there is no doubt that as our knowledge with regard to them increases so our power of dealing with these affections will become greater.

In the *Lectures on Suppuration and Septic Diseases* which I published some years ago, I attempted to point out the various conditions which came into play in the production of septic affections, and to estimate their relative importance. Our knowledge with regard to the conditions under which the tubercle bacillus acts is, however, by no means so full as that with regard to the pyogenic organisms, and one reason for this deficiency is that it is difficult to carry on cultivations of these organisms outside the body, while their growth both outside and inside the animal body is very slow; hence there are many difficulties in the way of the performance of similar experiments to those on septic infection, and the direct connexion between cause and effect cannot be so readily traced. It is quite clear, however, that similar factors must come into play, that conditions exist which favour or hinder the entrance of the parasite into the body, which enable it to obtain a foothold in certain parts, and which permit or encourage it to go on growing in these parts, and to cause the morbid changes characteristic of tuberculous disease.

There are a good many cases on record in which the bacilli have entered through wounds of the skin, and the characteristic lesions in such cases are the development of a sore at the point of entrance, followed by tuberculous disease in the neighbouring lymphatic glands, and subsequently it may be in the tissues and organs of the body. This mode of entrance is, however, comparatively rare. In order to inoculate the tuberculous virus into animals with certainty it is necessary to form a pocket beneath the skin into which it is introduced, and in which it may lie at rest; moisture and the possibility of remaining in the part for some time are essential for the growth of the bacilli. If the tuberculous virus is simply rubbed into scratches in the skin the blood containing the virus quickly dries, and in this way the growth of the bacillus is prevented, while even where there is enough moisture the organisms are usually rubbed off or carried away before they have had time to obtain a footing in the wound.

The most common point of entrance of these bacilli is, without doubt, the mucous surfaces of the body, more especially of the digestive and respiratory tracts. Thus, in children, one of the most frequent seats of tuberculous disease is the lymphatic glands, chiefly the cervical, the mesenteric, and the bronchial glands. In the case of the cervical glands, infection usually occurs from the throat, from carious teeth, or from ear disease, eczema of the scalp, &c. In the case of carious teeth or otitis media, there are suppurating cavities through which the bacilli may enter, but in many instances there is no definite evidence of a primary lesion at the point of entrance, the only sign of disease being the enlarged glands in the neck, and yet in all probability the infective material has in most cases entered from the throat. In the same way it is not uncommon to find the mesenteric glands in children much diseased, although there is no tuberculous ulceration of the intestine. Klebs states that the presence or absence of tuberculous ulcers in the intestines of animals which are fed with tuberculous material depends to a great extent on the size of the particles of the tuberculous matter. He found that finely divided particles of tuberculous material were absorbed without lodging and causing disease at their point of entrance in the intestinal mucous membrane, and were usually caught in the mesenteric glands, though in some cases they passed them, and lodged in various internal organs. On the contrary, where the animals were fed with large and firm tuberculous masses, such as cheesy glands or pieces of lung, intestinal ulceration occurred. In accordance with these results, it is only what we should expect that in many cases the point of entrance will not be evident, and this will more especially be the case in children, where the chief source of infection is probably the milk from tuberculous cows. And just as in the experimental, so in the natural infection, the virus may escape the glands, and produce the first symptoms of the disease in parts distant from the point of entrance.

Another common seat of infection is the respiratory tract, the virus being inhaled into the lungs, and either setting up disease in the pulmonary alveoli in the first instance, or, as in the case of the intestine, passing through the alveolar epithelium and being carried to the bronchial glands, and setting up disease there without any previous affection of the lung. Indeed, it seems very probable that in most cases the source of the joint infection is diseased bronchial glands. In order to reach the joint from these glands, the virus must of course be carried by the blood, and it has been demonstrated that the tuberculous growth may destroy the wall of an artery or vein, and project into the lumen of the vessel, and thus furnish the conditions necessary for the entrance of the organisms into the blood-current; or the virus may reach the blood from the lymph-stream, more especially when the parasite has entered from the intestine and has attacked the wall of the thoracic duct. When large quantities of the virus are poured into the blood in one or other of these ways, general tuberculosis results; but it is perhaps most common for the bacilli to enter the blood singly or in small numbers at a time, and then, unless they meet with conditions which favour their deposit in some suitable organ, they are quickly destroyed.

It is possible, also, that in some cases infection occurs through the genital mucous membranes, especially where there is tuberculosis of the prostate or of the uterus. This mode of infection is much more likely to occur in the female than in the male.

Lastly, it is held by some that the disease is often hereditary—that is to say, that infection has occurred before birth, the infective material having come from the male, being present in the semen, or from the female, chiefly through the placenta. In support of transmission from the male the following facts may be mentioned.

Jani examined the generative organs of several individuals who had died of tuberculous disease, and found tubercle bacilli in the seminal tubules in five cases, in the prostate in six, and in the Fallopian tubes twice, and in none of these cases was there any local disease. From these facts it has been concluded that, apart altogether from the presence of tuberculous disease of the genital organs, tubercle bacilli may be present in the genital passages of tuberculous individuals, and thus gain access to the ovum. In connexion with Jani's observations, which, however, are of doubtful accuracy, I may very briefly allude to some very interesting experiments which have been performed by Maffucci.

Tubercle bacilli were injected into new-laid eggs, which were then incubated. Eighteen eggs were inoculated, and at the same time an adult hen and a guinea-pig. The guinea-pig died after 40 days of tuberculosis of various internal organs, and the hen after $2\frac{1}{2}$ months of internal tuberculosis, especially affecting the liver. Of the eighteen eggs, nine proved sterile, and in one the embryo died before full time, but no tubercle bacilli or tubercles were found in it. Eight chickens hatched out on the nineteenth day, and they were all small and delicate, but very active. One of these died after 36 hours, but no tubercles were found in it, while the others lived for from 20 days to $4\frac{1}{2}$ months, and in all of these, with one exception, tubercles and tubercle bacilli were found after death in the internal organs. The tuberculous disease first appeared and was most advanced in the liver, and next in the lungs, and Maffucci came to the conclusion that infection occurred through the area vascularis, and that, therefore, the virus was carried, in the first instance, to the liver.

With regard to Jani's statement as to the presence of tubercle bacilli in the seminal fluid of tubercular men, I may mention that Landouzy and Martin have injected the semen of tuberculous rabbits into guinea-pigs, and have in this way produced tuberculosis; while, on the other hand, Rohlff has failed to cause tuberculosis in rabbits by the injection of the semen of tuberculous men into the anterior chamber of the eye. While these facts show that the possibility of the conveyance of tubercle bacilli to the ovum by the semen cannot be absolutely denied, the probability of such an occurrence seems to be slight.

The infection of the fœtus from the side of the mother must also be rare, but might conceivably occur under two conditions, viz. where there is tuberculosis of the Fallopian tubes leading to infection of the ovum as it passes downwards, or where the placenta becomes the seat of tuberculous disease. Numerous experiments have been made to ascertain whether after inoculation of a pregnant animal with an infective disease the young become infected, and it has been found that, as a rule, the young do not become affected. Unless the disease has first established itself in the placenta, or unless there has been rupture of placental vessels leading to the establishment of a communication between the maternal and the fœtal circulation, organisms circulating in the blood in healthy placental vessels, are, as a rule, unable to pass into the fœtal circulation, and this is apparently also the case in tuberculosis. Thus Toledo injected tubercle bacilli into the veins, pleural cavities, and subcutaneous tissues of pregnant guinea-pigs, but failed to find tubercles or tubercle bacilli in the young by any of the ordinary methods of investigation. Only one or two cases have been published either in animals or in man where the young at the time of birth have shown evidences of tuberculous disease, and, as in the experiments on animals, while women have died of acute tuberculosis during pregnancy no evidence of tuberculosis has been found in the fœtus.

While therefore it would seem that transmission of tubercle bacilli to the fœtus and their development there is a rare condition, I cannot help entertaining the suspicion that this possibly occurs oftener than one would think. Two chief difficulties stand in the way ; the one the difficulty of realizing how the bacillus can pass into the ovum at the time of conception, and the other how, if it does so, it can remain dormant for a long time in the growing body without producing any symptoms of disease. One would expect that if the bacillus gained access to the ovum it would either at once begin to grow, in which case it ought to destroy the ovum, or that it would soon be destroyed by the actively growing cells. Post-natal infection is a much more easy explanation. But in syphilis we have an example of an organism which only obtains access to the body by direct infection from man to man. Here there is no question of infection by food, air, &c., and yet we find that the spirochæte is transmitted to the offspring in a very remarkable way. We also find that the effect of the spirochæte on the fœtus varies very much. In many cases the fœtus is killed, in others the child is born with active syphilitic disease; in others again the disease appears a few weeks or months after birth, while in others no sign appears, or at least is evident till after the lapse of years. To some extent this may depend on the period during fœtal life, at which the spirochæte gained entrance, but the late appearance of the disease is a remarkable example of the length of time that organisms may remain latent.

I confess that I cannot divest my mind of the suspicion that something of the same kind may be the case in tuberculosis, and that we are going too far in attributing all cases to infection after birth and in looking on heredity as only an inheritance of a special susceptibility to the attack of the tubercle bacillus. There is, I think, quite a possibility that the bacilli are also inherited, but may remain dormant for a long time till circumstances arise which increase the susceptibility of the body.

The conditions which enable tubercle bacilli to obtain a foothold in the tissues, and which favour or hinder their growth, are very various, and are, as I have already said, but little understood. In my lectures on 'Suppuration and Septic Disease',[1] I referred to one very important condition which held good in the case of all the organisms which I had investigated, viz. the number primarily introduced, and it will be remembered that I deduced certain very important laws from my experiments, one of them being that in animals not extremely susceptible to a disease it was necessary to introduce a number of organisms at first in order to set it up, and another that the severity of the resulting disease varied directly with the number of organisms introduced in the first instance. I have not myself tested this matter in the case of tubercle, but from experiments which have been made by others, it seems that the same laws hold good in this disease. Thus Gebhardt experimented with the milk of tuberculous cows, and found that in cases where the original milk was virulent, it produced no effects whether

[1] Young J. Pentland, 1889. See also 'Report on a Study of the Conditions of Infection'. *Brit. Med. Journal*, July 31, 1886.

injected subcutaneously or into the peritoneal cavity when it was diluted forty times or more. In experiments on feeding animals with the sputum from phthisical patients he found that infection did not occur when the sputum was diluted more than eight times, although the same sputum diluted 100,000 times caused infection when injected subcutaneously. He obtained the same results when pure cultivations of tubercle bacilli were used, and he notes that the disease runs a much slower course when the number of bacilli originally introduced was very small. Wyssokowitsch found that it was necessary to inject more than forty tubercle bacilli into the veins of rabbits in order to produce infection, and he makes the same observations as to the more severe character of the disease, the greater the number of bacilli primarily introduced.

The conditions which favour the deposit of these organisms in bones and joints are for the most part unknown, but experiments have shown that when large numbers of non-pathogenic organisms are injected into the blood they are rapidly deposited, and retained in the various organs, and one of their favourite seats is the medulla of bone, especially in the neighbourhood of the epiphysis. It has further been shown that the endothelium of the blood-vessels takes up organisms floating in the blood, and this fact is of great interest in connexion with the development of the tubercles from the vascular endothelium, to which I have previously referred. It is clear, however, that these facts alone are not sufficient to explain the affection of the joints, for we have to account among other things for the limitation of the disease, in the first instance at any rate, to a single bone or joint. König supposes that many cases of joint disease are due to embolism, the embolus being a plug of material containing tubercle bacilli. This view, however, even if it were correct, and the evidence in favour of it is very slight, does not help us much, for it is difficult to see why the embolus should stop just where it usually does, and besides we can hardly suppose that only a single group of bacilli escaped into the blood-vessels, and if there were more than one, why the disease should be only in one part. Besides, both from observations of Jani and others, if correct, and from experiments, it appears that a few bacilli may float about in the blood without causing local disease. Thus Steinheil produced tuberculosis in guinea-pigs by intraperitoneal injection of the expressed juice from the psoas muscles of patients who had died of phthisis, and Kastner has similarly caused tuberculosis in animals by the expressed muscle-juice of cattle suffering from advanced tuberculosis. Apparently there was no evidence of local disease of the muscles in these cases, and therefore we must assume that the bacilli were floating in the blood or juices of the body without causing local disease. It is quite clear from the above considerations that there must be local conditions at work as well.

One very important local condition is a previous injury, and I have already referred to Krause's experiments, which clearly demonstrate this point. We can readily understand that injury may act in various ways in determining the occurrence and localization of infective diseases. One very obvious way in which injury may act is by leading to extravasation of blood, and, if bacilli are floating in the blood, to their deposit in the part. Injury also favours the growth of the extravasated bacilli, in that the result of the trauma is the production of changes in the part similar to those noticed in the early stage of inflammation, these changes being necessary for repair, and at the same time implying, in the first instance, a weakening of the resisting power of the tissues. Even where there is no extravasation, a slight injury may favour the deposit of bacilli on account of the disturbance of the circulation, more especially the slowing, which results. As a rule, the cases where injury comes into play are usually attributed to a slight injury, such as a slight sprain or blow; the injuries are seldom said to have been severe. It is noteworthy that after severe injuries, such as fractures or amputations in tuberculous subjects, tuberculous disease does not occur at the seat of injury. I can recall more than one instance of a patient suffering from tuberculous joint disease who sustained fractures, in one case of the shaft of a bone, the epiphysis of which was the seat of tuberculous disease, and yet, although the injury occurred in the immediate neighbourhood of an extensive tuberculous deposit, but not actually involving it, the fractured ends united without the development of any tuberculous disease at the seat of injury. It is probable, as I pointed out in connexion with septic diseases, that after a violent injury there is so much reparative material, and the repair is so vigorous, that the bacilli cannot obtain a foothold, while slight injuries only disturb the nutrition of the part, or at most set up the early stage of inflammation, and thus produce conditions favourable to the development of the parasite.

We also not uncommonly notice that after tuberculous joint disease has become quiescent, and apparently got well, it may recur as the result of a slight injury. In these cases it is probable that the bacilli or their spores have remained dormant in the interior of hard tuberculous masses, and only wake up again when brought in contact with fluids and living tissue ; as the result of the injury these hard masses may be broken up and become infiltrated with the fluid poured out, and thus conditions may be furnished which enable the bacilli to grow again.

That the commencement of tuberculous diseases of bones and joints is often attributed to an injury is a fact so well known as not to require notice here, the point which has been so much disputed is whether the injury was in reality the starting-point of the disease, or whether the disease was not in existence before, and the injury either only attracted attention to the part, or at most gave the disease, so to speak, a fillip. I have myself no doubt from various clinical facts that injuries such as sprains may directly lead to the deposit of tubercle bacilli in the injured part and the development of tuberculous disease, and I believe this is due to some interference with the local protective mechanism as the result of the injury. I could mention a number of cases which to my mind clearly indicate this, but I need not take up space in doing so. I may, however, allude to the following points which came out in a statistical analysis of a considerable number of cases which I made some time ago.

1. That where there is no history of injury, the proportion of cases of tuberculous joint disease occurring in males as compared with females, commencing before and after 10 years of age, is practically the same, viz. 60 : 40.

2. That the proportion of cases attributed to injury in males and females under 10 years of age is practically the same as where there is no history of injury, viz. 62 : 38, while after 10 years of age the proportion alters very much, viz. 85·3 : 14·7.

3. That of the cases in males attributed to injury, by far the largest proportion began after 10 years of age, viz. 28·4 before to 71·6 after, while the reverse is the case in females, viz. 58·4 before to 41·6 after, numbers which do not at all correspond with the facts in cases where there was no history of injury.

Now it is generally held that the liability of males to injury is greater in later life than that of females, while I think we may safely assume that before 10 years of age their liability is the same. In correspondence with this the proportion of uninjured and injured females below 10 years of age is about the same as that of males, while in later life there is an increase after injury of about 14 per cent over that proportion in males, and a diminution of 14 per cent in the case of women, i.e. instead of the proportions remaining the same there is an increase in males of 28 per cent over females. Whatever be the exact meaning of the difference in the proportion between males and females at different periods of life, it is therefore clear from all these facts that injury plays a part which is not merely accidental, but that it is an active exciting cause of the disease.

A further point which these statistics seem to indicate is that there is a local as well as a general susceptibility to injury, for it is not always in cases of disease of the most exposed joints that one most often gets a history of injury, and also the frequency with which the different joints are affected varies somewhat in males and females respectively.

Lastly, it seemed from these statistics as if injury were not only an active agent in the production of these diseases but also as if it determined a graver form. The cases in which injury was given as the cause were more serious than those where no cause was assigned as judged by the severity of the treatment required for cure, by the results as regards complete recovery, and by the occurrence of suppuration. In the cases which followed injury, amputation and excision were much more frequently required, suppuration more often occurred, and the recoveries were fewer than in those which apparently commenced spontaneously.

It would be interesting, if the above points should be confirmed by more extensive statistics, to establish, if possible, some relation between the pathology of these diseases and the injury in order to account for the facts. It is conceivable that the depression of vitality of the tissues, as the result of the injury, may not only furnish a favourable nidus for the development of the tubercle bacilli, but may also leave a more or less lasting effect, enabling them not only to obtain a foothold but also to grow more luxuriantly. That this is not altogether improbable is shown by the fact that the occurrence of an injury such as a twist of the joint during the course of the disease may render a trouble which was only progressing slowly a permanently active one. And it is also well known with regard to the use of violence in overcoming deformities, the result of tuberculous disease, that this violence may again light up the process and lead to recurrence. It is conceivable also that injury may produce a graver disease by determining its outbreak in a special tissue, more especially in the bone. In the statistics to which I have referred, the facts as to the primary seat of the disease are very imperfect, because the treatment was not, as a rule, such as to elucidate this point, nor were special investigations made in cases where a decision was possible. Nevertheless, it is striking that of the cases where there was little doubt that the bone was primarily affected a considerable excess occurred in those where there was also a history of injury. Thus of 301 cases the bone was undoubtedly primarily affected in 94 or 31·2 per cent. Of the 193 uninjured cases the bone was the primary seat of disease in 53 or 27·4 per cent ; in 108 traumatic cases the bone was primarily affected in 41 or 37·9, an excess of primary bone disease after injury of 10·5 per cent. It seems to me that injury would most probably tell more on bone than on the soft parts, for the latter slide before a blow, while the bone receives the full force of it, and in sprains the part of the ligaments on which the strain chiefly tells is probably the attachment of the ligament to the bone. Again, in the ends of bones the formative process is, of course, most active during the period of growth, and disturbances of the circulation such as are produced by injury may readily act as the starting-point of the disease, enabling the virus to gain a foothold in the part, which it does the more easily as the tissue is in a young and transient state.

Apart from the question of injury there is some local condition which is not very clear which influences the outbreak of the disease more frequently in one bone or joint than in another. Varying estimates have been given by different writers as to the relative frequency with which the individual bones and joints are affected, the variations being due partly to the age of the patients examined, and partly to whether they were in- or out-patients. I need not go into all these statistics, but I think the following table which I have compiled from various sources gives a fair estimate of the distribution of the disease including all ages. The table clearly shows the existence of some local predisposition which we cannot as yet define, which renders one part more liable to be attacked than another.

Spine	23·2 per cent
Knee-joint	16·5 ,,
Hip-joint	14·6 ,,
Tarsus and ankle-joint	14·4 ,,
Elbow-joint	6·3 ,,
Wrist and hand	6 ,,
Skull and face	5·5 ,,
Sternum, clavicle, and ribs	5·2 ,,
Pelvis	3·5 ,,
Femur, tibia, and fibula	3·5 ,,
Shoulder	1·5 ,,
Scapula, ulna, and radius	1 ,,
Humerus	0·8 ,,
Patella	0·1 ,,

Another local factor which in all probability influences the occurrence of the disease, and which in my opinion certainly favours its spread, is chronic inflammation. It is, of course, almost impossible to point to any individual case and say that that case illustrates the occurrence of tuberculous disease in a part which was previously the seat of some chronic inflammatory trouble, for the natural reply is, how do you know that the chronic inflammatory trouble was not tuberculous from the first? In the case of tuberculous cervical glands, however, we see that these often become enlarged as the result of what I think we must admit to be simple irritation from the mouth, head, or neighbouring parts, and that the glands so enlarged may ultimately become the seat of tuberculous disease, and we get this history so often that there seems little reason to doubt that the previous inflammatory enlargement has predisposed the part to the subsequent infection. Further, when tuberculous disease has commenced chronic inflammation is set up in the vicinity, and the tuberculous growth spreads in the directions in which the chronic inflammation is most marked. Again, it seems to me that the best explanation of the good results which sometimes follow aseptic incisions into tuberculous joints, where the synovial membrane is much thickened, and where none of the disease is removed, and also the good results of partial arthrectomies where only part of the disease is removed, is that the operative procedures have relieved or diminished the chronic inflammation around the tuberculous area, and have thus checked the progress of the disease. Among the cases which form my statistics there were 19 cases of disease of the knee-joint without suppuration, in which simple incisions were made through the thickened synovial membrane into the joint, none of the tissue being removed, and yet 15 of these showed marked improvement as the result of this treatment. This method of treatment was commenced on the principle of relief of tension before the tuberculous nature of these diseases was understood, and it is difficult to find any other explanation of the results than by supposing that the relief of tension led to cessation of the chronic inflammatory condition, and thus interfered with the growth of the bacilli.

Other factors which aid the extension of tuberculous disease, probably by keeping up a state of chronic inflammation in the part, are movement and the pressure of diseased surfaces against each other, whether from the weight of the body or from the tonic contraction of the muscles surrounding the joint.

The presence of pyogenic organisms along with tubercle bacilli is a very potent factor in aiding the spread of tuberculous disease. The tubercle bacillus evidently finds in many individuals great difficulty in obtaining and maintaining a foothold, and anything which depresses the vitality of the tissues will, without doubt, aid its progress. We have seen how the disease frequently assumes increased activity or springs again into life after an injury, one effect of the injury being to depress the vitality of the part. It may also be often noticed that, while the general health of the patient remains good, the local affection is very chronic and makes but little progress, while if the health becomes lowered, the local disease assumes a more rapid course, and suppuration often occurs. And so we might instance a number of facts in support of the statement that anything which interferes with the healthy state of the part and diminishes its vitality leads to more rapid extension of the tuberculous disease. Now, one of the most powerful depressing agents, both local and general, is a septic state of a wound. The septic organisms, by virtue of the products of their growth, interfere seriously with the vitality of the tissues, and render them less able to resist the invasion of other parasites, while these products, being absorbed, still further favour the local and general spread of the disease by their effects on the system generally. Thus, apart from the suppuration, profuse discharge, hectic fever, &c., which are the results of sepsis, the local tuberculous disease makes more rapid progress when there is a septic condition of the diseased part than when the skin is unbroken and the tissues are not depressed from this cause. It may be pointed out that this is not in accordance with the prevalent opsonic view at the present time. On that view the septic organisms would grow because the resistance of the body was diminished against them, but their presence would not affect the opsonic index against tubercle. The clinical evidence does not, however, support this view, but on the contrary implies diminished resistance against tubercle as the result of the presence of sepsis.

The influence of sepsis in keeping up the tuberculous process is well seen when we compare the result of the aseptic drainage of abscesses connected with tuberculous disease of bones and joints with that obtained in septic cases. Taking the cases of spinal abscess in statistics which I compiled some years ago from Lord Lister's case-books and my own, we have a record of 58 cases treated by drainage, of which 49 remained aseptic from first to last, while 9 became septic. Of these 49 cases, at the last note 38 or 77·5 per cent had healed, 5 were improving but had not yet healed, 1 was still in hospital, and 5 had died ; while of the 9 septic cases, none had healed and 3 had died. I need not go into the statistics with regard to all the other bones, but the result is very similar ; in the case of the hip-joint, however, I may mention that we had 25 cases of suppuration connected with this joint treated to the end by aseptic incision and drainage, and of these, 72 per cent were cured, 24 per cent were incomplete, some doing well, some not, and 4 per cent had died. Contrast this result with Mr. Howard Marsh's table of 260 septic hip-joint cases, of which 32·8 per cent were known to be cured, 23·7 per cent were incomplete, and 33·5 per cent had died. Contrast also our results in spinal abscesses, treated aseptically, with the universal opinion of surgeons before the antiseptic era, that these abscesses but rarely healed after they burst or were opened. The serious interference with healing, caused by the presence of pyogenic organisms, would also be still more evident if we contrasted the severity of the treatment required for cure in cases with aseptic and with septic sinuses respectively. I need, however, only mention here that in 105 cases of disease of the larger joints with aseptic sinuses excision or amputation was only required in 37 or 35·2 per cent, while in a similar number of cases with septic sinuses these operations were necessary in 69 or 65·7 per cent.

It is true that in these septic cases the bad results as regards life may be due directly to the pyogenic organisms setting up and keeping up suppuration and septic disease, quite apart from any extension of the tuberculous process, but it cannot be the presence of the septic organisms alone which prevents the wounds from healing, for we know that suppurating wounds in healthy tissues heal readily enough in spite of the sepsis ; it must be that the septic condition, superadded to the tuberculous disease, prevents the latter from being destroyed by the tissues, and not only so, but actually aids the growth of the tubercle bacilli.

I have also found in experiments that the disease is more rapid in animals where tuberculous sputum (i.e. septic tuberculous matter) is used, than when an approximate number of tubercle bacilli in pure cultivation is injected. This influence of sepsis is also, no doubt, the main explanation why, as a matter of experience, partial operations, such as gouging or scraping away the diseased parts, are not looked on with favour, for the septic condition, if not eradicated at the time of the operation, rapidly lowers the vitality of the part which may have been left free from disease, and thus reinfection soon occurs from the diseased portions left behind.

It has also been pointed out by König and others that tuberculous meningitis is more frequent in septic than in aseptic cases ; thus, of sixteen cases of tuberculous meningitis which occurred in König's practice eleven affected septic cases. In former times, too, phthisis seems to have been more common after these joint diseases than it is now, and this fact I am also inclined to refer to some extent to the septic condition of the wounds. Thus Billroth gives the proportion of deaths from phthisis and general tuberculosis in cases of tuberculous joint disease as 27 per cent, while König, working more antiseptically, gives it as 16 per cent. In our own cases the mortality from tuberculosis is very much less, but this may be to some extent due to the shorter length of time that the patients were under observation. Of our 386 patients, only 17 or 4·4 per cent are known to have died of tuberculous disease, including tuberculous meningitis, while only 42 or 10·8 per cent are known to have suffered from phthisis or tuberculosis elsewhere.

Passing now to factors which act in a general rather than a local manner, the first which we have to note is the question of age. The frequency with which the disease commences at various periods of life differs greatly in the case of different joints, but as a whole it is most frequent in childhood. This is well seen in the accompanying table, where we have first the percentages of the total cases, commencing in each quinquennial period up to 50 years of age, and secondly, the percentage of males and females. Thus, of every 100 cases admitted, 14·3 were males in whom the disease commenced before the end of the fifth year, &c. We thus see that the disease commences most frequently, both in males and females, during the first quinquennial period, and steadily decreases as age advances.

This table does not, however, represent accurately the risk of the occurrence of these diseases at different ages, for it may quite well be that a greater number of cases occur during the first five years of life, because a greater number

TABLE *showing percentage proportion of cases of bone and joint disease, commencing in each quinquennial period, and in males and females respectively.*

Age.	Total.	Males.	Females.
1–5	23·2	14·3	8·8
6–10	16	9·5	6·5
11–15	14·6	9·5	5
16–20	15	9·5	5·8
21–25	8·5	6·3	2
26–30	8·8	5·3	3·3
31–35	4	4	—
36–40	3	2·4	·8
41–45	2	2	—
46–50	2	1·8	·4
Above 50	2	1	1

of persons are alive at that age than at any other. In fact, it may be that the percentage proportion of individuals attacked during the first five years of life is actually less than that of those attacked say between 15 and 20 years of age, when considered in relation to the number of persons alive at these ages, and thus although more cases commence in the first quinquennial period, the actual probability of the occurrence of tuberculous joint disease may be greater in later life. Investigations of this kind have been made with regard to phthisis, and have led to the surprising result that in Copenhagen, Sweden, and various German cities, the danger of phthisis in any given individual constantly increases with advancing age, and that in advanced life a larger proportion of the individuals alive at that age die of phthisis than at the period of life in which it has been supposed to be most frequent (15 to 30 years). Fassbender has applied a similar mode of investigation to cases of tuberculous disease of bones and joints, and found that although the results did not correspond to those obtained in phthisis, yet the proportion of adults and old people affected was in reality greater than seemed to be the case.

Employing the German statistics of the proportion of persons per thousand alive at different ages, I have calculated the real frequency of the disease in my cases, and in the following table we have the ratio per thousand (expressed as a percentage) of my cases of disease of the seven larger joints beginning in each quinquennial period, to the persons alive at that quinquennial period. In the first column I give the apparent frequency, in the second the real frequency as calculated from my own cases, and in the last the real frequency as calculated by Fassbender.

Age.	Apparent frequency.	Real frequency. (mine.)	Real frequency. (Fassbender.)
1–5	232	167	108
6–10	153	134	145
11–15	150	145	113
16–20	153	164	157
21–25	85	98	77
26–30	88	120	109
31–35	41	60	76
36–40	30	48	106
41–45	20	36	66
46–50	20	42	85
In decades. 50–60	14	17	About 60
60–70	0	0	About 42
70–80	7	33	About 21

From this table it will be seen that my results, in the main, confirm Fassbender's conclusion that the real frequency of these diseases is greater in advanced life than has been supposed, but that it is much less than in youth. In my list the disease commences most frequently between 1 and 5 years of age, then declines and rises again between 15 and 20, and then again steadily declines, with the exception of slight rises between 25 and 30 and between 45 and 50; the accuracy of the latter numbers is, however, very doubtful, because I had only a few cases in my list which commenced at that age. My results agree with Fassbender's in the rise between 15 and 20 years of age, but disagree somewhat in the frequency between 1 and 5 and in later life.

Great differences exist as to the period of life at which the disease commences in different joints, as is evident from the following table in which I have indicated the percentage proportion of cases of disease in each of the seven larger joints, commencing in each decade.

TABLE *showing percentage proportion of total cases commencing in each decade affecting each joint. Thus, of* 149 *cases commencing during the first decade* 30·2 *per cent were cases of hip disease, &c.*

DECADES.	I.	II.	III.	IV.	V.
Hip	30·2	20·3	4·8	—	12·5
Knee	29·5	22·8	18·2	36·6	6·2
Ankle	5·4	5·9	3·6	3·3	12·5
Tarsus	4·6	5·9	8·4	3·3	18·7
Shoulder	—	1·6	4·8	—	—
Elbow	6·7	9·2	6	13·3	18·7
Wrist	·6	8·4	15·8	13·3	6·2
Fingers	1·5	4·2	2·4	—	—
Ribs	—	—	1·2	10	12·5
Os calcis	2·6	2·4	2·4	3·3	—
Odd bones	6·7	3·2	3·6	—	—
Spine	12	15·2	28	20	12·5

Thus, of 149 cases of tuberculous bone and joint disease (including ribs, fingers, &c.), which commenced during the first decade, 30·2 per cent were cases of hip-joint disease, 29·5 per cent were cases of disease of the knee-joint, and so on. Now from this table we see that of the cases commencing in the first decade the highest point is occupied by the hip-joint ; in the second decade by the knee-joint ; in the third decade by the spine ; in the fourth decade by the knee ; and in the fifth decade by the tarsus and elbow. As regards the various joints, we see from the former chart that hip-joint disease commences by far most often during the first decade, and its frequency diminishes very rapidly. The knee-joint is also most frequently attacked during the first decade, but the fall in frequency is by no means so rapid, and the cases are fairly numerous even above fifty years of age. Ankle-joint disease also commences slightly more frequently before ten years of age, but also very frequently in the second, and to a less extent, in the third decade. Disease of the tarsus is much more evenly distributed over the first three decades. There were no cases of disease of the shoulder-joint during the first decade, and they were most frequent in the third. The elbow-joint was rather more frequently affected in the second than in the first decade. Disease of the wrist-joint was most common in the third decade, and very rarely commenced in the first. Disease of the fingers was most common in the second, of the ribs in the fourth, and of the os calcis in the fourth. Disease of the spine was most common in this list in the third decade.

From the above list we would arrange the various bones and joints in the following order of frequency of occurrence, from youth upwards :—hip ; knee ; ankle and elbow ; tarsus ; fingers ; spine ; shoulder ; wrist ; ribs. In order of frequency of occurrence during the first decade we have :—hip ; knee ; spine ; elbow ; ankle ; tarsus ; fingers ; wrist. While this list gives a fairly accurate idea of the state of matters, there is one glaring discrepancy from what we know to be the case, viz. with regard to the spine. Spinal disease is in reality by far the most frequent tuberculous disease of bone during the first decade of life. Thus, taking the surgical out-patients seen at Paddington Green Children's Hospital up to June 1888, we have a total of 2,997 at or below 10 years of age, and of these 190 were cases of tuberculous disease of bones and joints. Of these 190 cases 78 were cases of spinal disease, 44 of hip-joint disease, 24 of knee-joint disease, 13 elbow-joint, 3 of tarsus, 1 of ankle, 2 of shoulder, 2 of wrist, 8 of fingers, 1 of ribs, and 14 of various other bones. This gives us the following order of frequency below 10 years of age, which we may contrast with the order in in-patients :—

Out-Patient List.	In-Patient List.
Spine.	Hip.
Hip.	Knee.
Knee.	Spine.
Elbow.	Elbow.
Fingers.	Ankle.
Tarsus.	Tarsus, excluding os calcis.
Shoulder.	Os calcis.
Wrist.	Fingers.
Ankle.	Wrist.
Rib.	Ribs.

Thus, there is no very marked discrepancy except in the case of the spine, and this discrepancy is quite in accordance with what we know of the course of spinal disease in children and adults. Cases of spinal disease have only rarely been admitted to the wards unless when abscess was present, and we know that suppuration in connexion with spinal disease is not common in very young children, but is very common in the second and especially in the third decade. Thus, out of 60 cases of disease of the spine, which I saw myself as out-patients, I only found it necessary to admit 9, while of 29 cases of hip-joint disease I admitted 10, and of 13 cases of knee-joint disease I admitted 7. Thus, the small number of spinal cases treated as in-patients during this decade and the smaller excess of hip-joint cases over knee-joint cases in in- than in out-patient practice is readily explained. These results correspond very closely with those given by other writers.

I may mention another point with regard to age, viz. that several authors—Müller, for example—have held that tuberculous disease of the spine does not occur before the third year of life. In our list of in-patients, however, we have one case which began at 3 months, and 3 others during the first year of life. Of the out-patients 4 were only a few months old when they came under observation, 3 were a year old, 9 in the second year, and 6 two years old. It is certainly the fact that chronic tuberculous disease is rare during the first year of life. Thus, Frobelius, with a material of over 91,000 children in a Foundling Hospital, found that the deaths from tuberculosis in children under one year of age were 0·4 per cent of all the children, and 2·2 per cent of all that died. He concludes that tuberculosis is a rare disease during the first year of life, that sex has no influence over the disease at this age, that overcrowding and bad ventilation predispose to it, that inhalation tuberculosis is the most frequent form, and that the disease, though sometimes localized in one organ, usually becomes rapidly general.

In my statistics I have also found that age not only affects the commencement of these affections, but also influences their severity, a fact long known and accepted. That this should be so is not a matter of surprise, for the activity of the vital processes and the resisting power of the body diminish with age. I need not go into all the points which show the increasing severity of these affections with advancing age, but I may refer to one, viz. the frequency of suppuration. Taking only the cases admitted to the hospital, I find that during the first decade 66 per cent ultimately suppurated; during the second decade 74·5 per cent; and during the third decade 86·2 per cent. No doubt this does not give an absolutely accurate idea of the relative frequency of suppuration, for of out-patients during the first decade really only a small number suppurated, and the above figures are, no doubt, in all cases too high, but more especially during the first decade. This increasing severity of the disease in joint cases as age advances may be to some extent due to the increasing proportion of cases in which the disease commences primarily in the bone, and also to the greater frequency of sequestra over soft caseating deposits.

Sex is also another important factor in the production of these diseases. Thus, in our 386 patients under treatment in hospital, 251, or 65 per cent, were males, and 135, or 35 per cent, were females. This is a fact which is noted by most authors, although the relative percentages of the two sexes may be somewhat differently given ; in the case of the spine, the statements are the most contradictory. The relation of the sexes varies at different ages, as is shown in the former table (p. 109). Thus, of the total number of cases admitted, 14·3 per cent were males, and 8·8 per cent were females, at or below five years of age, &c. The predisposition of the sexes to disease also varies according to the joint in question, as seen in this chart, where we see that the numbers most nearly approach one another in the case of the knee-joint, 57·6 per cent being male, and 42·4 per cent female, and are furthest apart in the case of the tarsus, where 85·8 per cent are males, and 14·2 per cent females. (The cases of shoulder-joint disease were too few to be of value.)

Percentage Relations of Males and Females in each Joint.

	Hip.	Knee.	Ankle.	Tarsus.	Shoulder.	Elbow.	Wrist.
Males . . .	59·7	57·6	81·9	85·8	50	74·3	75·9
Females . .	40·3	42·4	18·1	14·2	50	25·7	24·1

Further, it appears that the disease is more grave in males than in females, and that to some extent independently of age or injury, whether we test the matter by the severity of the measures required for cure, by the results of treatment, or by the frequency of suppuration. This is a point which is not referred to, so far as I have seen, by other writers, although some, such as Albrecht, give tables of the methods of treatment employed in the two sexes, and these tables show a larger proportion of cases treated by the expectant method, and a smaller proportion of cases treated by excision and amputation in females than in males. This fact would, however, correspond with the less susceptibility of females to the disease; diseases when they occur in individuals but little susceptible to them, being as a rule milder than when they attack the highly susceptible.

Among other general predisposing conditions are those which have led to the belief in the heredity of tuberculous disease. I have already referred to this matter on p. 94, but apart from the question of heredity of the actual disease there is no doubt that it is more apt to occur, and is more severe in some families than in others. This may in part be due to greater opportunities of infection where one or more members of a family are already the subjects of tuberculous disease, but it also seems that certain families have a greater tendency to contract the disease than others. In other words, the conditions which render a patient liable to disease are transmissible to his offspring. Where these conditions are present and fully developed the bacilli naturally get an easier and a firmer foothold, and grow more luxuriantly than in other individuals, and the disease is thus correspondingly graver. Scrofulous children are more predisposed to the occurrence of tuberculosis because the tissues, apart from their peculiar tendency, are less strong and active, seeing that the children are usually delicate, and are thus more confined to the house and to badly ventilated rooms, &c., than healthy children. These or similar conditions of the tissues may also be induced by poverty with its attendant evils. The bad hygienic conditions under which poor children live, their confinement to badly ventilated rooms, or to the foul alleys of large towns, the deficient quantity and bad quality of their food, &c., are all factors which deprave the constitution and render it less able to resist the attacks of any parasitic disease. There is also some reason for supposing that, apart from the poor quality and deficient quantity of the food, its chemical constitution is of some importance, and notably that an excess of vegetable food is bad. As regards food, Bidder, in speaking of the treatment of these diseases, lays great stress on the avoidance of substances rich in potash and also of starchy materials, and strongly advises the employment of albuminous foods rich in soda and fat. A probable confirmation of this view is the noteworthy fact that tuberculosis is, as a rule, very common in herbivorous animals, and can usually be readily induced in them, while on the other hand, it seldom occurs in the carnivora. Man who employs a mixed diet stands midway between these two groups in his susceptibility to this disease, tuberculosis being more often local and less virulent than in the herbivora, while it is much more frequent and destructive than in the carnivora. In this way also Bidder explains the much greater frequency of tuberculous diseases in the western part of Germany than in the eastern, although the density of the population is greater in the latter; it appears that the inhabitants of Eastern Germany employ less vegetable diet than in the west, and eat large quantities of salt meat.

CHAPTER X

ON THE CURABILITY OF TUBERCULOSIS AND THE CAUSES WHICH INTERFERE WITH RECOVERY

Before going on to the discussion of the various methods of treatment, we must inquire what the natural tendency of tuberculous disease is as regards recovery, in what way spontaneous cure takes place, and what factors tend to oppose its occurrence.

The relation of the tubercle bacillus to the living tissues varies much in different species of animals. In some, such as guinea-pigs, the tissues are invariably overcome in the struggle with the parasite, and the result of the subcutaneous inoculation of even a few tubercle bacilli into these animals practically always leads to the production of a local tuberculous lesion, subsequent dissemination of the disease over the body, and the death of the animal. On the other hand, in the dog, for example, the tissues are much more powerful in their action on the bacilli, and unless the latter are introduced into the body under exceptionally favourable circumstances, they die out, and the animal remains well. Thus, in the case of dogs, large numbers of bacilli must be used, whether for inhalation or injection ; small numbers usually produce no effect, and, further, there is a very strong tendency to localization of the lesions, as shown, for example, by Tappeiner's inhalation experiments, in which large quantities of infective material were used, and the tubercles remained limited to the lungs in the great majority of the cases. In man the conditions are somewhat analogous to those in the dog ; the tubercle bacillus in many cases makes headway only with great difficulty, the disease often remains localized for a long time or altogether, and there is a constant tendency under favourable circumstances for the process to come to a standstill ; in fact, in many cases comparatively little is required to turn the scale against the parasite. Hence in the case of man there is a great probability of recovery from tuberculous lesions.

Recovery may take place either after the formation of a communication between the tuberculous deposit and the exterior, or without any such communication. Where a tuberculous deposit has opened externally, a considerable portion is evacuated, and when healing occurs, only a fibrous induration, with sometimes a little caseous material in it, is left to mark the seat of the original disease. Where no communication has formed externally, the retrogressive changes are of various kinds, depending on the extent and character of the lesion, more especially on whether the tubercles are discrete or agglomerated in masses, and on whether caseation has occurred or not. Where the tubercles are discrete and not caseous at the time that the bacilli cease to grow, the probability is that the tubercle will disappear and leave practically no trace behind, the amount of fibrous tissue resulting from the organization of each single tubercle being too small to be noticeable. How this exactly takes place is not quite clear. In specimens from cases of synovial disease treated by the old tuberculin, in which retrogression was occurring, I found apparently two sets of changes. In the one the epithelioid cells of tubercle seemed to disappear, probably by a process of atrophy, their place being taken by smaller cells, which developed into fibrous tissue ; this seemed to be the most common appearance. In other cases the epithelioid cells themselves became spindle-shaped, and developed directly into fibrous tissue. Similar appearances may also be found in synovial membrane, in which improvement is taking place quite apart from the use of tuberculin, but I think the first form is the most common—viz. that the epithelioid cells atrophy and disappear, and a small fibrous scar is formed from the cells outside the tubercle. Under these circumstances a true cure results. Where recovery takes place in a case of early synovial disease where the tubercles are still discrete and not very numerous, the process is no doubt of the nature above described, and the amount of newly formed fibrous tissue being extremely small, and in patches rather than continuous, there is little or no ultimate limitation of movement. Cases of tuberculous synovial disease recovering with complete restoration of movement are not very common, but I have had a number where the treatment was begun quite early, and persevered in for a long time, with complete recovery as regards appearance and function, and no apparent proneness to relapse. As a rule, however, somewhere or other the tuberculous tissue is massed together, and then, if complete recovery of the tuberculosis does take place, a greater or less amount of stiffness is left behind, owing to the larger amount of new fibrous tissue formed.

Where the tuberculous masses are larger, or where caseation has occurred, at any rate to a marked degree, complete cure seldom occurs, although the disease not uncommonly becomes quiescent. In such a case, a large amount of fibrous tissue is formed around the mass, and, no doubt, a considerable amount of the tuberculous material disappears, or is converted into fibrous tissue, but where the mass of tuberculous tissue is large, remains of tubercles or portions of caseous material, often infiltrated with calcareous salts, to such an extent as to form small calcareous nodules, are generally found towards the centre of the new fibrous tissue. These calcareous masses are more common than tissue showing a recognizable tuberculous structure, but in both cases it has been found that tubercle bacilli, or their spores, may be present in an active state in these remnants. Thus, Dr. Sidney Martin, in his paper on 'healed' or retrograde tubercle, read at the meeting of the British Medical Association in July 1891, states that while the fibroid and pigmented miliary tubercle never contains any tubercle bacilli, the calcareo-caseous tubercle almost constantly does. Similar conclusions have also been arrived at by other observers, both from microscopical observations and from experiments on animals, and clinically we know that these encapsuled deposits often contain the tuberculous virus in an active state, from the frequency with which the tuberculous disease recurs after an injury causing rupture of the encapsulating material. Hence we can only speak of cure in those cases where the result is more or less fibroid induration with complete disappearance of the tuberculous material. Encapsulation of a deposit is not true cure, but its occurrence, nevertheless, illustrates the fact that the bacillus often has a hard struggle for existence in the human body, and often fails to make headway or even to hold its ground.

What exactly happens when ‘ spontaneous cure ’ occurs is not quite clear. No doubt in cases of true cure the bacillus is in some way or other destroyed, and then the process naturally at once comes to an end, but in the case of encapsulation this is clearly not the explanation, for, as I have just mentioned, these encapsuled deposits usually contain active bacilli or spores. It must be that something or other has either led to temporary diminution of virulence of the bacilli, or to cessation of chronic inflammation around the deposit, or to both, with the result that the inflammatory tissue around the tuberculous deposit has developed into fibrous tissue, and formed a capsule around it which prevents the further spread of the disease, so long as this capsule remains uninjured. Whatever be the cause which leads to this result, it seems to be in most cases a local one, for not unfrequently while a tuberculous process in one part of the body is improving, a fresh outbreak may occur elsewhere. Similar changes in the local condition are often seen to occur in a reverse direction without any discernible cause, for example, the patient's health may remain good and yet an abscess develops in connexion with the local disease, which has remained up to that time very much *in statu quo*, and this is due not, as is supposed by some, to mixed infection from the accidental entrance of pyogenic organisms, but to extension of the tuberculous process. In connexion with the retrogression of tubercle, it is very curious to note in almost all the statistics, notably in Heitler's, and in those published in the *British Medical Journal* by Fowler and Sidney Martin, the large proportion of cases dying of cancer in which obsolete tubercle was found, as if either the change in the tissues which led to the cessation of the tuberculous process predisposed them to the cancerous invasion, or the occurrence of cancerous disease led to the cessation of the tuberculous process.

These changes indicating healing or retrogression have been most carefully studied at the apices of the lungs, and in these parts they occur either as fibrous and often pigmented indurations without any trace of tuberculous structure, or as encapsuled deposits, generally cheesy or calcareous, but sometimes still showing tuberculous elements. The frequency with which these evidences of arrest of tuberculous disease is found at post-mortem examinations is variously given by different authors. Thus Heitler, in a paper published in the *Wiener Klinik* in 1879, states that in 16,562 post-mortem examinations, obsolete tubercles, or rather calcareo-caseous nodules, were found in the lungs in 789 cases or about 4 per cent of the whole ; Fowler, in a much smaller number of post-mortem examinations, found signs of obsolete tubercles in 9 per cent, and Sidney Martin in 9·4 per cent, while Coats gives the frequency of these deposits in patients dying of non-tuberculous diseases as over 23 per cent, and Harris as 38 per cent in persons over 20 years of age. Harris, however, states that in some of his cases evidences of active tubercle were found on microscopical examination, and as all were not examined microscopically he thinks that the proportion of 'healed' tubercle would require to be considerably reduced. As to the relative frequency of fibroid changes, which, if resulting from tubercle, imply really cured lesions, and of encapsulation of tuberculous deposits, Sidney Martin found the ratio to be 1 : 4, thus reducing his percentage of really cured tuberculosis to 2·7 per cent in post-mortem examinations of patients dying of non-tuberculous diseases. While, however, it is not certain that all these fibrous indurations have really resulted from tuberculous deposits, it is probable that Martin's figures represent fairly accurately the facts of the case.

With regard to surgical tuberculosis I can give no definite figures, but no doubt there are a considerable number of cases in which healing or encapsulation of tuberculous lesions occur even without treatment. I should think that encapsulation of calcareo-caseous deposits occurs probably more often in glands than anywhere else. In the case of tuberculous glands we frequently see, that while some suppurate, others remain enlarged and, as years pass, gradually diminish in size;

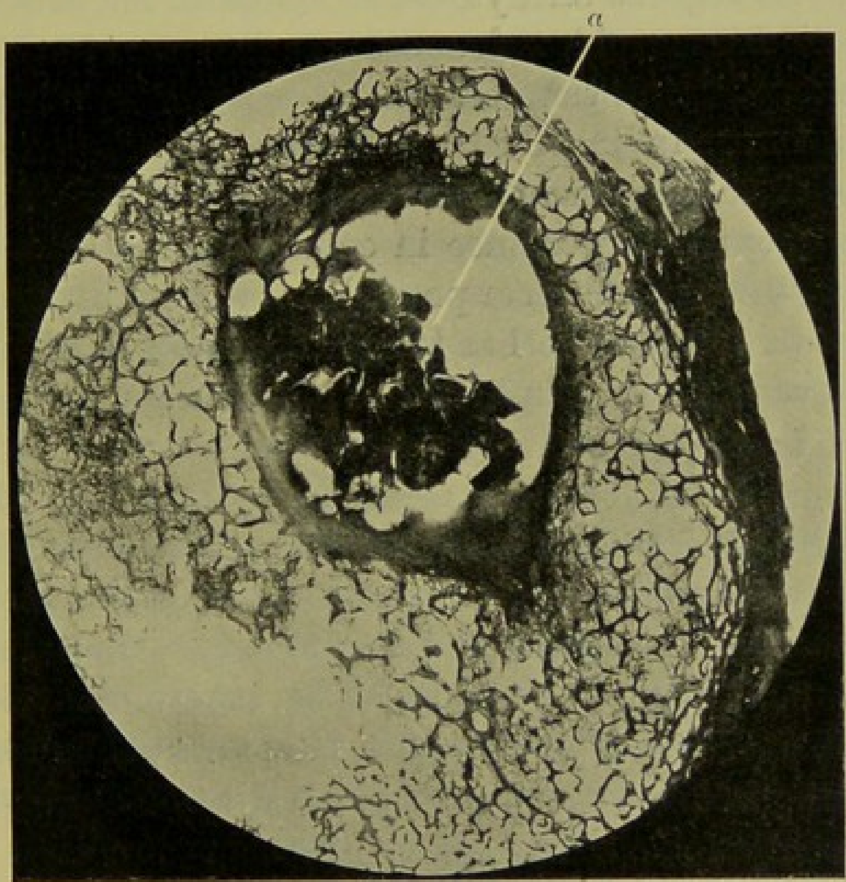


Fig. 46.—Section of the internal condyle of the femur showing the presence of an old encapsuled deposit (*a*) in the substance of the bone. The deposit is surrounded by a dense wall of fibrous tissue, and in the interior there is a quantity of cheesy and calcareous material with remains of the trabeculæ of the bone.

while we know, as the result of operations for the removal of tuberculous glands, that these contain caseous material.

As regards diseases of bones and joints I should say that, in the case of pure synovial disease, we have in a good many cases a true recovery, though in others there often remains, somewhere or other, an encapsuled tuberculous mass. On the other hand, where there are deposits in the ends of bones, encapsulation is the rule in the great majority of cases which recover without operation or abscess (see Fig. 46). In fact, although I have examined microscopically a considerable number of bones with old standing quiescent tuberculous lesions I have only once found appearances which justified the view that a bone deposit had been really cured ; in all the other cases encapsulation and calcareous deposition had occurred and the deposit remained as a constant source of danger. As regards anchylosis, although in the case of bony anchylosis I have seldom found distinct traces of tuberculous tissue except where tuberculous deposits were present in the bone, I have, in most cases of fibrous anchylosis, found remains of tuberculous tissue somewhere or other. This is a point of great importance in connexion with the hope of obtaining better position or possibly movement by subsequent treatment. Experience has taught the great danger of such procedures and the explanation is furnished by the fact which I have just stated.

As regards the *causes which oppose recovery* they are practically a continuance of those causes which I have previously referred to as being concerned in the production of the disease. I need therefore do little more than enumerate them here. Thus the presence of an inherited tendency to tuberculous disease, or, as one is now inclined to regard it, a deficiency in the resisting power, is just as potent in preventing recovery as in encouraging infection. And the various circumstances which have been referred to as lowering the general resisting power to infection, such as confinement in the house, life in bad hygienic conditions, residence in a bad climate, exposure to cold and wet, insufficient quantity and poor quality of food, and intercurrent diseases such as measles, scarlatina, whooping cough, &c., are equally potent in preventing recovery.

Among the local causes which set up the disease and which also tend to keep it up when it has once developed, the most important are those which tend to set up, and keep up, a state of chronic inflammation in the part. I have already pointed out that the tuberculous disease when spreading is always surrounded by a greater or less extent of tissue in a state of chronic inflammation, and that the disease tends to spread in the direction in which this tissue is most abundant. This statement is to some extent in contradiction with the view which seems to be widely held at the present time, viz. that inflammation is a protective process, and is nature's defence against infection. While I quite admit that one of the results of inflammation is the accumulation of lymphocytes and of serum with probably increased antibacterial properties in the part, the function of the tissue cells in the inflamed area, especially during the early stages, is diminished and more or less in abeyance, as shown, for example, by Lister's experiments on the pigment cells of the frog. My own opinion is that in many bacterial infections such as tubercle the main defence of the body is provided by the tissue cells rather than by wandering cells and blood-serum, and if the activity of these cells is diminished the tubercle bacilli may make headway and spread in the part.

Of the causes which increase the chronic inflammation, apart from the presence of the tuberculous disease, movement of the affected parts, and in the case of joints, pressure of the inflamed joint surfaces against each other, are the most important, and the improvement in the part when these two causes are removed is often very striking. Injury is also not only a potent factor in the production of these tuberculous diseases, but, as we all know, is very apt to aggravate an existing lesion, or to light up a disease which may have been quiescent for a long time. In the lighting up of a quiescent lesion the effect of the injury is either to rupture the fibrous capsule surrounding the tuberculous deposit or, where this fibrous tissue is only small in amount, to lead to the passage of fluid into the deposit, thus providing fresh pabulum for the growth of the bacilli. Its action in aggravating an existing disease may be partly due to increase in the inflammation and partly to the accompanying swelling interfering with the lymph flow, and producing a stasis of lymph in the part, a condition of matters which appears to be favourable to the growth of the bacilli. Disturbance in the circulation of the blood must also be of importance—for example, where the disease affects the lower extremity, if the limb is allowed to hang the free circulation of blood in the part and the removal of waste products are interfered with, and, as we know, wounds under such circumstances do not heal, or only with great difficulty. The results of Bier's treatment seem at first sight to be against this view, but in its active flow of blood and serum follows the passive congestion. Another local obstacle to the cure of a tuberculous deposit is where it has become encapsuled, and where therefore the defensive arrangements of the body cannot come into play. The bacilli are protected in the encapsuled area and many retain their vitality and virulence for a long time.

Apart from these various factors on the part of the body, the conditions on the part of the tubercle bacillus itself may exercise a considerable influence on the spread of the disease, and although these conditions are not under the control of the surgeon, it is well to bear them in mind. I have formerly pointed out that the severity of an infective disease depends to a great extent on the initial dose, and this also holds good in tuberculosis. As cases of bone and joint disease no doubt arise not merely from individual bacilli carried to the part by the blood, but also and probably most commonly by actual emboli of tuberculous material containing bacilli coming from some central focus, generally I think from the bronchial glands, the severity and acuteness of the disease will depend to some extent on the number of bacilli present in the original embolus. The virulence of these bacilli also varies to some extent, and it is found in experiments on animals that if the virulence is diminished by artificial means, the attenuated bacilli tend to set up local lesions, resembling scrofulous diseases in man rather than the more acute general disease, which is the usual result in the lower animals. On the other hand, it has been found that the virulence of certain organisms is increased by passage through highly susceptible animals, and it may be that in the case of tuberculosis in highly predisposed individuals the bacilli may gain in virulence, and thus the children, apart from their hereditary predisposition, are apt to get a more acute form of the disease as the result of the greater virulence of the bacilli which have been growing in their affected relatives, as well as from getting a large initial dose.

Another thing which favours the growth of the tubercle bacilli is the concurrent growth of other organisms. In the case of the lung the presence of other organisms, more especially of the micrococcus tetragenus, seems to have a great deal to do with the rapid breaking down of the tissue, and in open tuberculous deposits elsewhere there is no doubt that the presence of the ordinary pyogenic organisms leads to extension and persistence of the disease to a very marked degree. This is a point to which I shall subsequently return.

CHAPTER XI

TREATMENT OF TUBERCULOUS DISEASE OF BONES AND JOINTS

Methods which Act on the Body—General Hygiene—Value of Rest and Extension

Coming now to the treatment of tuberculous diseases, we must consider it under two separate headings—1. Methods of treatment which aim at improving the condition of the body as a whole, or of the affected part in particular, with the view of enabling the tissues to overcome the bacillus—methods, in fact, which do not act directly on the tuberculous virus, but only indirectly through the tissues of the body; and 2. Methods of which the essential feature is the removal or destruction of the tuberculous tissue, and with it of the tuberculous virus.

1. Methods which act on the Body and not directly on the Tuberculous Disease

These methods may act generally or locally, or both.

(*a*) *General Treatment.*—The first essential in the general treatment of these cases is to put the patient under as good hygienic conditions as possible, and the first requisite is that he should have pure air, and plenty of it. Where it is possible, it is well for these patients to live in the country, but where this is not advisable, a good deal can be done by free ventilation and plenty of cubic space.

In this connexion the question of climate naturally arises, but that is one which I shall not enter into beyond a few general remarks. The first question which we have to consider is, at what period of the disease the patient should be sent to a different climate. The conditions here are not so simple as in the case of phthisis. In that disease comparatively little can be done by local treatment or operative interference, and the treatment must be directed almost solely towards getting a better state of health and improving the condition of the lung ; in surgical tuberculosis, on the other hand, a great deal can often be done by local treatment—operative or otherwise—and it is always a question whether the local or the climatic treatment is, for the time being, of most urgent importance. In bone and joint disease it is mainly in the early stage, while there is as yet no question of operative interference, that the change of climate is of greatest value, or, again, after the necessary operative interference has been carried out ; where an operation is impending, or where such methods of treatment as extension are necessary, change of climate is, for the time being, inadvisable. The problem as to when it is best to send the patients to the country or when to keep them in town, so that the local treatment may be carried out under one's own superintendence, is thus a very difficult one, and quite different from that which has to be faced in connexion with phthisis.

Having decided to send a patient away, the next question is, Where he should go and what amount of liberty he should have. The determination as to place will depend to a considerable extent on the view which one takes as to the action of climate in the treatment of tuberculosis. Two views are held with regard to this matter—the one, that in the air in certain localities substances are present which have a specific anti-tuberculous action ; and the other, that the usefulness of climate depends on its effect in improving the general condition of the body, thus acting only secondarily on the tuberculous disease. The first view is that which is generally held by the laity, more especially with regard to sojourn at the seaside and to sea voyages, and it is no doubt the mainspring of the remarkable pilgrimage to Margate, which seems to be the first and most essential part of the treatment of surgical tuberculosis in their minds—a pilgrimage undertaken without the slightest consideration as to whether that is the climate which suits the patient best or not. Indeed, I have known patients persist in staying at the east coast health resorts, although they were never well there, on the idea that, though their bodily health was suffering, their tuberculous disease was being cured by the specific substances (iodine, ozone, or what not) contained in the air. This is, I am satisfied, an erroneous and hurtful superstition, and I agree with the view taken by the great majority of the authorities on climate—viz. that the efficacy of climate as an anti-tuberculous agent depends solely on its action in re-establishing the vigour of the body and enabling it to oppose successfully the parasitic invasion. From this point of view there is no one place which will suit all cases, and the decision must depend on a knowledge of the peculiarities of the patient, and on the stage and situation of the disease.

The first point to ascertain is the temperature which suits the patient best, some preferring hot weather, others being well only in a cool place. The question of temperature must also be considered in connexion with the possibility of the patient taking active exercise in the open air. Where a patient is unable to walk, the place chosen must be warm and dry, and it must also be sheltered from winds, because he ought to be out in the open, as far as possible, all day. Many patients undoubtedly do best at the seaside, but there are others—and I am not sure that they are not in the majority—for whom somewhat high inland situations are the most suitable. In the case of the latter patients, I believe the best thing to do is to send them to a farm-house in a high, dry inland part, such as Yorkshire in summer, Devonshire in winter, and let them be as much in the open air as possible. Where a seaside place is chosen, I think that in the early stage of the disease, or where the patient is weakly, the south coast health resorts are preferable, as a rule, to those on the east coast, although, after the disease has improved or been got rid of by operation, the east coast stations in summer often brace up the patient extremely well, and, so to speak, put the finishing touches to the treatment.

Another point of importance in connexion with a sojourn in the country is the question of exercise.

In connexion with Sir A. Wright's recent works much stress has been laid on the question of auto-inoculation in connexion with exercise, massage, &c., the view shortly being that during exercise some of the products of the local tuberculous disease are forced into the circulation and set up similar reactions to those induced by the injection of dead bacilli. If the dose thus given is not in excess, exercise is beneficial in this way as well as in improving the general health ; but the difficulty is the want of accurate control of the dosage. Whether this theory be correct or not, it has been found, for example, at the Brompton Convalescent Home that graduated exercises carried out to an extent not previously thought advisable are of the greatest benefit to the patients.

In surgical tuberculosis the question of exercise differs according to the situation of the disease. Where the disease is situated in the upper extremity there need be no difficulty as regards walking exercise, which, however, should never be carried so far as to tire the patient. While, however, exercise and fresh air are invaluable, the great tendency of injuries to lead to fresh outbreaks of the disease should also be borne in mind, and amusements or pursuits should be avoided in which there is an unusual risk of injury, especially of sprains.

Where the disease is situated in the lower extremity, I do not think that attempts at walking are good. Certainly not where the foot is placed on the ground and the weight of the body is borne on the affected limb. In some cases of knee-joint disease an immovable apparatus of silicate plaster of Paris, &c., is applied, and the patient allowed to walk about. This is not good treatment at any rate when the disease is active. The best plan in these cases is the use of Hessing's splint, in which the weight is borne on the pelvis and the foot does not touch the ground, or a Thomas's splint, which acts similarly. Where, however, the disease is at all active I believe that it is better that the patient should be kept in a recumbent position, wheeled into the open air, and exercise given him in the form of general massage. No doubt, this is only practicable in the well-to-do, but neither is change of climate practicable for the poor, except for a limited number and for a short time, while for a small fee a relative or attendant can acquire a sufficient knowledge of massage to enable him to do what is necessary to keep up the general nutrition of the muscles.

As to diet, it should be as nutritious and easily digested as possible, the meals should be more frequent than usual, considerable quantities of fat, or in its place cod-liver oil, should be given, and, in accordance with Bidder's views, to which I have referred, substances containing much potash should be avoided, more especially excess of vegetables. As to medicine, general tonics and substances to improve the digestion, cod-liver oil, &c., are indicated, but these must be considered in reference to the individual case.

(*b*) *Local Treatment*—(1) *With the object of improving the condition of the tissues at the seat of disease, so as to interfere with the existence and extension of the tuberculous virus, and not with the view of acting directly on the tuberculous tissue.*—We have already seen that one of the chief local obstacles to recovery is the state of the parts indicated by the condition of chronic inflammation, and that there are, apart from the presence of tuberculous tissue, two very evident causes which keep up this condition—viz. a condition of unrest, such as may be caused by movement or sepsis, and, in the case of joints, pressure of the diseased surfaces against each other. I shall, therefore, shortly refer to some of the means of avoiding these troubles, and of diminishing this chronic inflammation. The methods of treatment which act on this principle are grouped together under the heading of *expectant treatment.*

In combating this condition the first requisite is, as far as possible, to give absolute rest to the part, rest both from mechanical agencies and from chemical irritants, such as sepsis. The value of absolute mechanical rest is so great and so universally acknowledged, that one would think that in this matter, at least, there could not be any difference of opinion, and yet, so eminent a surgeon as Schede holds that complete immobilization of tuberculous joints is a hurtful thing, as evidenced by the frequent occurrence of effusions into healthy joints after they have been kept at rest for a long time and then left free, and he asserts that the cessation of the function of the joint leads to atrophy, that the synovial secretion ceases, the capsule shrinks, and movement becomes difficult and painful. He, therefore, in the case of hip-joint disease, applies extension without any other retentive apparatus, and allows the patients to move about in bed, and even in some cases encourages them to sit up, and he attributes the less satisfactory results which he has obtained in knee-joint disease as compared with hip-joint disease, partly to the lesser degree of movement which has been permitted in that joint. As to this point I think the question depends on the stage of the disease and its acuteness, and that in the early stage absolute rest is requisite. At the same time it is very probable that the tendency is to immobilize the joint for too long a time, and that after the disease has come more or less to a standstill a little movement, as apart from bearing weight on the part, may be a good thing in keeping up the nutrition of the tissues. Conditions leading to atrophy of bone can hardly indicate a vigorous action of the tissues in combating the tuberculous virus, and we see in skiagrams of diseased joints how very extensive is the atrophy of the bones in the neighbourhood, and not only of the diseased bone but of the other healthy bones which take part in the formation of the joint. Hence it cannot be good to keep the parts at rest too rigidly and for too long a time, as is apt to be the case when they are put up in plaster of Paris. During the acute stage of the disease, however, I think that absolute rest is essential.

In the case of tuberculous joint disease, surgeons, with very few exceptions, are unanimous in recommending rest, and it is sometimes very striking how much improvement results, even in very bad cases, from absolute fixation of the affected joints. In many cases of joint disease, the unrest is, however, not only due to movement, but also to a large extent to the tonic contraction of the muscles surrounding the diseased part and causing pressure of the joint surfaces against each other. When the bone has become affected, the joint is always found to be more or less completely fixed, the fixation being due in the early stage almost entirely to reflex contraction of the muscles surrounding it. The result is that the joint surfaces are kept constantly and firmly pressed against each other, and, as a consequence, the chronic inflammation in the bone is kept up, and rapid destruction of the surface of the bone subject to the pressure takes place. This is seen in the hip-joint, for example, in the flattening of the upper surface of the head of the bone, and in the enlargement of the acetabulum in the upward and backward direction. This muscular contraction, especially in the early stage, may be looked on as symptomatic of inflammation of the bone; in pure synovial disease, there may be marked thickening with comparatively little interference with movement within certain limits, certainly without complete rigidity.

Hence, when the bone is inflamed, mere rest of the joint as obtained by fixation apparatus will not be sufficient; the muscles would still be able to contract and keep up the pressure and inflammation. It is, therefore, necessary in these cases to combine with the rest a moderate amount of extension sufficient to tire out the muscles, and prevent this violent pressure of the joint surfaces against each other. Many surgeons object strongly to extension, under the impression that its object is to separate the joint surfaces from each other, and have pointed out that, unless very heavy weights are employed, no separation of the joint surfaces can as a rule be effected, while such weights may do great injury to the joint by stretching and irritating the inflamed ligaments, and not only to the affected joint but also to the healthy joints below. This is perfectly true, but separation of the joint surfaces ought not to be the object of the extension, and, even if it were readily possible, is not at all desirable. The object is not to separate the joint surfaces, but to prevent them from being pressed together—two totally different things. Hence, extension is chiefly of use in bone disease.

Where the case is one of pure synovial disease, and where there is no marked rigidity of the muscles, there is no object in employing extension unless deformity is present ; in fact, it will probably do harm. And further, from this point of view, it must be borne in mind that a weight which, in the first instance, relieves the patient, may, if continued after the tonic contraction of the muscles has been overcome, cause a great deal of pain and mischief from stretching of the inflamed ligaments. For example, to take a case recently under my care, a man with hip-joint disease of nine months' standing, complete rigidity, and great pain, especially in the knee, and starting of the limb at night, the employment of a 5 lb. weight at once relieved his pain, a long splint being also used. Thirteen days later he began to complain of pain about his hip-joint, especially in front, and this was relieved by reducing the weight to 3 lb. Ten days later there was return of this same pain, which at once disappeared on leaving off the extension and employing the long splint alone. In this case, I have no doubt that the muscular rigidity gave way more rapidly than usual, and that the fresh pain was the result of undue stretching of the inflamed capsule. It is, therefore, important in these cases to watch the extension, and to diminish the weight as soon as it is evident that the muscular resistance has been overcome.

I may, perhaps, best illustrate the value of extension in tuberculous bone disease by considering its effect in disease of the spine with paralysis. In spinal disease there are, in addition to the presence of tubercle, two factors at work in keeping up the chronic inflammation, and thus causing the destruction of the bone and the consequent curvature, viz. 1, the weight of the upper part of the body ; and, 2, the contraction of the muscles around the diseased portion of the spine, keeping the inflamed bones tightly pressed against each other. The inflammation so kept up is apt to spread to the meninges, causing thickening of them, pachymeningitis, which may be either of a simple inflammatory nature, or may be combined with tuberculous infiltration ; this thickening of the meninges leads to pressure on the cord, and is one of the causes of paralysis. This condition of pachymeningitis being, as I have said, kept up to a great extent in unison with the osseous inflammation by the action of the weight of the body and of the muscular contraction, it is clear that the first indication as regards treatment in a case of paralysis is to see what can be done by relieving these conditions. The best way of doing so is, I believe, by the use, in addition to complete recumbency, of extension to the head and feet, although I have seen improvement follow recumbency alone, especially when combined with the use of the actual cautery; this is a point which I shall speak of presently. It is, I think, becoming too much the fashion nowadays to perform the operation of laminectomy at once in these cases in order to relieve the pressure on the cord ; I think that in all cases a preliminary trial should be given to double extension, and that probably most cases would yield to that treatment without operation ; that certainly has been my experience.

The great importance of the second factor, viz. the tonic contraction of the muscles surrounding the spine, in keeping up the inflammation of the bone and leading to the subsequent paralysis, is not, I think, thoroughly realized, and the result is that it has appeared to some that the object of extension to the head and feet in these cases was to undo the curvature of the bone, an attempt which would probably only do harm. I have been surprised that this factor has not been more generally recognized, seeing that Lannelongue, who is undoubtedly the highest authority on the pathology and treatment of spinal disease, has laid special stress on the production of curvature and the extension of the disease as the result of this tonic contraction of the muscles surrounding the seat of disease, and on the value of double extension as a means of overcoming this trouble. Lannelongue states, in illustration of the effect of this muscular contraction, that he has seen a curvature occur while the patient has been kept absolutely at rest in the recumbent posture, and where the weight of the body could not therefore be the cause. I have seen the same thing in a case where a psoas abscess was opened and drained in an adult, and where the patient was kept absolutely recumbent and never allowed to sit up or raise his shoulders for any purpose whatever. When put to bed there was no distinct evidence of curvature, but after some months an acute curvature was quite manifest. Here also the weight of the upper part of the body could not be the cause.

I shall mention three cases to illustrate the advantage of extension. The first case is that of a boy aged 4½ years, who was admitted to Paddington Green Children's Hospital on April 6, 1888. Three years and a half previously the child developed tuberculous knee-joint disease after a fall, and this was under treatment for three years with good result. About 2½ years before admission the back was noticed to be weak, and the child was treated at a general hospital, first by plaster of Paris jackets, and subsequently by these combined with a jury mast, which he was still wearing when he came to Paddington Green. The curvature had been getting more marked and the child was rapidly losing flesh. He had been unable to walk for nine months during the last three months the legs had been rigidly extended. There was no history as to the anæsthesia.

State on admission: The patient is a delicate-looking child, fairly well nourished: both lower limbs somewhat wasted. There is a well-marked antero-posterior curvature affecting the 8th, 9th, 10th, and 11th dorsal vertebræ; no pain on tapping the spine, T. 100·8°. There is almost complete muscular paralysis of both lower limbs with wasting of the muscles; he can only make the very slightest movements, and that after great exertion. Bladder and rectum not affected. Skin and patellar reflexes much exaggerated. Marked contraction in lower limbs at knee-joint in whatever position leg is placed. Sensibility to touch and pain is absolutely lost in both legs up to groin, and there is an area of diminished tactile and painful sensibility on the abdomen up to the level of the umbilicus.

In this case, seeing that the paresis had lasted so long, I thought that laminectomy was certainly required, but, while waiting till it was convenient to perform it, extension was applied to the head and legs with weights of 3 lb. at each part, and the patient was put on 20-grain doses of benzoate of soda every four hours. On April 12 it was noted that there was marked improvement as regards sensation, which was now present, though still much below normal, in both lower limbs ; the proposed operation was therefore deferred. On April 25 it is noted that there was slight increase in the motor power, diminution in the patellar reflex, and considerable improvement in sensation. And on the 28th the sensation to pain, heat, and cold was quite normal in both limbs ; the sensation to touch had also improved, but was not yet quite normal. The next note is on June 2, when it is said that the patient can move the limbs quite freely in bed, and that sensation was normal ; on the left side the knee-jerk was still increased and ankle clonus was present ; on the right the knee-jerk was normal, and there was no ankle clonus. Towards the end of June he had an unexplained febrile attack, from which, however, he soon recovered, and was sent to the convalescent home in a Phelps box on July 14.

This patient improved steadily, and towards the end of 1890 was allowed to give up the Phelps box, and was fitted with a light support. Four months later he fell while climbing, and had recurrence of pain in his back, and was put back in the box. In July 1891 he went to Margate for ten weeks, and on his return was found to have some recurrence of the paralysis. He was re-admitted on October 27, 1891, but owing to an outbreak of diphtheria in the ward he was sent to the convalescent home four days later, where double extension was again applied. He subsequently recovered.

In this case the immediate effect of the double extension was very striking, and the only possible fallacy would be that the improvement was due to the benzoate of soda. Though I have in one or two cases seen improvement which I could only attribute to this drug, I have never seen anything so rapid or striking, and I cannot think that this objection is of much importance.

In the second case which I shall mention the trouble was not so marked. It is that of a boy aged 11, who was admitted under my care at King's College Hospital, on January 8, 1890. Three years previously he noticed that his back was 'growing out', but he had no pain and did not seek advice till ten months before admission, when he found that his legs were getting weak; this weakness gradually got worse, till, for the last three months he had been unable to walk and hardly able to move his legs in bed. On admission he was found to have an angular and also, to some extent, lateral (concavity towards the right side) curvature in the mid dorsal region, involving four or five vertebræ with acute prominence at the middle. He could, with great effort, move his legs slightly, but was quite unable to stand. There was no impairment of sensation. The patellar reflexes were exaggerated; there was ankle clonus on both sides, most marked on the left. No bladder or rectal trouble.

Extension by weights of 3 lb. each were applied to the head and legs and the body was fixed between sand-bags.

On January 13 it is noted that the ankle clonus is distinctly less and that the patient can move the legs better. His condition rapidly improved, and on April 29 he was sent to a convalescent home in a Phelps box, the reflexes being then normal and the muscular power completely recovered. He was kept in this box till February 15, 1892, when, as he seemed quite well, and had, in fact, been getting out of the box for the last two or three months without the knowledge of the nurses, he was allowed to leave it off. He was then able to run about quite well.

The third case was that of a girl, aged 13 years, who was admitted to Her Majesty's Hospital in connexion with Dr. Barnardo's homes, on October 1, 1891. In December 1889 her left foot was amputated on account of tuberculous disease. In the autumn of 1890 she began to complain of numbness in her legs, with difficulty in walking, but at that time no lesion was discovered. An angular curvature, however, developed soon afterwards in the upper dorsal region, and she was therefore placed in the infirmary in connexion with the Ilford homes in the beginning of May 1891, and kept recumbent for some months. As she did not improve she was transferred to Her Majesty's Hospital on October 1, 1891. Towards the end of November her condition was as follows: There was an angular curvature in the upper dorsal region, involving four vertebræ (4th, 5th, 6th, and 7th), not very abrupt. There was complete paralysis of motion in both lower extremities and complete anæsthesia as high as the ribs. Increased knee-jerk. Inability to control the bowels, but she knew when they were going to act. Increased frequency of micturition, but no incontinence.

At that time Dr. Milne, the acting medical officer, asked me to see the case with a view to laminectomy, and I advised him to apply double extension to the head and legs till I could arrange to come down, and if necessary operate. This was done on November 30, weights of 4 lb. each being used. Three days later it was noticed that she could move her toes, and she could feel a touch there and also over the lower part of the body and both thighs. On the 10th of December she could draw up her legs, and sensation had much improved. She was, however, at that time much troubled with incontinence of urine. The paralysis of the legs steadily improved, and had quite passed off in about six weeks, the rectal trouble was well, and the incontinence of urine was also less. At the beginning of March an abscess was found in the posterior triangle of the neck, which was opened and found to lead towards the diseased spine. This did well. The spine was also decidedly less curved than before the treatment was commenced.

The thing which strikes me as so remarkable in these cases is the very early improvement which takes place, so early, indeed, as almost to tempt one to think that after all some slight opening out of the curve must have taken place relieving the pressure. Although when the extension is long continued some slight improvement in the curve does occur in some cases, I cannot think that this is the explanation of the improvement in the paralysis. I believe that the relief is due to the rapid cessation of the congestion of the membranes and absorption of inflammatory material, as the result of the relief of the undue pressure of the inflamed bones on each other.

Although in these cases the operation was avoided by the employment of rest and double extension, and although I believe that most cases would yield to that treatment, I am far from saying that laminectomy is not sometimes necessary. In the instances I have related the cause of the paralysis was no doubt a pachymeningitis, which was kept up by the irritation caused by the weight of the body and the tonic contraction of the muscles surrounding the spine. In other cases, however, in addition to the inflammatory thickening, the membranes are infiltrated with tuberculous tissue which may not yield to treatment within a reasonable time, and for the relief of which it may be necessary to slit up the meninges. Or, again, the pressure is not uncommonly due to the presence of pus in the spinal canal, and unless this pus communicates with an abscess outside the canal, which can be opened, thus relieving the pressure, the only way of getting rid of the trouble will be by laminectomy. What I wish to urge, however, is that the operation should not be performed till double extension and rest in the recumbent position have been efficiently employed for at least two or three weeks. The same principle of extension first, followed by the use of proper retentive apparatus is, I believe, the best routine treatment, wherever applicable, in the case of tuberculous joint disease, where there is either superficial or deep disease of bone, as evidenced by fixation, &c. In this way, also, deformity can be most quickly and satisfactorily overcome. I should not, however, as I have said, advise extension in cases of pure synovial disease, unless where deformity is present, and then only till this is corrected.

CHAPTER XII

TREATMENT OF TUBERCULOUS DISEASES OF BONES AND JOINTS—*Continued*

METHODS WHICH DO NOT ACT DIRECTLY ON THE BACILLI—COUNTER-IRRITATION — ARTHROTOMY — PRESSURE — MASSAGE. TUBERCULIN

BENEFIT is also derived in some instances from other measures, which are of known value in cases of chronic inflammation uncomplicated by tuberculosis. In a case of chronic osteitis or periostitis, one of the first things that one suggests, in addition to rest and elevation of the part, is counter-irritation in some form or other. In other cases one makes free incisions into the affected part, sometimes combined with partial removal of the inflamed tissue, and, where the soft parts are affected, pressure carefully applied is sometimes of advantage, as also is massage. These measures also do good in some cases of tuberculous disease, I believe by reducing the chronic inflammation around, and thus bringing the parts into a healthier state, and I may therefore make a few remarks with regard to them.

Although counter-irritation is a favourite remedy in cases of simple chronic inflammation, and was formerly much employed in tuberculous disease, yet, under the erroneous idea that the only object of local treatment in these cases is to act directly on the tuberculous tissue, counter-irritation has been thrown aside by many, and some forms of it, especially the use of the actual cautery, have been derided. As I am trying to show, however, a great deal can be done in these diseases by getting rid of the attendant chronic inflammation, and for this purpose the severer forms of counter-irritation, viz. blisters or the actual cautery, are of value in suitable instances. I have not seen much good result from the use of counter-irritation in pure synovial disease, and in the case of superficial joints, such as the knee, I think that it may do harm.

On the other hand in cases of disease of deep-seated bones, such as the hip and shoulder-joints and the spine, I feel sure from experience that the actual cautery is sometimes of great use, especially where there is much pain. In applying the cautery in cases of bone disease, it must be done freely by means of a broad flat cautery at white heat, passed rapidly two or three times over a considerable area of skin; in the case of the spine, on each side of the spinous processes; in the case of the hip and shoulder, both in front of and behind the joints. After the application of the cautery, warm boracic fomentations are applied till the slough separates, and then savin ointment, either pure or diluted with vaseline, is used, and the sore kept open for about six weeks. I believe the best results are obtained when only the superficial portion of the cutis is destroyed, and when, therefore, many nerve terminations are exposed. The objection to this is that it is very difficult to keep these sores from healing rapidly, and savin ointment often causes such pain that it cannot be employed. Under such circumstances, it may be necessary to open up the sores as they heal by the use of potassa fusa or by fresh application of the cautery.

In 1888 I put together all the cases of tuberculous diseases of bones and joints of which I could find notes, which had been under the care of Lord Lister or myself as in-patients, for several years. In this way, I made a list of 412 cases of disease of bones and joints, and, among these, the actual cautery had been applied in 24 instances, and in a considerable number with marked and immediate improvement; in fact, in 17 of these 24 cases, or 70·8 per cent, no further operative treatment was required.

Another method of treatment which is commonly employed in the treatment of simple chronic inflammation with the very best results is to make free incisions into the inflamed tissues, aseptically of course, on the principle of relief of tension. In the case of chronic periostitis, there is no more effectual remedy than to make free incisions through the inflamed periosteum, and in the case of osteitis to gouge the inflamed bone extensively. In chronic enlargement of bursæ free aseptic drainage will frequently effect a cure, and a certain proportion of hydroceles are cured by incision and drainage. A good many years ago Lord Lister attempted to apply this same principle to the treatment of chronic synovial disease (the tuberculous nature of the disease not being at that time thoroughly understood), and with a certain amount of success. That good results may follow simple incisions into joints, the seat of tuberculous disease, although none of the disease is removed, is not more surprising, indeed not so surprising, as that good results may follow simple laparotomy in cases of tuberculous peritonitis, and yet there are now numerous cases on record in which the abdomen has been opened in cases of tuberculous peritonitis, either intentionally or by mistake, and where, though nothing further was done, though the wound was simply stitched up again, considerable improvement, in some cases apparently cure, followed the incision.

But with our present improved methods of performing arthrectomy and treating chronic abscesses, I think that simple arthrotomy has a comparatively small field. When we have once gone so far as to lay open a joint, we may as well go somewhat further, in most cases, and remove at least as much of the tuberculous material as is easily accessible. At the same time there are some cases where the disease is more or less stationary, or only progressing slowly, where an aseptic arthrotomy may be sufficient to lead to recovery. The cases most likely to do well are those where the thickening of the synovial membrane is not very great, and is firm, and where, on cutting through it, no cheesy or softened spots can be seen.

Of the other two methods of overcoming chronic inflammation I need say nothing. Pressure has been long employed in the treatment of tuberculous joint disease, more especially in the form of Scott's dressing, and some years ago Saxtorph recommended firm pressure by means of large masses of cotton-wool and silicate bandages. It seems to me that pressure must be very carefully employed, and that it is only of use in pure synovial disease. With massage also, which is recommended by those who seem to consider it a universal panacea, I think the very greatest care is required, and for my own part, with the exception, perhaps, of some stationary cases, I should not advise its employment. If used, the only permissible form is effleurage. If we accept Sir A. Wright's views, this caution is particularly necessary, because the result of the massage, according to him, is to produce an auto-inoculation, the dosage of which cannot be gauged. Whether this view be correct or not, I think that massage is better avoided while the tuberculous disease is progressive.

In addition to the methods which act more or less locally and indefinitely, attempts have been made to increase specifically the resisting power of the body as a whole to invasion by the tubercle bacillus.

About twenty years ago Koch introduced a glycerine extract of cultivations of tubercle bacilli as a method of treating tuberculosis, and this had a most remarkable action on tuberculous lesions. A few hours after the injection of this tuberculine the temperature of the patient went up, accompanied by a feeling of illness and sometimes a rigor. At the same time the tuberculous lesion became very much swollen and inflamed, and this was followed in a few days by subsidence of the swelling and marked improvement in the local lesion. Subsequent injections led to still further improvement up to a certain point, and in some cases to complete cure of the original lesion. In the great majority of cases, however, especially when the injections were discontinued too soon, the disease quickly recurred, often, however, not in the original spot, but in the vicinity or even elsewhere in the body. Indeed, some have held that one of the greatest dangers of the old tuberculine as administered at first was the risk of dissemination of the disease. Partly as the result of this fear of dissemination, partly from the great frequency of recurrence, and partly on account of the depression of vitality from the febrile reactions associated with the injections this method has fallen into disuse except in the hands of a few men.

Some years later Koch published a further paper, in which he described a new tuberculine which was to a considerable extent free from the noxious substances present in the old, and it is this substance which is now being used pretty extensively. Its use at present is largely the result of Sir Almroth Wright's interesting work on opsonins. Roughly put, his theory is that the injection of an emulsion of dead organisms leads to the development of bodies in the blood which, coming in contact with the bacilli, opsonize them, i. e. render them more suitable pabulum for the phagocytes, which are then able to engulph and destroy them. Wright gives very minute doses, e. g. $\frac{1}{5000}$ m.g. or less of the dead bodies of tubercle bacilli, and repeats them at considerable intervals, on an average about once every ten days. Very varying reports have been made as to the results. I have myself used it in a great many cases, but I must say that I have been very disappointed. I cannot, indeed, convince myself that I have seen any greater improvement in joint and bone disease or, indeed, in tuberculous disease elsewhere by the employment of the vaccine method than one would have expected to follow careful treatment on former expectant lines. It must not be forgotten that in many cases there is a natural and marked tendency for tuberculous disease to undergo cure, and one must be careful not to confuse this natural cure with the result of vaccine treatment. Large clinical experience is necessary to place the proper value on this vaccine treatment, and I cannot say that I have seen any results which would lead me to substitute it for active surgical treatment in cases where from my former surgical experience one would judge that operation was desirable. On the other hand, I would in most cases follow up operation by this treatment in the hope that it might prevent a further outbreak of the trouble, and also employ tuberculin on Wright's lines as an addition to the expectant method.

CHAPTER XIII

TREATMENT OF TUBERCULOUS DISEASES OF BONES AND JOINTS—*Continued*

METHODS WHICH ACT DIRECTLY ON THE TUBERCULOUS TISSUE—IODOFORM—GENERAL CONSIDERATIONS INFLUENCING THE QUESTION OF EXPECTANT VERSUS OPERATIVE TREATMENT

I MUST now pass to the consideration of the methods which act directly on the tuberculous tissue and the tubercle bacilli, and these are of two kinds, viz. : (1) the use of substances which are supposed to destroy the bacilli ; and (2) the removal of the affected parts by operation.

A variety of substances have been used, both generally and locally, with the view of interfering with the growth of the bacilli, but so far without any special advantage. Various antiseptics have been injected into the tuberculous tissue with the view of destroying the bacilli, for example, carbolic acid, creosote, guaiacol, &c., but these substances have failed in their object, and only irritate and weaken the tissues and enable the bacilli to spread. Thus Celli and Guarneri found that animals kept in cages and exposed to dry, finely powdered tuberculous sputum did not necessarily become tuberculous, but if their air-passages were injured, among other things by inhalations of sulphurous acid, a certain number became affected with the disease. Again, Sormain and Pellicarni administered creasote inhalations to rabbits which had been previously made tuberculous, and found that not only was tuberculosis of the lungs not prevented, but that the lung disease was actually worse in these animals than in others which had not been so treated. The only one of the substances which has been recommended to which I need refer is iodoform.

There has been much controversy as to the anti-parasitic effect of iodoform and its mode of action, and the question is still far from settled. Certainly no anti-parasitic effect can be produced outside the body; organisms grow, though perhaps more slowly, on soil thoroughly impregnated with iodoform, for instance, on the surface of potatoes thickly covered with the powder, while if tubercle bacilli are thoroughly mixed up with iodoform and introduced under the skin of a guinea-pig tuberculosis will still result. Indeed, septic infection has occurred in wounds, in several instances, from powdering them with dry iodoform, and this is one of the things to be guarded against in the use of this substance. Hence, in an operation performed through unbroken skin, iodoform cannot be recommended as an antiseptic with the view of preventing septic infection; this is certainly my experience, both in my own work and in what I have seen of the work of others. And yet if it is employed as an application to a putrid suppurating sore the smell very soon disappears and the suppuration diminishes. As an explanation of this fact it has been stated that, while pyogenic organisms grow in material containing iodoform, their poisonous products are apparently decomposed as soon as they are produced, and this decomposition of the bacterial products is accompanied by breaking up of the iodoform, and it is possible that the iodine thus liberated may act to a certain extent destructively on the bacteria. Whether that be so or not the destruction of the bacterial products deprives the bacteria of their weapons, without which they cannot do much harm, and they are then more rapidly destroyed by the tissues. And thus it may really be of service in tuberculosis not so much by destroying the bacillus as by breaking up its products and thus rendering it more or less incapable of doing harm. It has been pointed out by Krause that iodoform acts better in closed cavities away from the air, as in abscesses, than on a free surface, and that better results will be obtained in open tuberculous wounds by packing them well with gauze saturated with iodoform than by sprinkling the iodoform on the free surface. Certainly I have had several cases which seem to confirm this view, where tuberculous sinuses have done very well by slitting them up and stuffing them with iodoform gauze, better than by the former plans of scraping and draining them or injecting iodoform and glycerine. This packing is continued till the whole wound has granulated, but once that has occurred it should be given up, and if there is any cavity at the bottom a drainage tube should be substituted. As a matter of fact, in these cases I try as far as possible to make the wound conical with the apex at the bottom so that no cavity is left. Where the wound is tubular I do not advise stuffing, as the gauze is apt to act as a seton and keep up irritation and prevent the escape of the discharge.

We next come to the consideration of the various operative measures by means of which the tuberculous tissue is more or less completely removed. I must, in the first instance, say a few words as to the kind of cases in which expectant treatment is likely to prove successful, and those in which operation is desirable, but I need not go at any length into this question as I discussed it in a paper read at the Harveian Society in 1890, and published in the *Lancet* in October of that year. I need only indicate some of the points which influence our decision. Two points which exercise great influence in the minds of surgeons as regards this matter are the views which they hold as regards the curability of the disease by expectant means and as to the danger of infection of the body from the local focus. I have already discussed the question of the curability of the disease, and we have seen that, in many cases, the tubercle bacilli have difficulty in making headway against the body, and that very little will sometimes turn the scale in favour of recovery. Speaking generally, I do not think that we ought to take the very gloomy view as regards the prognosis of surgical tuberculosis which is held by some to whom the diagnosis, tuberculosis, at once suggests an extremely grave prognosis and a great necessity for radical operative interference.

The prognosis does not so much depend on the general views as to the curability of the disease as on the local condition of the individual case, and its tractability or intractability to treatment.

Another point which is not without influence is the question whether and how far the presence of a local deposit is a source of danger to the body generally, and to what extent operative interference will prevent that danger. It is, of course, clear that the presence of an active tuberculous deposit must be a source of danger to the body generally, seeing the great tendency of the tuberculous virus to get into the lymphatic or blood-vessels, and that the thorough removal of the tuberculous deposit will remove a source of infection. But in the case of joint disease it does not by any means follow that the removal of the local trouble will save the patient from fresh tuberculous deposit, or can do more than remove one source of infection. For it must be remembered that it is only very rarely that the joint trouble is the primary tuberculous lesion, most usually it is secondary to tuberculosis elsewhere, more especially in the bronchial glands, and although the joint trouble is completely removed, the further development of tubercle in other parts may still take place from another focus. The question must also be looked at from another point of view—viz. may not the operation itself lead to dissemination of the disease. This only applies to such procedures as amputation through the affected parts, excision, arthrectomy, or partial operations, such as scraping ; by amputation above the affected part there is no reason to suppose that any dissemination can occur. There certainly seems some ground for believing that partial operations can lead to dissemination of the disease, and that, far from saving the patient from further disease, they may lead to further infection. Thus, as regards acute tuberculosis, it seems, now, to be the experience of several surgeons that it occurs most frequently in cases that have been operated on. Thus König states that, of eighteen cases of acute tuberculosis in his practice, sixteen occurred after operation, and in the statistics I have put together we have a record of seven cases after operation, two at least being, I think, directly caused by it.

Wartmann, in a large number of cases, found that, after excision, 10 per cent died of acute general tuberculosis, many of the cases being apparently directly due to the operation. Of course it must be remembered, with regard to all statistics of excision, that, up till quite recently, excision was only a very partial operation as regards removal of the disease, and statistics, based on excisions as formerly performed, are no answer to the proposition that the removal of the disease will diminish the risk of general infection. I know of no statistics embracing a sufficient number of cases where the results of amputation above the affected part, or of really complete arthrectomies or excisions, are given, and I can only say that as regards my own cases, while I have, I think, twice lost patients from tuberculous meningitis after partial operations, I have had no case of the kind after complete ones. It seems to me to stand to reason that complete removal of the disease by cutting beyond it, not by scraping or gouging, cannot cause any real risk of dissemination of the disease, while, on the other hand, it can only rid the patient of one source of infection, leaving him, however, exposed to the occurrence of dissemination from the original focus. Hence, I do not think that the hope of preventing the extension of the disease need influence us to a large extent in deciding on operation as against expectant treatment. But in a case where the decision is doubtful, this danger may be allowed to turn the scale in favour of operation. On the other hand, in deciding what operation should be done, where the patient is highly predisposed and likely to develop tuberculosis elsewhere, the danger of partial operations must be borne in mind, and the decision given in favour of radical measures.

The existence of marked hereditary taint or of phthisis or tuberculosis elsewhere is, however, of importance, seeing the latter are often aggravated by the local disease, especially if sinuses are present, and are, vice versa, often much benefited by complete removal of the local affection.

The age of the patient also influences the question in that the chances of recovery without operation are greater in the young than in the old, that synovial disease, the most favourable form, is more frequent in the young, that certain operative procedures, such as excision, are practically prohibited in children, &c.

The most important point in coming to a decision as to the question of operation is the local condition of the part, more especially the extent of the disease, the signs as to recovery or otherwise, and the conclusion arrived at as to the possibility of recovery by expectant means. In the first place, we can at once divide tuberculous diseases into two great groups—viz. those in which chronic abscess has formed, and those in which there is as yet no noticeable breaking down of the tuberculous deposit. Excluding cases in which suppuration has occurred, we have to consider in which of the remaining cases operative interference is indicated, and in which it is desirable to continue expectant treatment. I have pointed out in the former chapters that the joint disease frequently begins at one part either of the bone or of the synovial membrane, and that it spreads from that part over the rest of the joint. Hence we meet with two conditions at an early stage of the disease—viz. either diffuse involvement of the whole structures of the joint, or a limited disease of the bone or synovial membrane, the latter usually in the form of polypoid tuberculous masses, as described by König, but sometimes in the form of limited thickening of the synovial membrane. Where this second class of cases are seen and recognized in the early stages, it may be possible to cut short the disease by early operation, performed with the view of removing the diseased tissue alone. Hence such cases come under the head of those requiring operative interference. This leaves us with cases of general disease of the joint without suppuration, which may be of several kinds—viz. primary synovial thickening, without affection of cartilages or bone; primary synovial disease, with destruction of cartilage and caries of the surface of the bone; synovial thickening, secondary to an osseous deposit, with or without caries ; and, lastly, one or other of these conditions combined with serious deformity. Of these cases, a cure is least likely to be obtained by means short of operation where a deposit is present in the bone, and in cases where the situation of the deposit is known, and where it is easily accessible, as in the olecranon, condyles of the femur, &c., it is often advisable to operate early, especially if the disease is progressing.

The best cases for expectant treatment are those of pure synovial disease without destruction of cartilage, especially where the thickening is not very marked and is pretty firm, and in children expectant treatment should be employed in the first instance in all cases of diffuse synovial disease, and also for a time, at any rate, where caries of the bone is present, and should be persevered in so long as the disease does not progress, or other circumstances do not arise necessitating operation. The presence of marked deformity, the question as to which method of treatment will give the most useful result ultimately, and often the question which will be most speedy also influence our decision in many cases.

I may sum up as follows :—Operative treatment is desirable in the following cases : where chronic suppuration has occurred ; at an early stage where the disease is localized to one part of the synovial membrane or bone ; in many cases at a later stage where there is a deposit in the bone along with general synovial thickening ; in cases of diffuse synovial thickening where expectant treatment has failed to arrest the progress of the disease ; in cases where a better functional result can be obtained by operation ; in cases in adults where deformities are present, which can only be remedied by operation ; in many cases where there are septic sinuses ; in certain cases where phthisis is present, or where the general condition is such as to require removal of the disease ; in adults more frequently than in children ; in the poor more often than in the rich.

Expectant treatment should be employed, in the first instance, in cases of diffuse synovial disease without suppuration, provided that there are no reasons requiring immediate operative interference, and it should be persevered in for a long time ; also at first in cases in children where osseous deposits are present in parts where they cannot be reached without excision ; and in some cases where septic sinuses are present. Much depends, also, on the joint which is the seat of disease, for example, in the case of the hip-joint expectant treatment should be much longer persevered in than in a more superficial and easily accessible joint.

It is remarkable what an increasing proportion of cases do well without operation, quite apart from the use of tuberculine and other recent methods of treatment, as compared with some years ago. This is probably to a great extent due to the better hygienic conditions under which we live at the present time, but also it seems as if the disease were becoming less virulent. Certainly one does not find it necessary to operate nearly so often for tuberculous joint disease at the present time as was the case formerly.

CHAPTER XIV

GENERAL PRINCIPLES OF TREATMENT

Choice of Operation

The modes of complete removal of the disease in cases of tuberculous joint disease are three in number, viz.—(1) Complete removal of the diseased tissues, along with as little as possible of the healthy structures; this is what I understand by the term 'arthrectomy'; (2) removal of the diseased tissue along with certain portions of the ends of the bones, whether diseased or not, that is to say, excision; and (3) amputation above the affected joint.

We must now consider the relative advantages and disadvantages of these methods of treatment, and the principles which guide us in making our choice. Many circumstances influence our choice of the operative measure, the chief of which are the local condition, the general state of health of the patient and his age.

Taking first the influence which the local condition exerts on the operative procedures, we may consider it—(1) as to the influence of chronic suppuration; (2) as to asepsis; and (3) as to the distribution and character of the local disease.

1. *Chronic Suppuration.* The occurrence of chronic suppuration in connexion with tuberculous diseases of bones and joints greatly increases the gravity of the case, and exercises an important influence on the question of treatment. It usually indicates a progressive form of the disease, while opening of the abscesses if large, and if not performed aseptically, exposes the patient to very great dangers in consequence of the resulting decomposition of the contents and septic inflammation of the wall.

So impressed are some surgeons with the unfavourable character of these cases that they recommend the most radical operations (excision or amputation) in cases where suppuration has occurred. For example, König states that in the case of abscesses connected with tuberculous disease of bones and joints, drainage is practically never sufficient, and he limits the drainage of abscesses to those connected with the atrophic form of the disease (caries sicca), and to some cases in children. I suspect that this opinion must be founded on imperfect asepsis of the wounds, for though no doubt the occurrence of chronic suppuration greatly complicates the case, much can be done in many cases by less severe procedures than excision or amputation. In any case, however, abscess in connexion with tuberculous bones or joints very materially affects the treatment which should be adopted with the view of restoring the part to a healthy condition. We have not only the bone or joint disease to deal with but we have also the abscess itself, and the presence of this tuberculous pus indicates a grave form of the disease.

The treatment of chronic abscess has altered very much of late, partly since the introduction of the Listerian treatment of wounds, and partly since the demonstration of the tuberculous nature of these abscesses. Before the introduction of the Listerian treatment, the results in cases of large chronic abscesses connected with the bones and joints were very bad. If the abscess was opened, decomposition of its contents followed immediately, and if it was large, serious septic symptoms at once supervened, which only too often resulted in the death of the patient from one or other of the various septic diseases. Even if the patient survived the primary sepsis, he was left with freely suppurating sinuses, which went on discharging over a long period, and were usually followed by the development of hectic fever, and ultimately death. This was so fully recognized, especially in the case of abscesses connected with the joints or with the spine, that many surgeons very wisely left such abscesses alone, and did not interfere with them by operation. The result was that some of them became absorbed without having burst through the skin at all, while in others when the pus did ultimately make its way through the skin, the sepsis did not seem to be so acute, and in some instances the sinus gradually dried up. Other surgeons taking the view that it was the entrance of the air into these abscess cavities which did the harm, opened them by means of valvular incisions, the skin being divided at a different position from the opening through the deeper tissues into the abscess. In this way the communication between the surface and the abscess cavity was not a direct one, and in a certain number of instances the wound healed without the occurrence of septic complications. As a rule, however, these attempts also failed, partly because the necessity for the disinfection of the instruments and skin was not at that time known, and partly on account of the septic dressings which were subsequently applied to the wound. Still later, the contents of the abscess were in some cases withdrawn by means of a trocar and cannula, and afterwards by an aspirator. But this method did not become established, partly because the abscess cavity generally filled up again, and partly because, as the instruments were not sterilized, sepsis in the abscess cavity not unfrequently followed the puncture.

When Lord Lister began his work on the treatment of wounds, one of the earliest class of cases to which he turned his attention was spinal abscesses. As at that time their tuberculous nature was not recognized, he simply dealt with them from the aseptic point of view, opening them and draining them freely. As a result, he got rid of the septic risks almost completely, and in spite of their tuberculous nature, a large number (something from 65 per cent to 77 per cent) healed, although a considerable time (on an average of eight to twelve months) elapsed before healing was complete.

After the tuberculous nature of these abscesses was established, and it was shown that they were nothing more than tuberculous tumours with a softening centre, it became evident that by simply opening and draining them, the essential part of the disease, namely the wall, was left untouched, and that the main curative work had to be done by nature. Hence, surgeons came to the conclusion that in addition to evacuating the contents, something must be done to the wall to help to get rid of the solid tuberculous material. Mikulicz was one of the first to act on these lines, and his plan was to introduce a trocar into the abscess cavity, evacuate the fluid contents, wash out the cavity with weak carbolic lotion till the fluid returned clear, inject a 10 per cent emulsion of iodoform in olive oil and glycerine, and stitch up the puncture. This method was taken up enthusiastically by several surgeons in Germany, notably by Billroth and Von Bruns, and also in France, where a modification was made in that an ethereal solution of iodoform was substituted for the emulsion. The results of this method of treatment are fairly good, but in most cases the fluid re-accumulates, and the performance has to be repeated sometimes several times, while in a certain number of cases, a sinus which, unless carefully treated, may become septic, forms at the seat of puncture.

Very shortly afterwards, the following method, which is now generally adopted and which I certainly prefer in the case of spinal and other large tuberculous abscesses, was introduced. The necessary antiseptic precautions having been taken as regards the boiling of instruments, the disinfection of the skin, &c., a small incision is made at the most convenient point, the skin being drawn up so that when the pressure is relieved the incision in it comes to be at a different level from that in the deeper tissues. This incision is large enough to admit a fair sized large spoon, and it is best to use one of Mr. Barker's flushing spoons, by means of which the soft material is not only scraped away, but also washed away by the rush of fluid through the spoon (see Fig. 47). By means of this spoon, the surface of the abscess wall is gently but at the same time thoroughly scraped, free exit being allowed for the fluid. In parts where scraping is dangerous, as towards the peritoneum or along a large vein, a good deal of the degenerating material can be removed by introducing a piece of coarse marine sponge into the cavity, and rubbing the surface with it. The fluid used to flush the cavity is either sterilized salt solution or weak sublimate solution (1–10,000). When all the flakes of cheesy material have been evacuated, the instrument is withdrawn and the excess of fluid squeezed out, and from one to two ounces of a sterilized 10 per cent

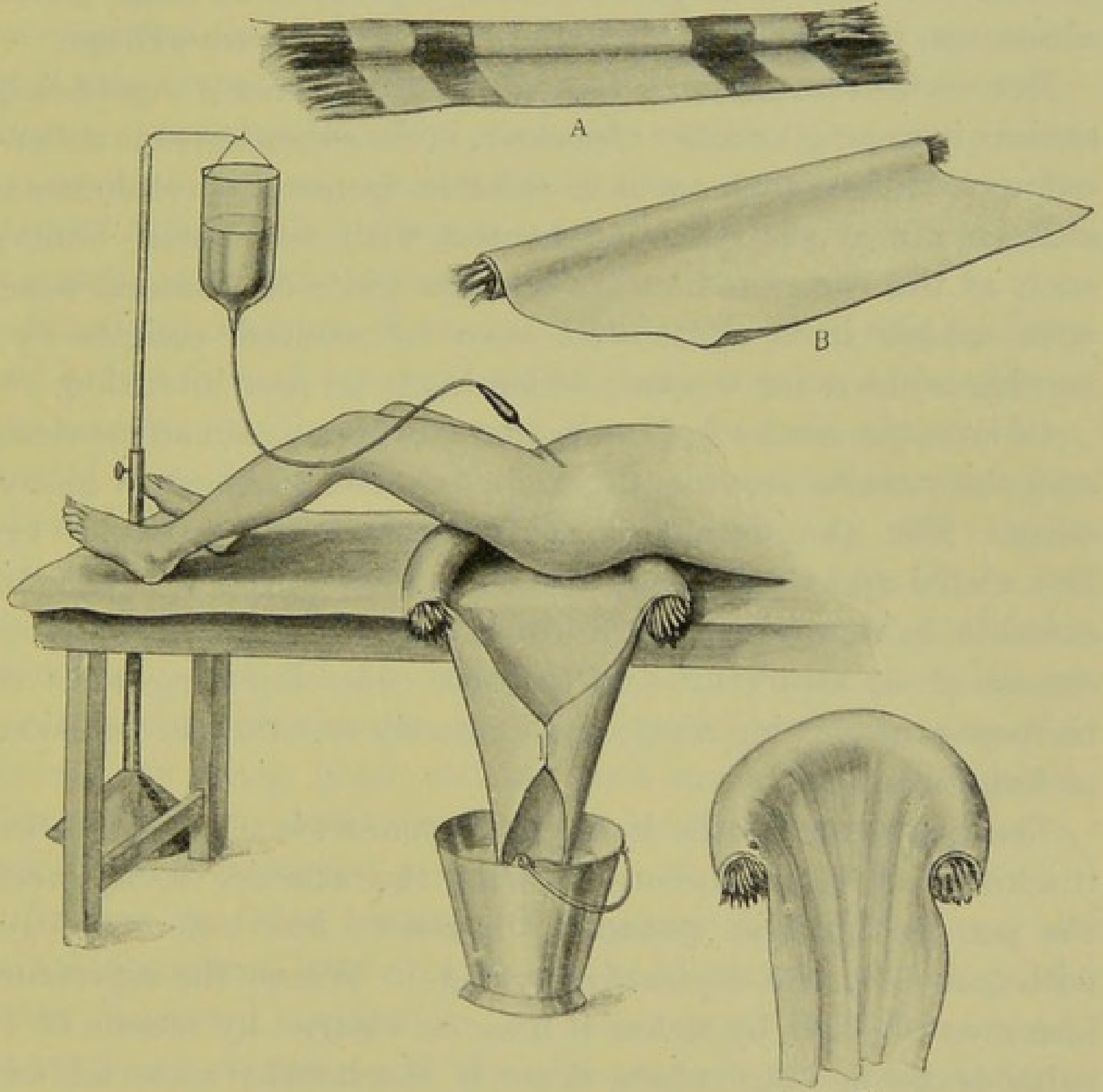


FIG. 47.—Arrangements for washing out a psoas abscess. A, B, and C, Mackintosh rolled up so as to form a trough and keep the bed dry.

emulsion of iodoform in glycerine is injected. The excess of this is allowed to run out, and then the wound is carefully stitched up, and antiseptic dressings applied. Cases treated in this way will all heal in the first instance by first intention, and in the great majority of cases the wound remains healed. Should a small sinus form, the operation must be repeated, the tuberculous sinus in the skin being at the same time excised. Similarly, if there is evidence of accumulation of fluid in the cavity, it may be necessary to wash it out again, but one should not be in any hurry to do this, because very frequently it becomes absorbed. This method, while on the whole most satisfactory, is not absolutely unattended with risk in the case of large abscesses, especially in large psoas abscesses, the danger being from shock and hæmorrhage.

In a certain number of cases where the abscess is superficial, such as in most glandular abscesses, in the subcutaneous tuberculous nodules which occur in children (gommes scrofuleuses), and in many abscesses connected with superficial bones, such as the ribs, the abscess and the piece of diseased bone with which it is associated may be excised completely, leaving a clean cut wound, which heals by first intention.

Of late, the method of aspiration has been again advocated, and the results seem quite to justify the method in many cases. For the details of this method see a paper by Drs. Calvé and Gauvain, in the *Lancet* for March 5, 1910. It consists in removing the fluid contents of the abscesses by means of an aspirator, and in some cases injecting what is termed a modifying fluid, most usually an ethereal solution of iodoform.

The aspirator needle is made to penetrate a considerable thickness of tissue before entering the abscess cavity, and the pus in the first instance allowed to flow out or gently withdrawn by the aspirating syringe. Where the aspirator becomes blocked by flakes it may be cleared by means of a suitable probe, but where there is much flaky material one or other of the 'modifying fluids' is injected and the cavity aspirated again at a later period. Where there is much caseous material the authors advise camphorated thymol (two parts of camphor to one part of thymol) with an equal quantity of sulphuric ether. Two to three c.c. usually suffice for an injection. In the course of two or three days a thick viscous fluid may be withdrawn. The other substance advised is a solution of iodoform in ether (5 to 10 per cent) or mixed with guaiacol, creosote, and olive oil. From 2 to 5 c.cm. of the solution of iodoform in ether is injected into the cavity after the pus has been evacuated, and care is taken not to withdraw the cannula till all the ether has been volatilized. The syringe is left attached to the cannula till the piston begins to be pushed up by the volatilizing ether, when it is detached and the gas allowed to escape. After a time the syringe is again connected with the cannula in order to ascertain by the forcing up of the piston whether any more fluid ether remains in the cavity. If not, the cannula is withdrawn, care being taken by gradually withdrawing the piston to prevent any of its contents from escaping during its transit and thus infecting the track. Of course all aseptic precautions are taken during and after the operation.

In a large number of cases of spinal abscess, this method has been followed by very satisfactory results, although in most instances the aspiration has had to be repeated on several occasions. This plan is no doubt to be strongly advised where the surgeon does not employ the strict Listerian methods, because the modern methods, where no antiseptics are used, are not suitable for free opening of these abscesses. But for my own part, I still prefer the plan of washing out the abscess, or where possible of excising the abscess, as being more radical, and more rapid, provided always that the treatment of the wound is regarded as a strictly bacteriological problem.

To sum up these remarks, I may say that in the case of spinal abscesses, one of two methods should be adopted, either repeated aspiration, as advocated by Calvé and Gauvain, or washing out the abscesses in the manner just described. Of these, the former is perhaps the safer, unless the surgeon is quite sure of his asepsis.

If now we apply these remarks about the treatment of chronic abscess to cases of bone and joint disease in which they are present we find that we have to vary the methods according to circumstances. In the case of suppuration in connexion with joint disease affecting the large joints such as the hip and shoulder we may in a considerable number of cases content ourselves with aspiration or scraping and washing out the abscesses.

In the other more superficial joints, one should try to ascertain especially by means of skiagrams, whether the abscess has originated in connexion with any deposit in the bone or not. Where the abscess is unconnected with the joint, having originated in connexion with a tuberculous deposit in the bone which has reached the surface outside the joint, the best plan, if the anatomical condition admits of it, is to excise the abscess wall completely, and to remove as thoroughly as possible the diseased portion of bone.

In some cases, however, the abscess may have originated in connexion with the synovial membrane, and may or may not communicate with the joint, and it may be treated in the first instance either by aspiration or washing out.

Where the pus is only present in the interior of the joint, and the patient is young, the joint should be laid freely open and search made for osseous deposits. If such deposits are found, they must be removed and complete synovial arthrectomy performed. In adults, however, excision, with thorough removal of the synovial membrane, is the best practice, unless the bone is so extensively diseased or the other conditions such that amputation seems desirable. The decision must vary with the joint affected.

Where we have both pus in the joint and abscesses around it, we have usually to choose between excision and amputation, and in adults, considering the length and extent of the operation of excision in such cases, amputation is, as a rule, the better practice. In some cases in children, however, it may be well to see what can be done by repeated aspirations in the first instance, or, where these fail, by as thorough removal of the tuberculous tissues as possible, persevering in the treatment so long as the wound remains aseptic and the general health does not suffer.

2. *Asepsis.* Another very important factor which influences our decision as to the kind of operation, is the aseptic or septic condition of the part. The presence of sepsis aids, as I have previously shown, the spread of the tuberculous disease, thus reducing the chances of recovery by expectant means;

hence it often necessitates the employment of more severe operative procedures than would otherwise be necessary with the view of effecting a cure. Anything which depresses the vitality of a part aids the progress of the tuberculous disease, and septicity is a very powerful agent in depressing vitality. Accordingly, we find that where septic sinuses are present the disease is much more stubborn, and the chances of cure without severe operative measures are much less than where the skin is unbroken when the case comes under treatment. Thus, to mention only one fact, the results at the hospital for hip disease published in the *Transactions of the Clinical Society* in 1881, were, as far as I understand, obtained in cases with septic sinuses. Of these, the certain cures by expectant treatment were 32·8 per cent ; and the deaths, 33·5 per cent. In our much smaller number of hip-joint abscesses treated by aseptic drainage, 25 in all, that is to say, in cases with aseptic sinuses, the certain cures were 72 per cent and the deaths 4 per cent.

Apart also from the fact that when sepsis is present there is much less likelihood of getting a cure without further operative measures, sepsis also increases the risk of dissemination of the disease, and thus increases the necessity for early and radical measures. I have already, in Chapter IX, pointed out the more frequent occurrence of tuberculous meningitis, and of phthisis, in septic cases as the result of the depression of the resisting power of the tissues both locally and generally, and also the risk of re-inoculation of the wound with tubercle after partial operations in septic cases, and I need not repeat what I have already said.

Further, the presence of septic sinuses influences the operative treatment, not merely by rendering the disease more stubborn, but also by introducing the risk of the various septic diseases. It is not always possible to eradicate the septic element during an operation, and hence, in cases of septic sinuses in connexion with pure synovial disease, and not leading into the joint, and where the cartilage is still intact, it is always questionable whether we can safely perform synovial arthrectomy or not on account of the risk of acute suppuration of the joint. And even if the case is one where complete excision would, in any case, be necessary, the presence of sepsis greatly increases the risk of the operation, making it decidedly greater than amputation above the seat of disease.

Septic sinuses may be met with in cases of tuberculous bone and joint diseases under two forms: (1) where there is very little secretion from the sinus and no accumulation in the deeper parts, and (2) where there is pretty free suppuration, where the sinus leads down to diseased bone, or where there is a cavity at the bottom from which pus can be squeezed out, and where in many cases there is a hectic temperature associated with the trouble.

In the first class of cases the outlook is not unfavourable with careful treatment, and in the first instance no operative measures need be adopted. The first essential is to put the affected part absolutely at rest, and in the case of the lower extremities, in an elevated position. The joint should be fixed with splints or plaster of Paris. If a plaster of Paris casing is employed it should be applied on Croft's principles so that it can be opened out when required and the sinus dressed and attended to, as may be necessary. According to Sir A. Wright a very important point is to induce a flow of serum into these dry sinuses so as to bring the opsonins into contact with the bacilli, and he administers citrate of potash and uses local applications for this purpose. As, however, I think, even although these sinuses contain septic organisms, that it is of importance to keep the wound aseptic, I do not like the proposed local applications, as I fear that they may favour the occurrence of further sepsis. The same effect may be brought about I think in a safer and better way by Bier's treatment by congestion, and I think that this is worth employing in these cases either in the extremities by the application of elastic bandage above the seat of the disease or elsewhere by the application of suction apparatus.

One often finds in these cases that injections of bismuth oxychloride are of great value, and in some cases lead to healing of these sinuses almost at once. The material used is an emulsion of one part of bismuth oxychloride, two parts of white vaseline, and one part of liquid paraffin. The sinus is in the first instance washed out with sterilized salt solution so as to get rid of any pus, and then the bismuth solution, which has previously been sterilized, is liquefied by heat to a little over the body temperature, and a syringe, which has also been sterilized and is warm, is filled, and the emulsion injected into the sinus slowly but with sufficient force to distribute it as far as possible in every direction. An antiseptic dressing is then applied and changed when necessary. The injection may be renewed when necessary: this depends on the amount of discharge, and if it is very slight two or three weeks may elapse before another injection is required. In several of my cases healing has occurred after one injection, and I should advise a trial of these injections before resorting to Bier's methods.

In the second class of cases it will become necessary in most instances to adopt some sort of operative treatment, though a short trial may be given of free drainage by a tube, frequent bismuth injections and Bier's method.

Where it is not deemed desirable to proceed to more radical measures, I believe the best treatment is to lay the sinuses freely open, scrape or clip away their walls, remove as far as possible the starting-point of the original abscess, whether in bone or in synovial membrane, sponge the surface of the wound with undiluted carbolic acid, stuff the wound with iodoform gauze or cyanide gauze freely sprinkled with iodoform, and allow it to granulate from the bottom. This stuffing should not, however, be continued after the whole wound has granulated, and this is especially the case where sepsis is present. To stuff a septic wound is bad practice, because the stuffing very soon becomes a septic mass which irritates the wound and is a source of danger. My experience is most distinctly that much better results are obtained in this way than by simply enlarging and scraping out the sinuses and inserting a drainage tube, as was the method formerly employed. As I have previously mentioned, Krause is of opinion that iodoform is more active where oxygen is absent than where it is present, and by stuffing a wound there will certainly be less oxygen in it than where a drainage tube is employed. However this may be, I can only say that since I took to treating septic tuberculous sinuses in this way my results as regards healing have very much improved. In cases of joint disease, however, this plan is only applicable to cases where the disease is not very marked nor rapidly progressive, and where there are only one or two sinuses. Where the sinuses lead into the joint, or are multiple, or where the disease is advancing, one of the three radical measures previously referred to should, I think, be adopted in most cases, the choice depending chiefly on the age and general condition of the patient, and on the local condition. At one time I was inclined to think that the presence of septic sinuses excluded arthrectomy, but I have now done several complete arthrectomies in such cases, sponging the surface of the wound afterwards with undiluted carbolic acid, and with good results.

3. *The distribution and character of the local disease.* In this connexion the most important point is whether the disease is limited to one part of the joint or affects the whole joint diffusely.

a. Cases of disease limited to one part of the synovial membrane or bone and not involving the whole joint.

Of the cases where the skin is unbroken when the patients come under observation, and where no suppuration is present, we have a group where the disease of the bone or synovial membrane is limited to one part of the joint, the rest of the structures being healthy. These are the cases which are especially suitable for operation, though unfortunately it is not always easy to diagnose the osseous lesions in the early stage, nor is it often that one sees the patient before the whole joint has become affected. In these cases the foci of the disease may be completely removed without seriously interfering with the function of the joint, indeed, with the result that the function of the joint is restored. I may mention three instances by way of illustration :—

1. In the first case, a boy *æt.* 5, the disease in connexion with the elbow-joint began after a fall about a month before admission. The external condyle of the humerus was considerably thickened, and there was a distinct diminution in the resonance of the percussion note at one part. There was no pain, and no thickening of the synovial membrane. An incision was made over the back of the external condyle, the periosteum was turned aside, and a portion of the bone, which was in part unossified, was gouged away ; a small collection of soft material showing tuberculous structure on section was found and removed ; the surface was sponged with pure carbolic acid, and the wound closed. During the operation the joint was opened, but was quite healthy. The wound healed by first intention, except at one point left open to allow escape of blood, and this soon healed, and the result was perfect restoration of the joint and cure of the disease.

2. A little girl, aged 3, was admitted with a swelling on the outer and back part of the elbow, which had been noticed for four months. There was a soft swelling the size of a small marble over the head of the radius, and slight puffiness of the synovial membrane around this nodule, but not elsewhere, and some limitation of movement, especially of rotation. An incision was made over this swelling, and it was dissected out along with a considerable area of the synovial membrane around ; it was found to consist of thickened synovial membrane containing tubercles, and in its interior there were a few drops of semi-purulent fluid. The disease extended to the synovial membrane under the orbicular ligament, and this was thoroughly dissected away ; the rest of the joint was healthy. The wound healed by first intention, and there was complete recovery of the joint.

3. Boy, *æt.* 7, admitted with pain and rigidity about the right hip for three months, complete limitation of movement, marked thickening of the great trochanter and neck of the femur, apparently no thickening of the synovial membrane,

no flexion or shortening, no thickening on the inner wall of the acetabulum. It was evident that there was a tuberculous deposit in the neck of the femur, which had probably not yet opened into the hip-joint. I therefore made an incision over the outer part of the trochanter, trephined through the dense bone, and then scooped out the neck of the bone till a cheesy mass was reached, apparently not far from the epiphysial line. The wound was sponged out with undiluted carbolic acid and left open. It took nearly six months to close finally, showing that I had not succeeded in getting out all the disease, but the free opening probably prevented further extension to the joint. When I last saw him about three years later, there was a considerable amount of movement in the joint, and apparently no disease.

Arthrectomy is also the proper treatment for those cases of pedunculated tuberculous growths from the synovial membrane, which have been described by König, Riedel, and others. Riedel mentions two instances in which these growths have been removed with success, and in my statistics there is a record of one such case also successful.

b. Diffuse disease of the joint. While it is self-evident that in these cases, with localized patches of disease, the removal of the affected tissue is the proper treatment, provided it be done aseptically, it is not so easy to come to a decision as to the nature of the operative treatment in cases where the disease is more diffuse, and which are evidently unsuitable for expectant treatment, or in which expectant treatment has failed. I have already referred to the treatment of cases where chronic suppuration has taken place, and where we have either unopened abscesses or septic sinuses. In the remaining cases, where there is considerable diffuse thickening of the synovial membrane, with or without deposits in the bones or caries of the surface, we have the choice of four methods of operative treatment, viz. arthrectomy, partial arthrectomy, excision, and amputation. Before proceeding to discuss the advantages and disadvantages of the three radical methods of treatment, I must say a few words as to the advisability of performing partial operations, and as to whether partial arthrectomy, i.e. removal of only a part of the diseased tissues should have a place in our operative measures. In joints where subsequent mobility is wanted, such as the elbow, and possibly also the knee, a great objection to complete arthrectomy is that such a procedure often involves removal of the fibrous capsule, and frequently of the ligaments, or at any rate their division, and consequently impaired strength and mobility of the joint. When I began to perform arthrectomies systematically I was of opinion that good results ought to be obtainable in a considerable number of cases by only removing a portion of the disease without breaking up the joint, and I therefore did this in several cases. My reason for this view was the good results of expectant treatment, and the fact which I have been trying to point out, viz. that the tubercle bacillus often has a hard struggle for existence in the body, and that very little will sometimes turn the scale against it. This is exemplified by the results of arthrotomy, the actual cautery, aseptic drainage of abscesses, &c. Further, in typical excision, as performed up till quite recently, no systematic attempt was made to remove all the diseased tissues, in fact, the synovial membrane was often left behind, and yet healing occurred in a considerable number of cases, though here, it is true, fistulæ frequently formed and remained open for a long time. In subperiosteal excisions it is of course impossible to remove all the diseased tissue, and yet this method sometimes yields good results, and is advocated by a good many surgeons. And in some excisions, especially in the case of the hip-joint, as performed at the present time, and even in some arthrectomies, scraping has to be resorted to as regards portions of the synovial membrane (quite an uncertain method as regards removal of the disease), and yet primary union after excision of the hip is the rule rather than the exception. Lastly, in several of the cases, in the statistics which I have been using, in addition to opening the joints, scraping or clipping away portions of tissue was employed, and in a considerable number with success. Thus nineteen cases of disease of the knee-joint were treated in this way, and of these thirteen were cured, or much improved, by the treatment, though in some of these a good many months elapsed before healing was complete.

Since these statistics were made up, I have performed several partial arthrectomies, but I must confess that on the whole I am disappointed with the results obtained, and the conclusion I have come to is that this operation has only a very limited field, and that in most cases, where it becomes necessary to remove diseased tissue, complete removal is preferable to a partial operation. In a few cases, however, partial arthrectomy may be of use, especially where on cutting into the joint the synovial membrane is found not to be markedly pulpy, where the disease is in the substance of the membrane, not on its surface, and does not affect the bone, and where no cheesy spots are present. In other cases it is better to go on to complete removal of the affected tissues.

CHAPTER XV

ARTHRECTOMY, EXCISION, AND AMPUTATION IN JOINT DISEASE

Having determined to remove the disease completely the question arises which of the three radical operations—arthrectomy, excision, or amputation, should be performed. Of these I may dismiss the question of amputation in a few words, because no general rules can be laid down with regard to it. Amputation is the least dangerous of the three radical operations, in fact, nowadays no special danger is attached to it ; it is possible that here and there a weakly patient may succumb from shock after amputation high up in the thigh, but otherwise, if aseptically done, there is no danger. Hence, in weakly patients who cannot stand a prolonged operation, such as arthrectomy or excision, and where a radical operation is necessary, amputation is the best. So where phthisis is present, at any rate if it is advancing and the patient rapidly going down hill, amputation is best, indeed, it is sometimes remarkable what an improvement takes place in the condition of the patient and of the lungs after amputation through healthy tissues above the seat of the disease. Similarly in waxy disease of the kidneys, if radical operation is possible at all, amputation is the least dangerous. Again, in adults, and especially in old people, where there is much suppuration about the joint, or where septic sinuses are present, amputation is, in the majority of cases, the best practice. In the young also, where the disease is extensive, especially in the bone, amputation may in some joints, such as the knee, be preferable to excision, and also where bad recurrence takes place after excision or arthrectomy, amputation may become necessary. In fact, no definite rules can be laid down, the decision must be made in each case according to the local condition and the general state of the patient. I shall, therefore, pass on to the question of arthrectomy versus excision, and in the first place I may describe exactly what I mean by these operations.

By arthrectomy I understand operations by which the whole of the tuberculous tissue is removed, with as little as possible of the surrounding healthy tissue. The term is not a good one any more than its substitute erasion, but as I am not an adept at coining words, I shall use it here in the sense which I have just defined. We may in reality perform a complete arthrectomy—i.e. complete removal of the disease without even cutting into the joint at all, or at any rate without removing any portion of the joint, for example, where tuberculous deposits are present in the ends of the bones and have not yet burst into the joint, as in the hip-joint case I have previously mentioned, where I tunnelled through the neck of the femur, or in the elbow-joint case, where I removed a deposit from the condyle of the humerus. Again, as in the elbow-joint with the synovial disease limited to the outer side of the capsule, though the joint was cut into, only a portion of the synovial membrane was removed, and yet I group that case under the cases of complete arthrectomy, because as far as one could judge the disease was completely removed. I term the arthrectomy complete because the whole of the disease was removed, not because the whole of the structures of the joint was cut away. As a rule, however, in complete arthrectomy the operation is a very extensive one, and requires much patience and great care for its satisfactory performance. The whole diseased tissue must be removed by careful *dissection*; scraping is quite unsatisfactory, unless as regards small points, especially in the cartilage, and then it must be very thoroughly done.

Let me describe a complete arthrectomy of the knee-joint where the whole synovial membrane is involved, as an example of the operation. The first thing is to expose the capsule very thoroughly, and this I do by means of two free longitudinal incisions, one on each side of the patella at a little distance from it, and I think it best in the first instance not to open the joint. Having made out the limits of the capsule, the tissues in front of the synovial membrane are carefully dissected off, and the whole of the membrane behind the quadriceps is thoroughly exposed. The dissection is then carried on each side well over the condyles, remembering that a fold of synovial membrane extends backwards for a considerable distance over the surfaces of the condyles; the lateral ligaments are then divided, and the synovial membrane separated from them. The dissection is then continued inwards to the edge of the patella on each side, and behind the ligamentum patellæ. The synovial membrane, being thus exposed as far as possible by these incisions, is then detached all round where it is reflected on to the bone and cartilage, and cut away as far back on each side as possible. The joint is thus freely exposed from the front, and a fringe of synovial membrane is seen around the edge of the cartilages of the femur, tibia, and patella; this is carefully removed, and then one may or may not connect the longitudinal incisions by a transverse one over the patella, sawing that bone transversely. Usually I have not required to make a transverse incision, but by dislocating the patella first to one side and then to the other, I have been able to get free access to the whole joint. The crucial ligaments are next divided and thoroughly cleaned, or, if much diseased, removed, and special attention is directed to the condition of matters in the intercondyloid notch. The joint being then forcibly bent the semilunar cartilages are removed, and the dissection of the synovial membrane is resumed. It is quite easy, as a rule, to define the outer surface of the synovial membrane on each side, and having done so separation is gradually effected by the finger and some blunt instrument between the posterior part of the capsule and the vessels and structures behind, and this is continued till the points of reflection of the posterior capsule on to the femur above and the tibia below are well defined. The synovial membrane is then cut off at these points, and the fringe around the cartilages carefully removed. Having now got away all the diseased synovial membrane, the ends of the bones are easily protruded through the wound, and the cartilages of the various bones carefully examined. If any depressions are seen they are carefully cleaned out, and if the cartilage is thin or loose anywhere that portion is removed along with a thin layer ($\frac{1}{4}$ inch) of the bone beneath. Very often the cartilages are covered with a thin layer of soft tissue, and this must be got away by shaving off the surface with the knife. If the cartilage is absent at any part, and the surface of the bone carious, a thin layer of the bone at that part must be cut away, remembering that the tuberculous tissue only extends into the bone for about one-eighth of an inch ; this layer can usually be removed by the knife or a gouge. Of course, if at any part the hole in the cartilage or the carious patch of bone are found to lead to a deposit in the bone, that must be thoroughly cleared out. Having satisfied ourselves by fresh inspection that all the disease has been removed, the wounds are closed, the crucial ligaments, if left, being stitched, and the patella, if divided, being wired. A drainage tube is seldom necessary, or if it is used it should be removed in two or three days. I think it is best in most cases not to use a tourniquet, for without it it is easier to distinguish disease, the pulsation of the popliteal artery can be felt, which is of importance in dissecting out the synovial membrane posteriorly, and the oozing from the wound is less. Subsequently no passive motion should be employed, and as there is a very great tendency to flexion in children, a back splint should be worn for a long time, sometimes for years.

In performing excision as it must be done in view of our present knowledge, the synovial membrane must be removed with as much care and in much the same manner as has been described in the case of arthrectomy ; but as the ends of the bones are sawn off, and all the cartilage-covered surfaces freely removed, the operation is considerably shorter, and the chance of disease being left behind is diminished. I need not go into any details as to the operation of excision, but shall proceed to discuss the relative value of the two operations and the points which determine our choice.

The first point is as to the relative danger of the two operations. As I have already said, the danger of these operations is, on the whole, decidedly greater than that of amputation—the danger being shock. There is also the further question as to possible risk of dissemination of the disease as the result of the operation. As regards the question of shock, the operations which I have described are prolonged operations, and there is always a good deal of collapse afterwards, but in only one of my arthrectomies has this collapse ended fatally. In two cases of excision, however, the patients have died of shock. Both of these were extensive operations in weakly persons; in one, an excision of the knee-joint, I had strongly advised amputation, but the patient would not submit to it, and begged me to excise his knee; the other was a case of hip-joint disease, with extensive affection of the acetabulum and pelvis.

The second point is as to which operation is most successful in eradicating the disease. In answer to this question, I should say decidedly that recurrence is less likely after excision performed as above described than after arthrectomy. This is not a matter which in any way lends itself to statistical study, because the failures in either case are not failures as regards the principles of the operations, but failures in carrying out these principles. The parts where it is most difficult to get rid of the disease in arthrectomy are about the margins of the cartilage, on the surface of the cartilage, where small pits containing tuberculous tissue may readily be overlooked, and recesses of the joint, such as the intercondyloid notch in the knee, the olecranon fossa, and the neighbourhood of the orbicular ligament in the elbow, &c. These are parts which are cut away or thoroughly exposed in excision, while the diseased synovial membrane can be readily removed in either operation. Further, in arthrectomy, deposits in the bone are undoubtedly more likely to be overlooked than in excision, though in the latter operation, also, they are occasionally missed (see Fig. 48). My own experience is that, the greater the care with which the disease is removed, the better the results, and that where arthrectomy is thoroughly performed, it is a most satisfactory operation. I certainly had more recurrences among the first cases in which I performed arthrectomy than I have now when I take greater pains to remove, as far as possible, every vestige of the disease.

The third point to be considered is as to the subsequent utility of the limb after these operations, and first as regards mobility. As regards arthrectomy, where the cartilages are

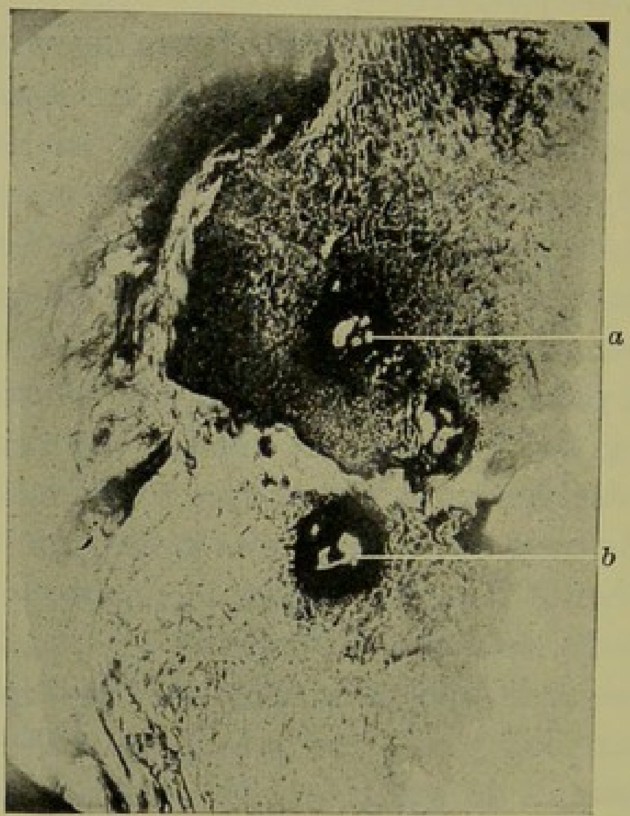


Fig. 48.—Section of bones from a case of excision of the knee-joint showing at *a* and *b* that both in the femur and in the tibia tuberculous bone deposits have been overlooked at the time of the operation.

intact, bony anchylosis does not, of course, occur, but if the joint is kept long at rest afterwards, there will be much stiffness, sometimes complete ; in most cases, however, there is a certain degree of movement, which increases on exercise. As a matter of fact, it is not necessary to keep the joint at rest for more than a few weeks in order to allow the ligaments to reunite, unless in the case of the knee-joint in young children, where the tendency to flexion is so great that a posterior splint must be continued for a very long time.

In the case of excision, the subsequent mobility depends in most cases on the amount of passive motion employed, though in the case of the hip-joint an undesirable degree of mobility often remains after excision. In the case of the knee-joint, excision, of course, leads to firm stiff joints, and arthrectomy of the same joint in children usually also leads to stiff joints, though somewhat yielding. In some cases, however, useful movable knee-joints have been obtained after arthrectomy, although I do not think it is a thing to be aimed at in children, on account of the risk of flexion. In the case of the ankle, a very excellent result as regards movement is obtained by arthrectomy combined with removal of the astragalus, while after excision a stiff ankle is the common result. In the elbow both operations yield a movable joint; excision probably gives the greater movement, but arthrectomy gives the stronger arm.

Next, as regards subsequent deformity. This question has mainly reference to the knee-joint, where, after both operations in young children, there is a marked tendency to flexion, and sometimes to rotation outwards and genu valgum. This is a matter which will be again referred to, but I may say here that, on the whole, the tendency to deformity is somewhat greater after arthrectomy than after excision.

Lastly, as regards subsequent shortening. This is a question of immense importance in the case of children, and can be answered decidedly in favour of arthrectomy. In that case, unless a deposit involves the epiphysial line, there is no interference with the growing part of the bone at the operation, and consequently no subsequent shortening. In excision, on the other hand, the results as regards shortening are very bad, and hence, in children, excision of the knee-joint is almost absolutely contra-indicated, and this also holds good as regards other joints, though no doubt to a less extent. Even after excision of the hip-joint very serious shortening may occur; I have seen one case where the leg was eleven inches shorter than the other when the patient had reached adult age. It has been stated as regards the knee-joint that, if intra-epiphysial excision is performed, the interference with growth is not great ; but the general experience in those cases where bone is sawn off, but the epiphysial lines are not touched, is that ossification of the epiphysial line is very apt to occur with complete arrest of growth. Various other factors probably increase this tendency after excision, but they need not be discussed here.

The conclusion as regards arthrectomy and excision which seems warranted by all the facts is that arthrectomy is the proper radical operation in children up to fifteen or sixteen years of age, and excision in patients who have reached their full growth. Certain exceptions as regards arthrectomy in adults may be made depending on the individual joints.

SECTION II

SYMPTOMS AND TREATMENT OF TUBERCULOUS DISEASE OF THE VARIOUS JOINTS AND BONES

CHAPTER XVI

DISEASE OF THE HIP-JOINT

Tuberculous disease of the hip-joint is essentially a disease of early life, seldom commencing after the period of puberty. Thus, in a chart which I made to illustrate the period of onset of disease in various joints and bones, I found, as regards hip-joint disease, that 59 per cent of the total number of cases commenced during the first decade of life, 32 per cent during the second, 5 per cent during the third, none during the fourth, 2·5 per cent during the fifth, and 1·5 per cent afterwards. In fact, in the case of the bones and joints in childhood, it is, next to the spine, the part which is most frequently the seat of tuberculous disease, and taking adults and children together, disease of the hip-joint occupies the third place in the total order of frequency.

Pathology

As in the other joints, the disease may commence either in the bone or in the synovial membrane, but it is by no means easy to make out the relative frequency of each in the hip, because the joint is deeply placed, and probably a considerably larger proportion of the cases of hip-joint disease recover with expectant treatment than is the case with any other joint. In my own cases also, the rarity of excision has prevented the accurate determination of these points. König found in museum specimens that in 15 cases the disease was primarily osseous in 8, and primarily synovial in 7. Haberern found in 132 out of 160 cases of excision, that 80 were certainly primarily osseous, 23 certainly primarily synovial, and 29 doubtful. Blasius, on the other hand, states that primary synovial disease is more frequent than primary osseous disease, and, as regards the femur, he gives the proportion of osseous and synovial disease as 1 to 3. From my own observations, I believe that the disease begins somewhat more frequently in the bone than in the synovial membrane, but I cannot accept results obtained from excision, such as Haberern's, as satisfactory, because the cases in which primary osseous lesions are present are much more likely to come to excision than those where the synovial membrane alone is affected.

As regards the seat of the primary osseous deposits, many authors assert that it is more frequently acetabular than

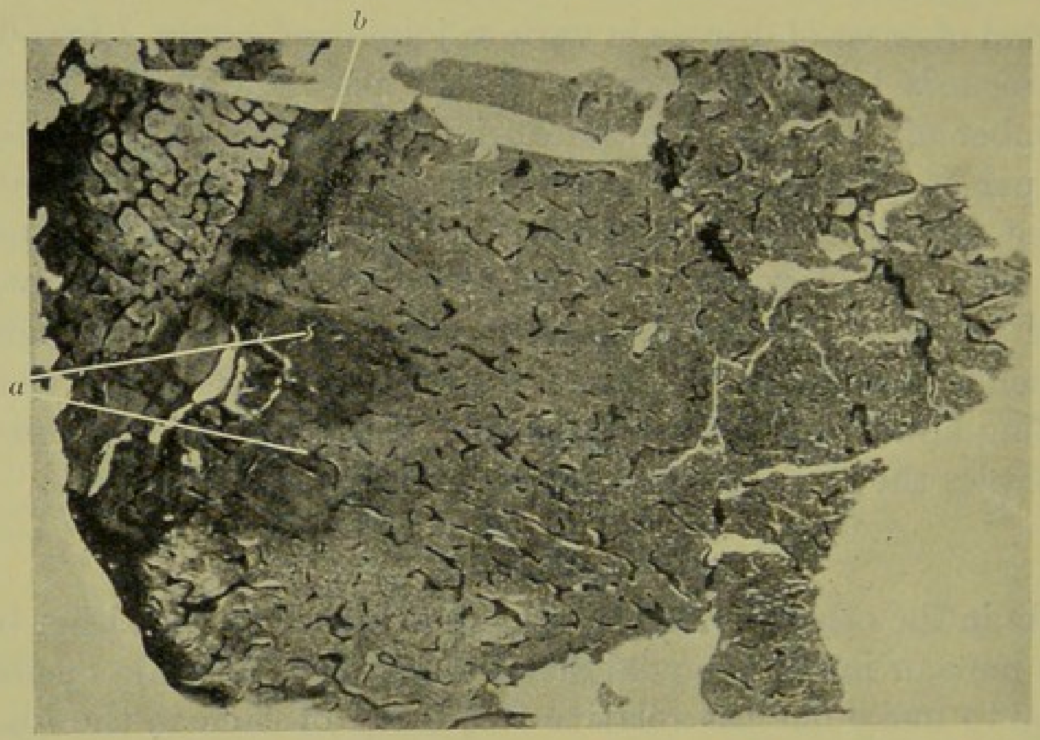


Fig. 49.—Soft deposit (*a*) in the neck of the femur, just outside the lower part of the epiphysial cartilage. It is destroying this cartilage (*b*) which is, at one part, completely perforated. It has also spread into the joint, and set up synovial disease. The rest of the neck is in a state of rarefying osteitis.

femoral. According to Haberern, in his list of 80 cases of primary bone disease, 50 commenced in the acetabulum, 23 in the femur, and 7 in both. It so happens that in the cases which I have excised the majority of the deposits have been in the femur, and I think Haberern's proportion of acetabular disease is much too high. In the femur the usual seat of the deposit is at the lower part of the neck, just outside the epiphysial cartilage (see Fig. 49). In some cases, it is further out in the neck and even in the trochanter (see

Fig. 50), but it is seldom that the primary deposits are found in the epiphysis. In the acetabulum the disease generally commences in the neighbourhood of the Y-shaped cartilage (see Fig. 51), and, in some cases, this cartilage may be completely destroyed and the pubis may be movable, giving a sensation of crepitus.

The relative frequency of soft caseous deposits and of sequestra varies much according to the age of the patient, but apparently, in any case, sequestra are most common. Thus, to refer again to Haberern's work, we find that of the 50 cases where the primary seat was in the acetabulum,

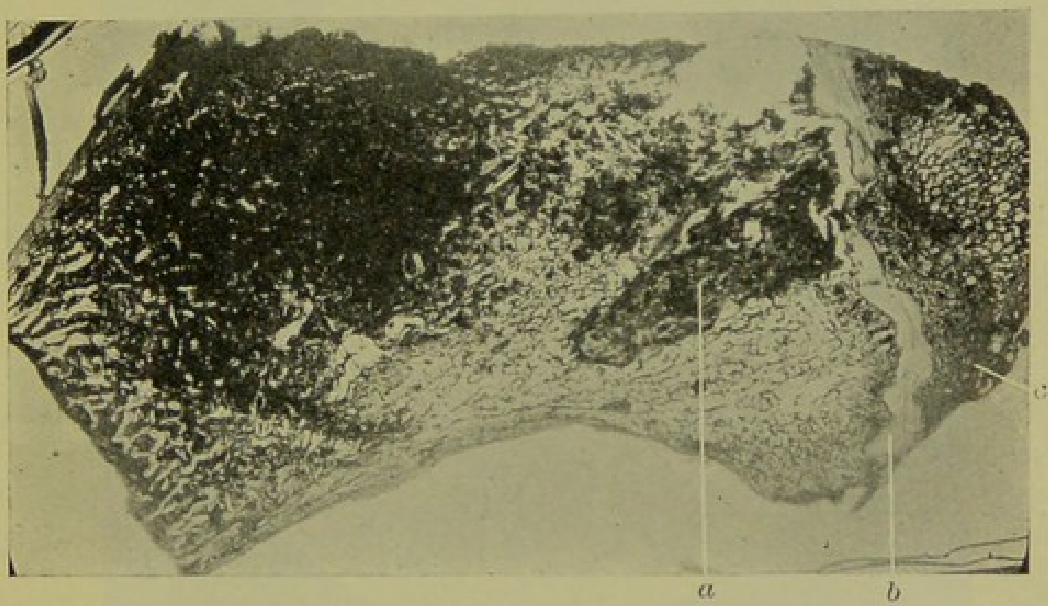


Fig. 50.—Sequestrum (*a*) in the neck of the femur just outside the epiphysial cartilage (*b*). Head of bone (*c*) is devoid of cartilage and the surface is carious.

31 were associated with sequestra and 19 were not, while in the case of the femur, sequestra were present in 14 and absent in 9, and of those where both bones were primarily affected, sequestra were found in 6 and absent in 1; the total result was 51 with sequestra and 29 without.

The course of events is as follows:—When the primary deposit is situated in the calcar, it spreads on the one hand towards the surface and on the other hand towards the epiphysial line (see Fig. 49). When it reaches the cavity of the joint the synovial membrane becomes affected, and the disease rapidly spreads over its whole surface. The soft tissue then extends over the articular cartilages of the femur and acetabulum, destroying them in the manner formerly described, and, reaching the surface of the bone, produces the condition of caries. The affection of the articular cartilages begins not only from the sides but also from the points of attachment of the ligamentum teres, which is affected early. As regards the cartilage, it must, however, also be noted that it is often much thinned at the points where there has been greatest pressure, and there it may be due to osteitis beneath, not necessarily tuberculous in the first

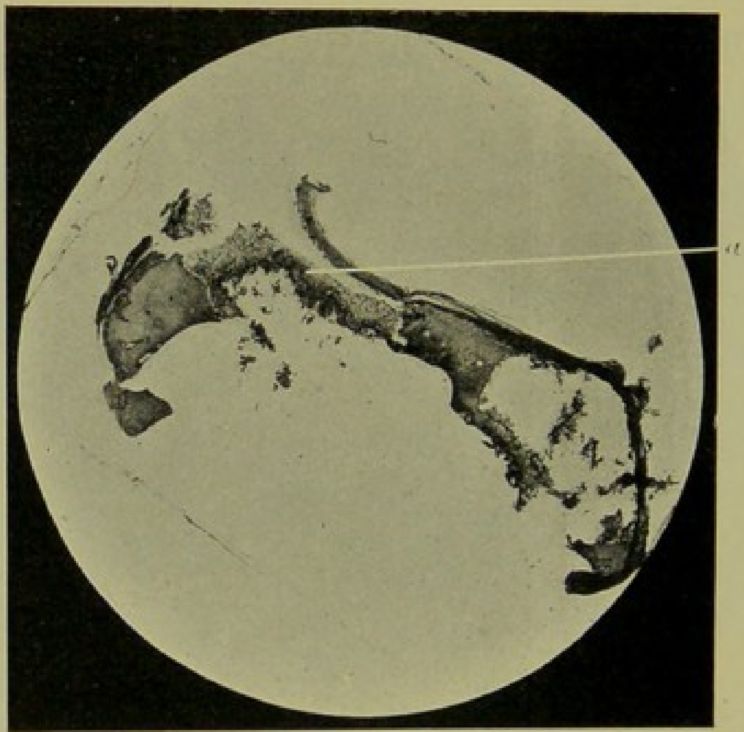


Fig. 51.—Primary disease of the acetabulum, about half the floor of the acetabulum (*a*) is destroyed by a soft tuberculous deposit. (See also Fig. 20.)

instance. In the case of a primary deposit in the calcar, the disease of the bone not only extends outwards into the joint, but also towards the epiphysial cartilage, which gradually becomes destroyed, at first at one part and subsequently, it may be, throughout its whole length ; in the latter case, the head or its remains is not unfrequently detached from the femur, and becomes connected with the acetabulum by adhesions.

In some cases the deposit is situated further outwards towards the trochanter, and may not open into the joint at all but outside the capsule, and thus lead to the formation of abscess not communicating with the joint. In these cases, however, the synovial membrane is very apt to become involved.

The disappearance of the head and neck of the femur and of portions of the acetabulum in these diseases is due partly to the carious destruction of the bones, but chiefly to the

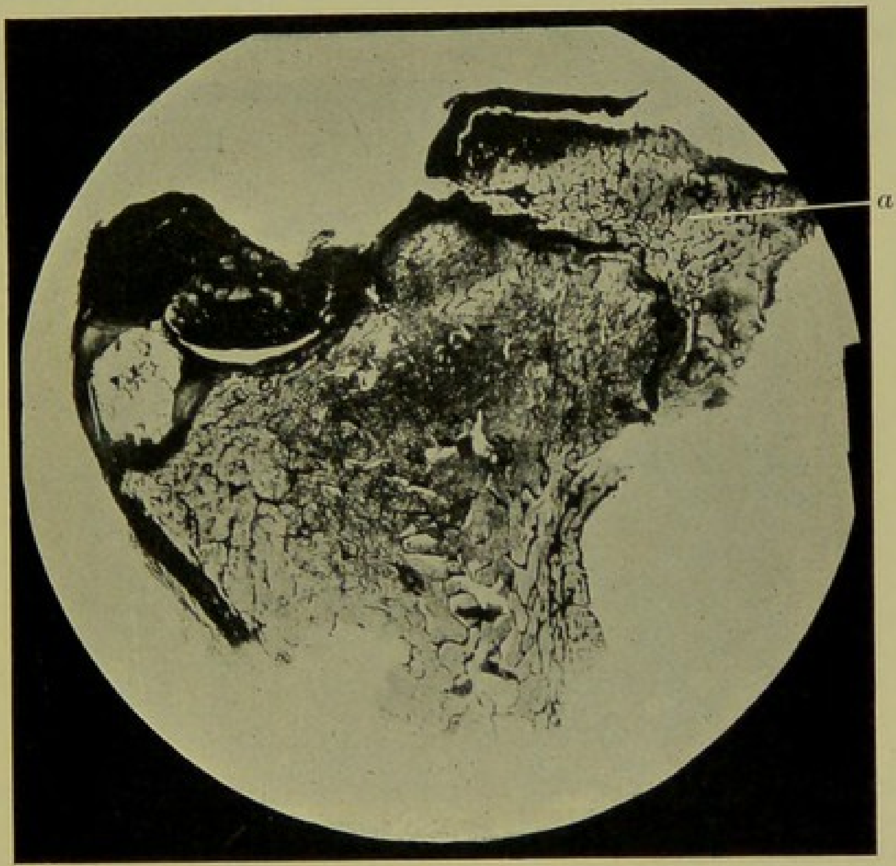


FIG. 52.—Head of the femur from a case of disease of the hip-joint showing flattening of the head (*a*) at the upper part from pressure, and also separation and partial destruction of the epiphysial cartilage.

rarefying osteitis which accompanies it, and this absorption of bone may go on rapidly and lead to shortening and bending of the neck of the femur and to enlargement of the acetabular cavity. This absorption is to a great extent brought about by pressure on the parts softened by the inflammation. Pressure of the inflamed and carious parts on each other is a very potent factor in keeping up rarefying osteitis and in causing the absorption of bone. The pressure is not necessarily from standing, for even in bed the tonic contraction of the muscles, the result of the irritation of the joint, keeps the upper part of the head of the femur constantly in contact with and exercising pressure on the upper and back part of the acetabulum. The result as regards the parts of the bones immediately in contact is twofold; on the one hand, the head of the bone gradually disappears, assuming a peculiar flattened shape (see Fig. 52); and, on the other hand, the acetabulum becomes absorbed at its upper and back part, new bone, though often only to a slight extent, being constantly formed from the periosteum around and thus maintaining a buttress (see Fig. 53). This enlargement or

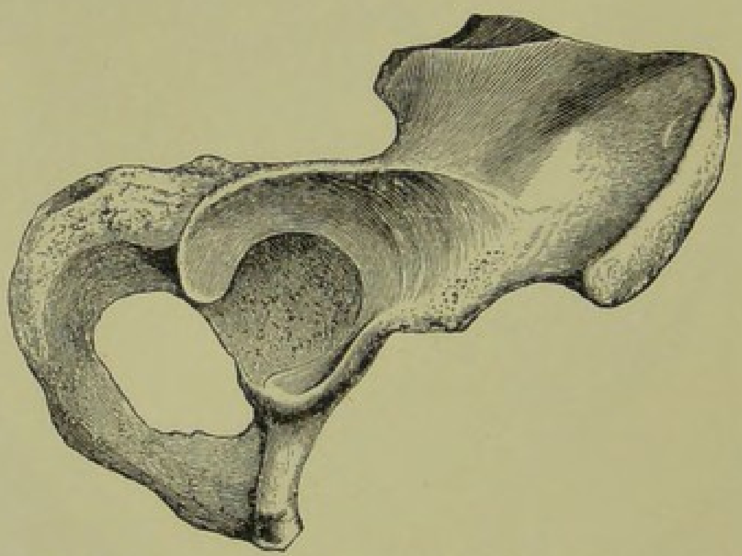


FIG. 53.—Enlargement of the upper and back part of the acetabulum ('wandering of the acetabulum'), as the result of hip-joint disease. (After BRADFORD and LOVETT).

'wandering' of the acetabulum, as it is termed in Germany, often goes on to a very great extent, and marked shortening and apparent dislocation may result from these two processes. In fact, this is by far the commonest cause of shortening in hip disease.

True dislocation is rare, and usually occurs as the result of some sudden movement which causes the shortened head and neck of the bone to slip out of the enlarged acetabulum, but it may sometimes occur even where the articular surfaces have not been much affected. Under such circumstances, however, there is usually very marked synovial disease with softening of the fibrous capsule, and the ligamentum teres has also become softened and converted into a tuberculous mass. Dislocation in hip-joint disease almost always occurs in an upward and backward direction. Cases have, however, been published where the head of the bone has passed in other directions, and I have seen two where it was dislocated forwards on to the pubis. Partial dislocation is more common and is due to destruction of the margin of the acetabulum without the formation of an efficient buttress. In this case

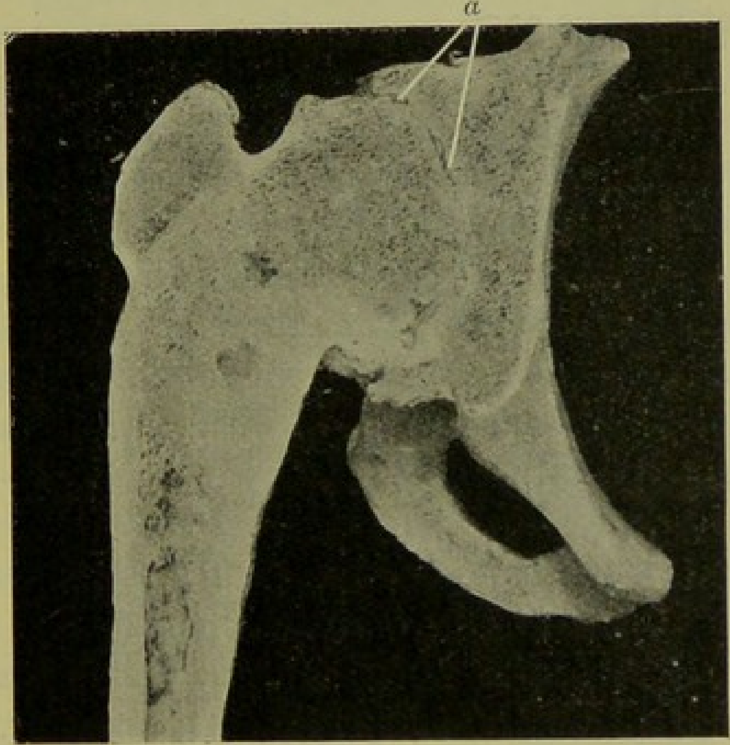


Fig. 54.—Anchylosis of the hip-joint, the result of tuberculous disease. Here and there, as at *a*, the bony union is not complete owing to portions of the articular cartilage still remaining intact. Great sclerosis of bone after recovery.

the centre of the head may be caught on the edge of the acetabulum and a groove formed in it at the point of pressure.

While the enlargement of the acetabulum and the absorption of the head of the femur are going on caseation of the tuberculous tissue is taking place, and thus the joint cavity generally contains a quantity of caseous material. About this time also chronic abscesses form around the joint, either outside or inside the pelvis. Those outside the pelvis usually communicate with the joint, though often by a very small opening, sometimes difficult to find. Their most usual seats are on the anterior and outer surface of the joint or behind in the gluteal region. The final result in bad cases where the cartilage has been destroyed is more or less complete bony anchylosis of the bones, spaces being left in some cases, as shown in the photo (at *a*), where portions of cartilage still remain (see Fig. 54).

Symptoms

In considering the symptoms and treatment of hip-joint disease it is convenient to speak arbitrarily of several stages, but it is not always easy to say of any given case in which stage it is, because the various stages run into one another. I shall describe four stages as follows: 1. Where the articular cartilages are still, in the main, intact, the acetabulum not enlarged, and the neck of the femur not absorbed. Here there is no shortening. 2. Where shortening is occurring, the acetabulum becoming enlarged, the cartilages being destroyed, and other destructive changes taking place, but where as yet there is no abscess. 3. Where in addition to these changes, which, however, may not have gone on to any great extent, we have the occurrence of chronic suppuration, either inside the joint or outside also, in the form of chronic abscesses. This stage also includes cases where the abscesses have burst or been opened, and where sinuses remain. 4. The stage of recovery with deformity.

1. Symptoms of the First Stage

Hip-joint disease most usually begins insidiously, though in some cases the onset is more or less acute. Even where an injury has apparently been the exciting cause of the disease, some weeks may elapse before any sufficiently definite symptom of the disease is noted. Usually when it is noticed that there is something wrong with the hip, the friends of the patient can call to mind that there has been a feeling of tiredness, or even pain, in the limb for some time; that there has been a little limping, especially in the morning, and a tendency to bear more weight on the toes than on the heel, and to keep the knee slightly flexed; that the patient has been pale, the appetite capricious, and the sleep disturbed.

As a rule, at the earliest period (probably after disease has existed a few weeks) at which the patients are brought to consult a surgeon, the symptoms are quite mild, and sometimes difficult to recognize. There is a slight limp, or rather dragging of the leg, especially in the morning ; the knee is somewhat flexed, the patient does not put the heel to the

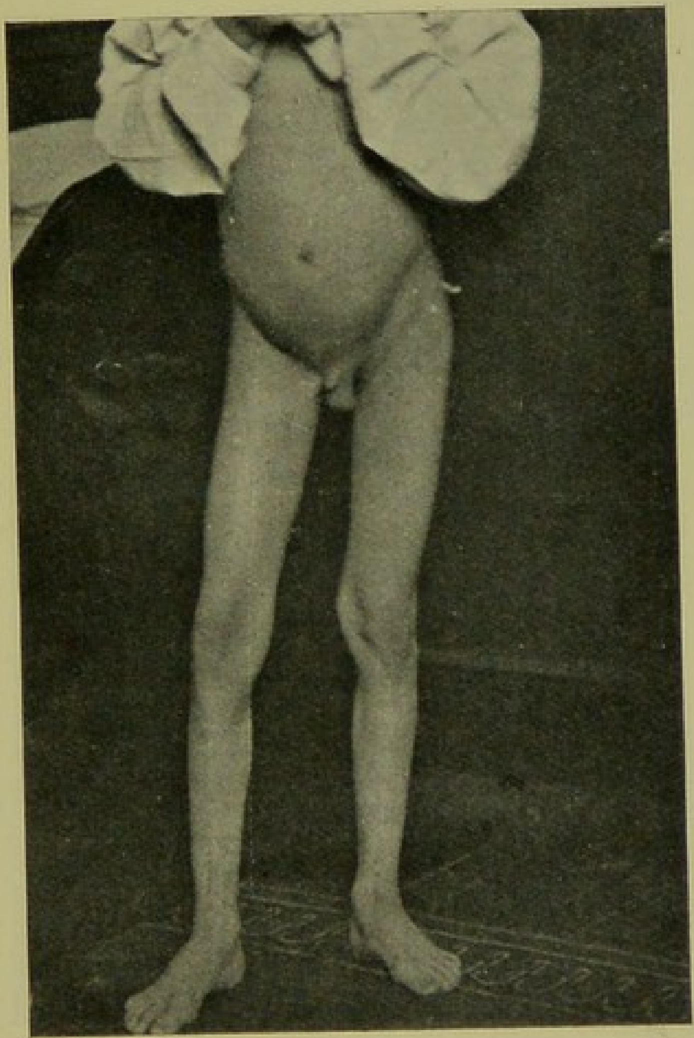


Fig. 55.—Hip-joint disease on the right side, obliquity of the pelvis towards the affected side, and slight flexion of thigh.

ground in walking, but bears weight on the balls of the toes, he is not so active as formerly, but does not in most cases complain of much pain and then generally on the inside or front of the knee, and there is some obliquity of the pelvis, leading to apparent lengthening of the limb. On looking at the limb the hip and knee are seen to be slightly flexed, there is slight apparent lengthening, the thigh is abducted and somewhat rotated outwards, and the movements of the limb are restricted (see Fig. 55). Viewed from behind, the buttock on the affected side is seen to be somewhat flattened, mainly due to the position of the limb, but sometimes, even at this early stage, due in part to commencing atrophy of the muscles (see Fig. 56), which is such a constant and early accompaniment of all synovial inflammations. The muscles

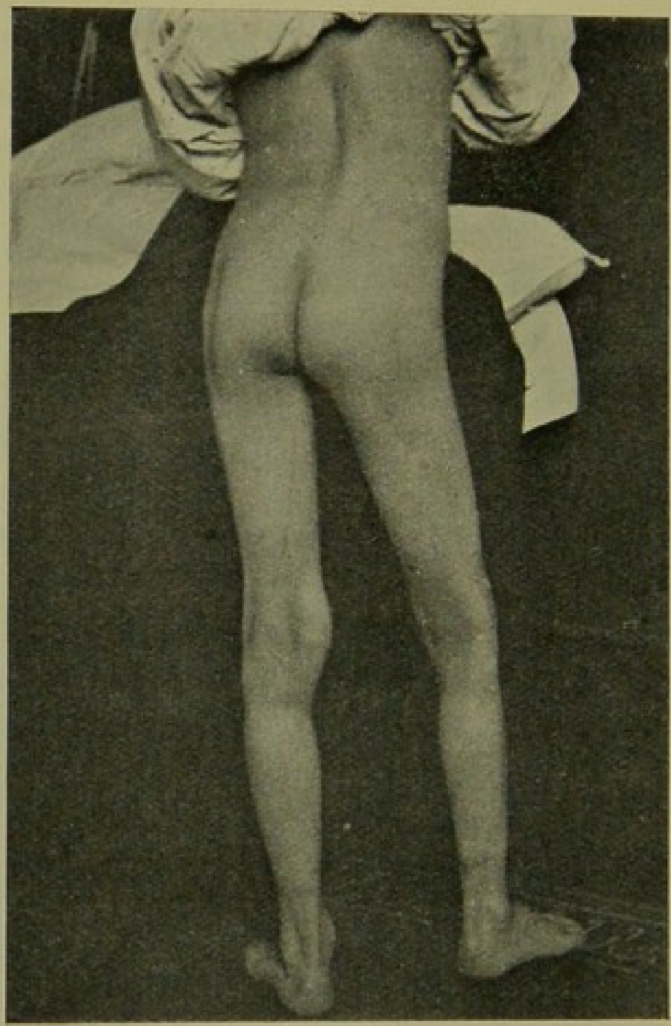


FIG. 56.—Same case seen from behind, showing the flattening of the buttock and the obliquity of the pelvis.

of the thigh also waste at an early period, and both in the buttock and the thigh the muscular contractility is much diminished. At this stage, unless in the acute cases, or where the disease is situated in the neck of the bone, there may not be any marked thickening of the tissues around the joint, but this varies very much, for even in these insidious cases, especially where the disease has been purely synovial at the commencement, the synovial membrane may be considerably thickened before there are any pronounced symptoms, and thus the fold of the groin may be more filled up than on the other side.

In examining the condition of the joint, the patient should be laid on his back on a table, and when the lumbar spine lies flat on the table, it will be seen that the thigh is bent to

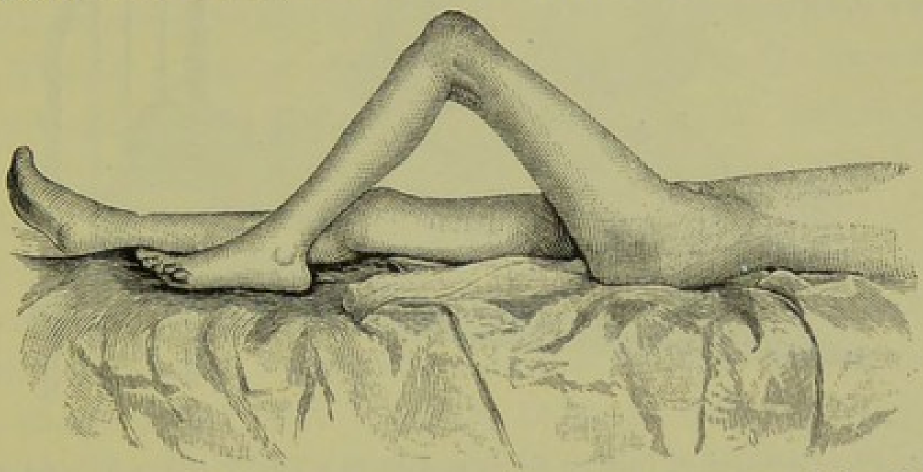


FIG. 57.—Hip-joint disease, showing the degree of flexion of the thigh when the spine is lying on the table.

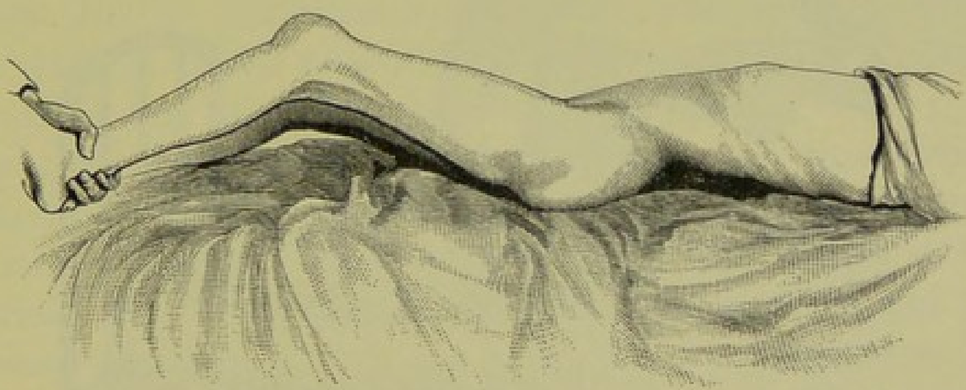


FIG. 58.—Hip-joint disease, showing the arching of the spine when the flexed thigh is pulled down.

a varying degree, while, when the thigh is placed flat on the table, the lumbar spine becomes arched forwards (see Figs. 57 and 58). As, however, in quite early cases this sign may be absent, while, on the other hand, it occurs in other affections, such as psoas abscess, the best plan is to follow it up by the converse procedure, viz. the study of the degree of flexion. This method is of especial value in infants and young children. For this purpose the child is again placed on his back, with the lumbar spine flat on the table. What is supposed to be the sound leg is first taken, flexed completely on the abdomen, and held in that position (Fig. 59). The other thigh is then flexed gently and slowly, and it will be found that when, or before, a right angle is reached the flexion

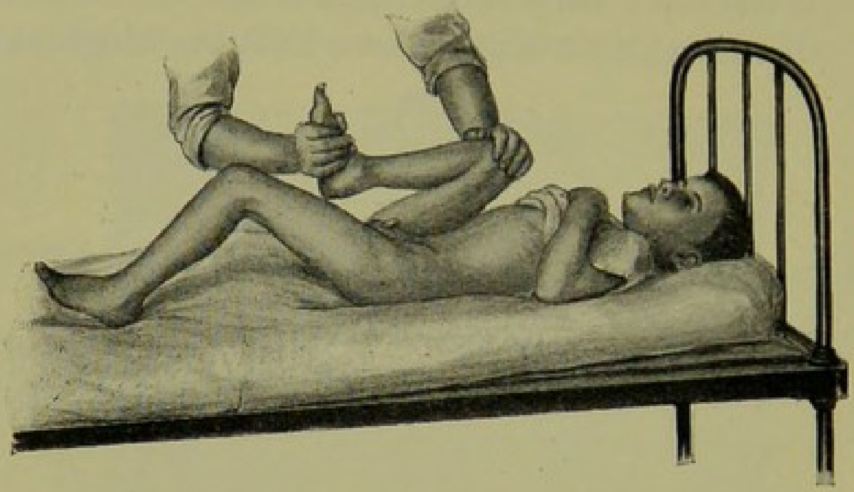


Fig. 59.—Method of testing flexion, &c., in a child. Sound limb bent upon pelvis and fixing it.

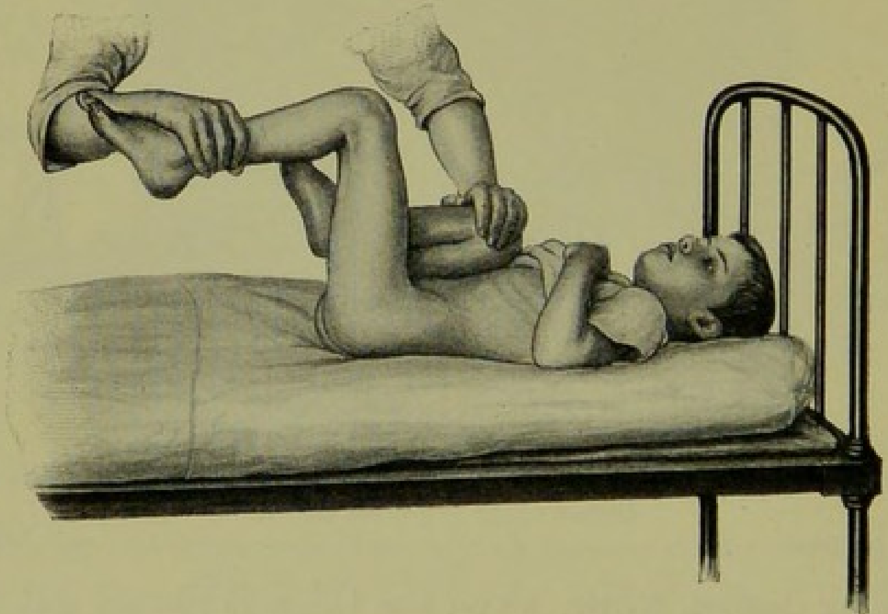


Fig. 60.—Method of testing flexion. The pelvis being fixed by the sound limb, the affected limb is bent, and when the limit of flexion is reached the pelvis begins to rise.

ceases, and on attempting to push the leg further, the pelvis rises from the table (Fig. 60). This sign is also found sometimes in sciatica, but in the case of hip-joint disease, when the limb is kept at the limit of flexion, attempts at abduction, adduction, or rotation almost at once involve movement of the pelvis ; if that is the case, the diagnosis of disease of the hip-joint may be safely made. The deficiency in extension may also be tested by turning the patient on his face, flexing the leg at the knee-joint, and then lifting the thigh from the bed. This can be done quite easily on the sound side, but is usually impossible on the affected one.

A further point in the diagnosis is the actions which cause pain. This is quite a secondary matter, and for my own part I avoid any such investigation as a rule, for it only frightens and hurts the patient without throwing any additional light on the nature of the case ; the restriction of the movements, which have been described, are of themselves quite sufficient. At this early stage movements of flexion, rotation (especially inwards), and adduction, if carried to excess, cause pain ; but the pain from jarring the limb by a blow on the knee or trochanter varies much in different cases, and is, as a rule, slight. The restriction of the movement, to which I have referred, is in the early stage almost entirely due to muscular contraction, and is very much diminished when the patient is examined under chloroform, nor is there any grating to be felt in the joint.

The symptoms which I have described are those which commonly occur in the early stage of hip-joint disease, especially where the disease has commenced primarily in the synovial membrane, or where the bone deposit has not yet communicated freely with the joint, but in some cases the symptoms begin more acutely and the position assumed by the limb is different. The chief variations are the following :— The pain may be very great from or soon after the commencement of the disease, and be chiefly complained of on the inner side and front of the knee. It may be excited by very slight movement, even by jarring of the bed, being due in that case to spasm of the muscles set up by the jar driving the inflamed bony surfaces together. This great tenderness of the joint is always accompanied by starting of the limb at night. The starting occurs generally as the patient is dropping off to sleep or as he wakes up, and is due to sudden and irregular spasm of the muscles when the control of the will is lost.

It also occurs during sleep, waking up the patient, and is probably often set up by turning in sleep. In bad cases this starting occurs many times during the night and leaves much aching behind. The child thus frequently cries out at night, and suffers much from want of sleep. The tenderness of the joint is further evidenced by the way in which the patient supports and lifts the leg by means of the other foot. In these cases the position assumed from the first is often adduction and flexion with tilting upwards of the pelvis on the affected side, giving rise to apparent shortening. In other cases there is marked thickening about the joint, either in front corresponding to the synovial membrane, or affecting the neck of the femur or the inner surface of the acetabulum.

These variations depend on the pathological condition, and to some extent indicate the state of matters in the interior of the joint. The insidious onset which I have described in the first instance coincides either with primary synovial disease, or with some osseous deposit which has not yet opened freely into the joint, although it may have affected the synovial membrane. Where the disease commences acutely, or where, after going on slowly for a time, it suddenly becomes acute, the primary seat of disease has been the bone, and the acute onset corresponds with the escape of tuberculous material from the osseous deposits into the cavity of the joint, leading to rapid infection of all the structures of the joint. Severe starting-pain implies inflammation of the bone, rarefying osteitis, especially beneath the cartilage, and indicates early destruction of the cartilage, absorption of the neck, and enlargement of the acetabulum.

In a certain number of cases, it is possible at an early period to diagnose the primary seat of the lesion before all the structures of the joint have become affected, and where this can be done the knowledge may have a very important bearing on treatment. The points to be examined are the relative size of the trochanter and the neck of the femora, the relative fulness in the groins, the condition of the inner surfaces of the acetabula as felt from the rectum, and the degree of restriction of movement.

Where the disease has commenced in the synovial membrane, and is still confined to it, there is fulness in the groin on that side, and measurement by callipers applied over the femoral artery in front, and at a corresponding place behind, shows a difference of a quarter to half an inch between the two sides. Further, there is no thickening about the trochanter or on the inner surface of the acetabulum, and the movement is not in the first instance greatly restricted.

Where the disease has commenced in the neck of the femur, it may be that when we first see the patient, the deposit is limited to the substance of the bone, and has not yet communicated with the joint, or it may have infected the synovial membrane, or have opened freely into the joint. In the first case there is thickening about the trochanter and neck of the femur without thickening of the synovial membrane, and when the deposit is in its usual position, viz. outside the epiphysial line, only slight pain and restriction of movement. In the second case there is, in addition to the symptoms just mentioned, fulness in the groin due to thickening of the synovial membrane, and somewhat greater restriction of movement; no thickening to be felt *per rectum*. In the third instance the symptoms become acute when the deposit opens into the joint, and consist of thickening about the trochanter, fulness in the groin due rather to fluid in the joint than to synovial thickening and glandular enlargement, much pain and starting, and marked rigidity of the joint from muscular contraction; no thickening felt *per rectum*.

Where the disease commences in the acetabulum, the whole thickness of the bone is usually affected, so that, on the one hand, the whole surface of the joint is early attacked, and, on the other hand, the periosteum on the pelvic side is thickened, and often there is a collection of cheesy matter or of pus between the periosteum and bone. Hence, the local signs are much pain and rigidity at an early period, some fulness in the groin, thickening on the pelvic surface of the acetabulum as felt by the finger in the rectum, no thickening of the trochanter or neck of the femur. Erichsen also states that in acetabular disease the pain is more in the region of the hip-joint than about the inner side of the thigh and knee as is usually the case.

In all these cases stereoscopic X-ray photographs should be taken both of the diseased and of the sound side. They will show the condition of the bone and whether deposits are present in them or not, or whether the surface is irregular and carious. The presence and position of deposits in the bone is a matter of great importance from the point of view of treatment, especially in the early stage of the disease.

Differential Diagnosis

The differential diagnosis of tuberculous disease is sometimes very difficult at this stage. Apart from the characteristic signs of disease of the hip-joint, the insidious onset of the disease, and, where it is attributed to an injury, the quiescent interval which usually intervenes before the symptoms commence, are sufficient to excite very grave suspicions. These are much strengthened if tuberculous lesions are found elsewhere, and the suspicion becomes almost a certainty, at any rate in young subjects, if the symptoms do not yield to treatment in the course of a few weeks. The most difficult matter is to distinguish tuberculous disease from subacute synovitis, due to some temporary cause, such as an injury. In that case the symptoms are always more acute and rapid in their onset, and when due to injury, follow almost immediately on it. The matter is very readily settled, however, by watching the effect of treatment. Where I suspect simple synovitis, I always put the patient to bed, without any apparatus, and tell the parents to prevent the child from getting up and standing for a week or ten days. At the end of that time, if the affection is a simple synovitis, distinct improvement will usually be noted, even without the use of retentive apparatus, whereas, if the disease is tuberculous, the patient will probably be worse, or at any rate not markedly better.

Another difficulty in diagnosis is from the congestive condition of the bones during rapid growth, 'growing pains,' as it is popularly called, or the 'Fièvre de croissance' of the French. This condition is usually met with near the age of puberty (15–17 years of age), affects the bones rather than the joints, more especially the lower part of the femur and the tibia, and is not limited as a rule to one joint or bone. It may be accompanied by fever and subsides very rapidly on rest in bed.

Again, where the trouble has commenced after an accident, in children one must be careful not to overlook the possibility of a separation of the upper epiphysis of the femur, as the result of the accident. Skiagrams have now shown that a certain number of cases of supposed tuberculous hip-joint disease after injury are really cases of separation of the upper epiphysis of the femur and not tuberculous at all. Where these appearances are found Von Pirquet's or other reaction should be employed, and if the result is negative the treatment must be that for separation of the epiphysis and not for tuberculous disease. This is an instance where the great value of skiagrams at an early period is evident, and wherever possible this method of investigation should not be neglected. At the same time it must be borne in mind that this separation of the epiphysis may really be the result of tuberculous disease.

In older patients commencing monarticular rheumatism and rheumatoid arthritis must also be borne in mind. As a matter of fact, in old patients tuberculous hip-joint disease is much less common than either of the other affections mentioned, and therefore the presumption is against it, and in the early stage in old people it is almost impossible to diagnose tuberculosis. In favour of it would be the greater pain and fixity of the joint, absence of grating, and the presence of other tuberculous lesions: at a later stage the formation of a chronic abscess would definitely settle the diagnosis in favour of tuberculosis, as also would distinct evidence of enlargement of the acetabulum. In the case of rheumatoid arthritis grating is observed early, and thickening from outgrowths from the bones is often present.

The diagnosis must also be made from other diseases not affecting the hip-joint, and of these perhaps the one most commonly confounded with it is spinal disease with psoas abscess, especially where there is no spinal curvature. Here the mistake arises from placing too much reliance on the difficulty of complete extension in hip-joint disease, and the consequent arching of the back, for in psoas abscess the leg is also frequently flexed and cannot be properly extended. In psoas abscess, however, there is no difficulty in flexion unless the abscess is large and has passed into the thigh, in which case there may be a mechanical obstruction to complete flexion, but in psoas abscess with the limb at right angles or at the position of greatest possible flexion there is no movement of the pelvis nor any restriction when the leg is abducted or rotated outwards and only in some cases when adducted, while there is a difficulty in rotating inwards. Further, in the case of psoas abscess fulness and fluctuation can generally be detected deep down in the iliac fossa and higher up in front of the loin, the latter point differentiating it from abscess in the iliac fossa in connexion with hip-joint disease, which does not ascend above the level of the iliac fossa. Then lastly, in spinal disease, even where no curvature is present, the lumbar curve (if the lumbar region is the seat of disease) is usually diminished or absent, and wherever the disease is present that part of the spine is rigid, and pain can generally be elicited by firm pressure on the transverse processes of the vertebræ.

In the more acute forms of hip-joint disease the question of diagnosis arises from acute osteomyelitis in the upper end of the femur, and from the gummatous epiphysitis of infants. The former affection is distinguished by the presence of high temperature, which very rarely occurs to any great degree in tuberculous hip-joint disease, by marked tenderness at the upper part of the femur, by thickening of the bone, and by the early and rapid formation of abscess. The latter condition is rare at the upper part of the femur, but if present is characterized by swelling, tenderness, powerlessness of the limb, and other signs of congenital syphilis. Wasserman's reaction for syphilis will be of great value here in settling the diagnosis. It is necessary to get a bacteriologist to do this.

In making the diagnosis of tuberculosis in doubtful cases there are two reactions which are also worth making, viz. Calmette's eye reaction, and Von Pirquet's skin reaction. Calmette's reaction seems to be too dangerous, and I do not advise it; in several instances troublesome ophthalmia has been set up. Von Pirquet's reaction, on the other hand, seems quite harmless. It consists in scarifying the skin in a suitable part and rubbing in some tuberculine. If the patient is tuberculous, redness and swelling appear in a few hours, and a distinctly inflamed patch is formed and remains two or three days.

It is usual, in giving the differential diagnosis of tuberculous hip-joint disease, to mention spinal disease without abscess and sacro-iliac disease, but as I shall refer to this point again I need only say here that with anything like a careful examination no confusion need arise. I have also seen infantile paralysis and appendicitis mistaken for hip-joint disease, but the free mobility and the loss of power in the limb in the former case, and the fever, seat of tenderness and swelling, and the free mobility of the hip when the abdominal muscles are relaxed in the latter, are sufficient to exclude the diagnosis of hip-joint disease. Again, I have seen a tumour of the pelvis, and also a tumour of the upper part of the thigh, mistaken for hip-joint disease on account of the restriction of the movements, the pain, and the swelling. Lastly, sciatica and hysteria have also to be borne in mind. In sciatica the pain extends down the back of the thigh and leg, and there are tender points along the course of the sciatic nerve: there is no pain on extension or movement in a semi-flexed position, but complete flexion is usually impossible on account of the pain due to stretching of the sciatic nerve, and the flexion is still more restricted if at the same time the leg is kept extended at the knee-joint. The hysterical affection is more difficult to diagnose in the hip than in most of the other joints, on account of its deep-seated position, but it is also much rarer than the others. Here one must be guided by the presence of other signs of hysteria, the irregularity of the symptoms, the absence of shortening, even although the disease has lasted for some time, and the freedom of movement under chloroform.

2. Symptoms of the Second Stage

In this stage the articular cartilages disappear more or less completely, the acetabulum enlarges in the upward and backward direction, and the neck of the femur becomes altered in direction and absorbed. In a good many of these cases, the process is accompanied by the formation of pus, but it is best from the point of view of treatment to exclude from the second stage all those cases in which there are visible abscesses or sinuses.

As this stage comes on, the position of the limb generally alters, and instead of abduction and apparent lengthening, the limb becomes adducted, and in some cases rotated inwards, while the flexion increases, and the pelvis on the affected side is held at a higher level than on the other (see Fig. 66).

In addition, there is a greater or less degree of real shortening, and from the tilting of the pelvis the shortening becomes apparently greater than it really is. There is also increased pain and rigidity at the hip-joint, increased atrophy of the muscles, shortening of the neck of the femur, and it may be real dislocation. The methods of examination as regards movement are the same as have been previously described, but as additional investigations must be made, it will be well to refer to some of the individual points in detail.

Where no treatment has been adopted during the first stage, the flexion is usually considerable, and may be a good deal more than half a right angle. This flexion is partly due to the greater ease of the position, and partly to the greater strength of the flexors over the extensors. The amount of flexion is considerably masked when the patient is standing, especially when he places his toes on the ground, owing to the lordosis of the lumbar spine, which is, of course, excessive when the flexion is great (see Figs. 61 and 62). In estimating the degree of flexion, therefore, it is necessary, just as in the first stage, that the patient be laid on his back on a flat table. The lumbar spine is then pressed down till it is lying flat on the table, or the limb pushed up till the same thing happens, and the point made out when, on further extension of the thigh, the spine begins to arch. The angle

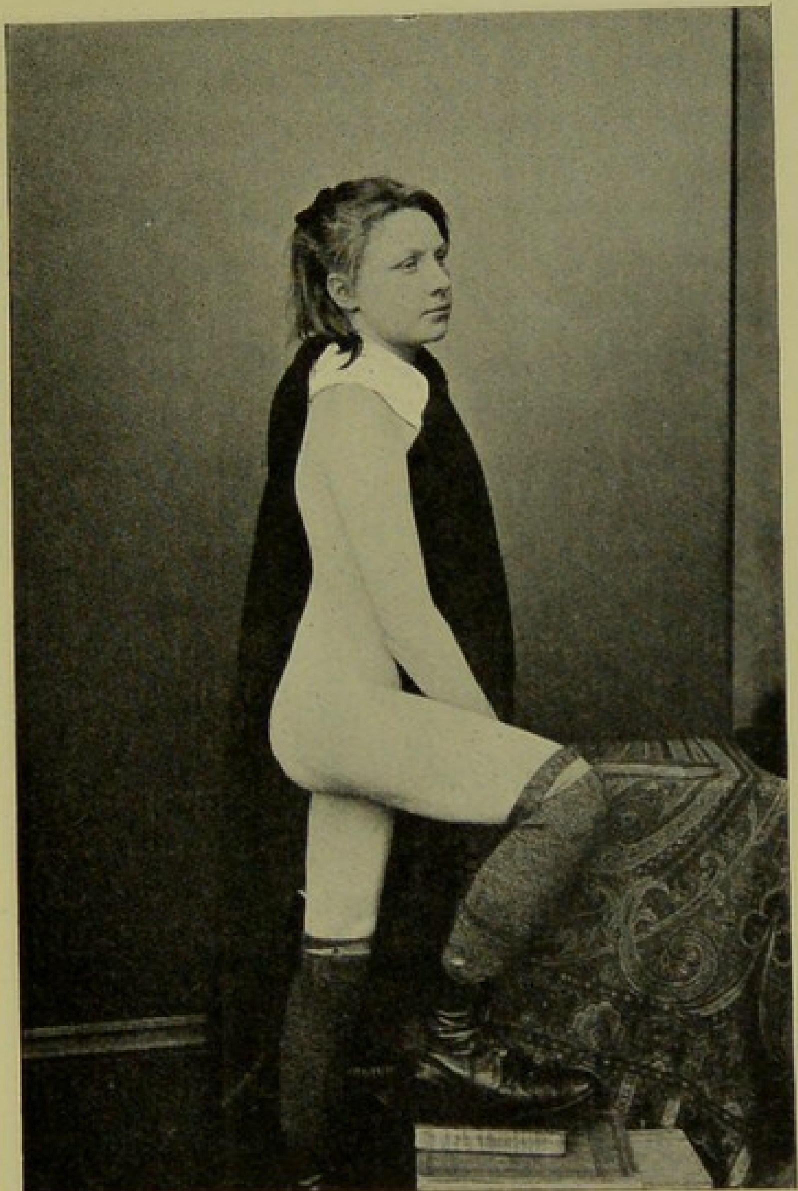


FIG. 61.—Hip-joint disease, showing the degree of flexion. (After BRADFORD and LOVETT.)

which the thigh forms with the table can then be readily measured.

The adduction of the limb is the most troublesome deformity from the point of view of treatment. The adduction is very evident on inspection, not only from the inclination of the affected limb towards the sound one, but also from the deep groove at the junction of the thigh and the perineum. The adductors, more especially the adductor longus, are shortened and may require division before the limb can be got straight. The degree of adduction can be measured by

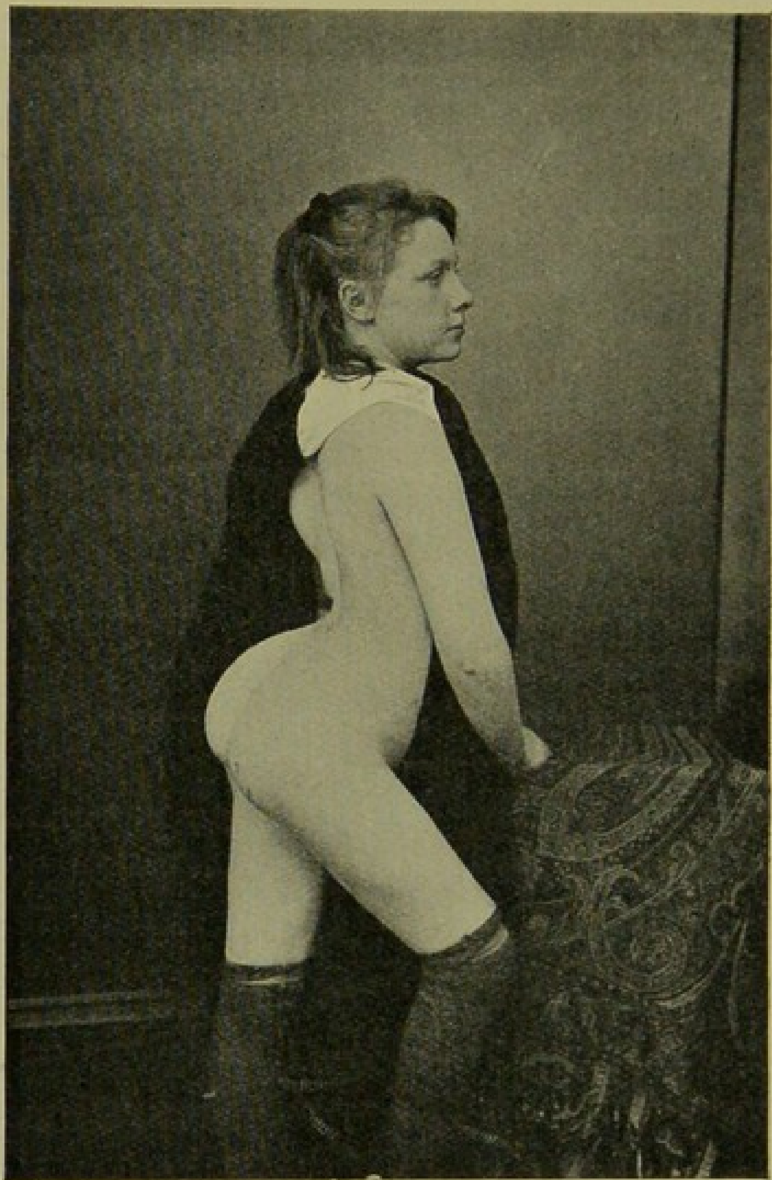


Fig. 62.—Hip-joint disease (see Fig. 61), showing extreme lordosis, when an attempt is made to bring the foot to the ground. (After Bradford and Lovett.)

the goniometer, the transverse bar being laid across the two anterior iliac spines, and the indicator placed parallel with the thigh on the affected side.

The greater the adduction the greater the obliquity of the pelvis, and the greater the difference between the apparent and the real shortening. Based on this fact, Lovett has constructed a table by which the amount of adduction can be readily determined by ascertaining, on the one hand, the distance between the anterior superior spines, and on the other, the difference between the real and the apparent

Distance between Anterior Superior Spines in Inches.

	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	11	12	13
¼	5°	4°	4°	3°	3°	2°	2°	2°	2°	2°	2°	2°	2°	1°	1°	1°	1°	1°
½	10	8	7	6	5	5	4	4	4	4	4	4	4	3	3	3	3	2
¾	14	12	11	10	8	8	7	7	6	6	5	5	5	4	4	4	3	3
1	19	17	14	13	11	10	9	9	8	7	7	7	6	6	6	6	5	4
1¼	25	21	18	16	14	13	12	11	10	9	9	8	8	7	7	7	6	6
1½	30	25	22	19	17	15	14	13	12	12	11	10	10	9	9	8	7	7
1¾	36	30	26	23	20	18	17	15	14	13	13	12	11	10	10	9	8	8
2	42	35	30	26	23	21	19	18	16	15	14	14	13	12	12	10	10	9
2¼	—	40	34	30	26	24	21	20	19	17	16	15	14	14	13	12	11	10
2½	—	—	39	34	29	27	24	22	21	19	18	17	16	15	14	13	12	11
2¾	—	—	—	38	32	29	27	25	23	21	20	19	18	17	16	14	13	12
3	—	—	—	42	35	32	29	27	25	23	22	21	19	18	18	16	14	13
3¼	—	—	—	—	39	36	32	30	27	26	25	22	21	20	19	17	15	14
3½	—	—	—	—	—	40	35	33	30	28	26	24	23	22	21	19	17	16
3¾	—	—	—	—	—	—	38	35	32	30	28	26	25	23	22	20	18	17
4	—	—	—	—	—	—	32	38	35	32	30	28	26	25	23	21	19	18

Difference in inches between real and apparent shortening.

shortening. I copy this table from Bradford and Lovett's book. Real shortening is ascertained in the ordinary way by measuring the distance between the anterior superior spine and the internal malleolus on each side, and Lovett takes the apparent shortening by measuring the distance between the umbilicus and the internal malleolus of each side. The difference between the real shortening and the apparent shortening is then taken, and the balance remains as the shortening due to tilting of the pelvis. 'Take an example :—Length (from anterior superior spine) of right leg, 23 inches ; of left leg, $22\frac{1}{2}$ inches. Length (from umbilicus) of right leg, 25 inches ; of left leg, 23 inches. Real shortening, $\frac{1}{2}$ inch ; apparent shortening, 2 inches. Difference between real and practical shortening, $1\frac{1}{2}$ inches. Distance between anterior superior spines (pelvic measurement), 7 inches. If we follow the line for $1\frac{1}{2}$ inches, until it intersects the line for pelvic breadth of 7 inches, we find 12° to be the angular deformity, and as the practical shortening is greater than the real, it is 12° of adduction of the left leg.'

Rotation inwards not infrequently takes the place of rotation outwards during this period, but unless true dislocation on to the dorsum has occurred, it is not excessive.

During the progress of this stage the limb becomes shortened from $\frac{1}{4}$ inch to 2 or $2\frac{1}{2}$ inches ; the average is $1\frac{1}{2}$ inches when the disease comes to a standstill. After the active disease has passed off, further shortening may also take place. The shortening during the active stage is, as I have already mentioned, usually due to absorption of the head and neck of the femur and alteration in the angle of the neck and shaft, further to absorption of the upper and back part of the acetabulum, leading to enlargement of the acetabulum in that direction, and slipping up of the head of the femur, in some cases to true partial or complete dislocation, and in some rare instances to perforation of the acetabulum and passing of the shortened head and neck into the opening. After the disease has come to a standstill the further shortening is due to deficiency in growth of the limb.

To ascertain the actual shortening, measurements are first made from the anterior superior spine of the ilium to the internal malleolus. The lowest point of the anterior superior spine, where it turns backwards, is marked on the skin on both sides as are also the tips of both internal malleoli. The leg is then extended at the knee-joint and the distance between the points measured off. In doing this the hands should not rest on the skin, lest the marks be displaced, and it should be noted that the tape does not touch anywhere, and that it is in a plane parallel to the leg. *Further, the sound limb must be placed in exactly the same position as the diseased one as regards flexion, adduction, and rotation,* otherwise error will arise. The difference between these two measurements gives the amount of real shortening of the limb, but this may be due not only to alteration about the hip-joint itself as the result of the disease, but also to deficient growth of the limb if the disease has lasted for some time. The amount of shortening due to changes at the hip-joint itself is ascertained fairly well by observing how far the tip of the trochanter is above Nelaton's line. Draw a line from the lowest point of the anterior superior spine of the ilium to the most prominent point on the lower and posterior surface of the tuber ischii. Normally this line will touch the tip of the trochanter. The distance which the tip of the trochanter is above this line indicates the amount of shortening due to changes at the hip-joint, and the difference between this measurement and the total real shortening ascertained as above described indicates the deficiency in the growth of the limb.

Another measurement which is of importance as indicating the degree to which the changes about the hip have proceeded is that of the relative distance of the two trochanters from the middle line. This measurement is readily made by means of a bar with an indicator fixed at its centre, and from this towards each side the surface is marked off in inches and parts of an inch ; sliding on each end of this bar is a vertical arm. The bar is laid on the abdomen at the level of the trochanters, exactly at right angles to the axis of the body, and with the indicator in the middle line, the lateral arms are then slipped inwards till they touch the outer surfaces of the trochanters, and the measurement on each side is then read off. Where one trochanter is decidedly higher than the other, then the bar must be placed at the level of the middle of the trochanter on the affected side, and on the sound side a line must be continued upwards from the outer surface of the trochanter parallel with the axis of the body. It will be found that at this stage of the disease, unless true dislocation on to the dorsum has occurred, the trochanter on the diseased side is nearer the middle line than the other. The cause of this is either absorption of the head and neck of the femur or deepening of the acetabulum, with sinking in of the head, and the diagnosis between these may be made by rectal examination, which sometimes shows thickening over the inner surface of the acetabulum in the latter case and not in the former. The chief importance of this measurement is, however, that it indicates whether the shortening is due to true dislocation on to the dorsum or simply to enlargement of the acetabulum. In the former case, unless there has been separation of the head or great absorption of the neck, the trochanter will be further away from the middle line on the affected side than on the sound one, while in the latter, as I have just pointed out, the reverse will be the case.

True dislocation is comparatively rare in hip-joint disease, but it does sometimes occur, and then usually about the commencement of the second stage. The most common form is dislocation on to the dorsum, but its mechanism is quite different from that of dislocation occurring as the result of injury. Instead of the head of the bone passing out through a hole in the lower part of the capsule, the capsule either stretches or tears at the upper and back part, and the head then simply slips upwards on to the dorsum or sometimes becomes caught on the rim of the acetabulum, a deep groove being then formed on the head at that part. Preceding the dislocation, the acetabular cavity usually becomes filled up by soft tissue chiefly arising from proliferation in connexion with the ligamentum teres ; at the same time the ligaments become softened and stretch. Where dislocation on to the dorsum occurs, the position characteristic of the second stage becomes exaggerated, more especially the rotation inwards. More rarely the head of the bone passes forwards and upwards so as to lie below the anterior superior spine of the ilium. In four cases of this kind which I have seen, the dislocation occurred suddenly, in two of them during sleep. The limb becomes rotated outwards to a marked degree, adducted, and flexed.

The pain in the early period of the second stage increases in degree coincidently with the destruction of the articular cartilages and the caries of the surface of the bone, the pain being both around the hip and also on the front and inner side of the thigh and knee. The starting-pains at night and the pain on movement and jarring the limb also increase. Towards the end of the second stage the pain diminishes on account of the marked fixation of the joint from partial anchylosis.

As the cartilages become destroyed, and the surface of the bones becomes carious, the rigidity of the joint also increases, being still, to a large extent, the result of muscular contraction but also, to some extent, due to shortening and thickening of the capsule, and towards the end of the stage to fibrous or bony anchylosis. The atrophy of the muscles, both of the buttock and also of the thigh, progresses rapidly, and, as mentioned with reference to the first stage, their reaction to faradism is very much diminished.

As regards the general condition of the patient during this stage, he becomes thin and pale and his appetite poor and capricious ; he is disinclined to move about, and his sleep is very much disturbed.

Diagnosis in the Second Stage

Apart from the diseases which are apt to be confounded with hip-joint disease, and which have been already mentioned, there are certain others which have to be borne in mind in examining a case in the second stage.

On hurried examination a congenital dislocation of the hip might be looked on as hip-joint disease, especially if only one hip-joint is affected. There is shortening of the limb, limping, and lordosis in congenital dislocation as in hip-joint disease, but in the former, instead of restriction of movement, there is excessive freedom of movement, without pain ; by extension, the limb can generally be drawn down to its full length, and, on the other hand, the head of the bone can be readily pushed up again. An X-ray photograph will show the state of matters at once.

In older people, the diagnosis from rheumatoid arthritis is often a very difficult matter on account of the deeply seated position of the joint. In both there is limitation of movement, and pain on movement, but in rheumatoid arthritis the shortening, flexion, and adduction are not such marked features, and there is usually considerable thickening about the bone. In the early stage, grating is felt in the joint, other joints are often affected, and there is absence of other tuberculous lesions.

In old people also it sometimes happens that after a fall on the hip-joint pain persists, and the limb becomes somewhat shortened, the condition, in some cases, being an osteitis, with absorption of the neck of the femur, though in others, no doubt, rheumatoid arthritis is set up by the injury.

Charcot's disease also occasionally affects the hip-joint, but there the symptoms are acute in the first instance, with pain and swelling about the joint, followed by increased looseness of the joint, which may be dislocated without pain, and usually accompanied by the early symptoms of locomotor ataxia, especially by the Argyll-Robertson pupil.

It is hardly necessary to refer to the diagnosis from true dislocation, in which the displacement occurs suddenly after a severe accident, and in which the malposition is at once complete and more marked than that in hip-joint disease. In some cases of disease, however, dislocation may occur spontaneously, and the case may be mistaken for tuberculous disease unless this is borne in mind. This occurs during recovery from acute fevers such as scarlet fever and especially during the delirium. In these cases inflammation of the ligaments followed by softening occurs and the head of the bone slips out of the socket. The condition may not be recognized till the patient begins to get about. An X-ray photograph will usually show absence of the destructive changes characteristic of tuberculous disease, and the history will also guide the surgeon to the true state of matters.

3. Symptoms of the Third Stage

The third stage is somewhat arbitrarily formed to include all cases where abscesses have formed and are either still unopened or have burst, leaving sinuses. This division is introduced on account of its clinical importance, and not on account of its pathological significance, for abscesses may occur early or late in hip-joint disease. Perhaps most often where abscesses are present they occur about the middle of the second stage, though sometimes where the case is acute they occur early, before any marked shortening, or, on the other hand, at a late period, after the disease seems to have come more or less to a standstill. These abscesses may appear either inside or outside the pelvis, most commonly outside. Those which occur in the limb usually point either in front of the trochanter or in the buttock, and they may or may not communicate with the hip-joint (see Figs. 63 and 64). In some cases the abscesses begin in the outer part of the capsule, and spread outwards rather than inwards. In other cases, especially where there is a deposit in the bone towards the outer part of the neck, the periosteum may be detached from the bone and pus may burrow its way under it, escaping beyond the attachment of the capsule, and then form an abscess; indeed, cases have been published where this has occurred when the deposits in the neck of the femur were in their usual situation, and where the abscess was opened, the necrosed fragment removed, and the case cured without opening the joint. Generally, however, on opening the abscess, a small canal will be found leading through the capsule into the joint.

The pelvic abscesses usually make their way into the iliac fossa, and point above Poupart's ligament, but, in some cases, they pass downwards into the ischio-rectal fossa or perineum. As regards these abscesses in the iliac fossa, Haberern, who has written an excellent paper on the subject, describes four modes of origin :—1. The abscess may be associated with disease or perforation of the acetabulum. This occurs most often in connexion with primary disease of the acetabulum, the pus, in these cases, forming under the periosteum in the first instance. 2. The abscess arises by rupture or perforation of the capsule of the joint at its upper and inner part, the pus then passing upwards over the innominate bone into the iliac fossa. This form is rare. 3. The capsule may be perforated at the middle of the ilio-

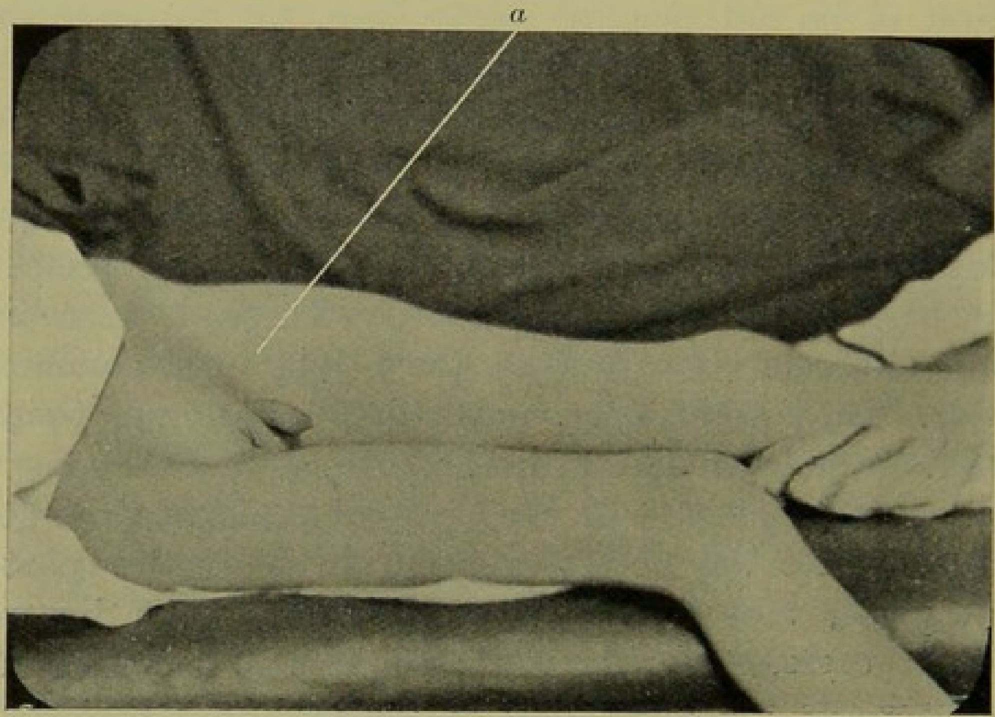


Fig. 63.—Disease of left hip-joint showing abscess (*a*) pointing in the most usual place, at the upper and outer part of the thigh.

femoral ligament, and an abscess develops between the adductors and may pass into the pelvis along the ilio-psoas muscle. 4. The abscess may not communicate with the joint or with diseased bone, but arise from suppuration of the glands in the iliac fossa, which are often enlarged in cases of hip-joint disease.

The key to the diagnosis of the point of origin of these iliac abscesses lies mainly in the examination per rectum. If with the finger in the rectum swelling is felt on the inner surface of the acetabulum the probability is that the abscess has started from that point, and if that is the case, on sharply pressing on the iliac swelling fluctuation will be felt by the finger in the rectum. If there is no swelling to be felt per rectum in the true pelvis then it is probable that the abscess has originated in one of the other three ways mentioned. (In some cases, however, the channel of communication with the iliac fossa may be very narrow.) The next point would then be to see whether there is any fulness in front of the hip-joint or at the inner side, and whether fluctuation can be detected between the hand in various positions below Poupart's ligament and the hand above Poupart's ligament. If not, then the abscess

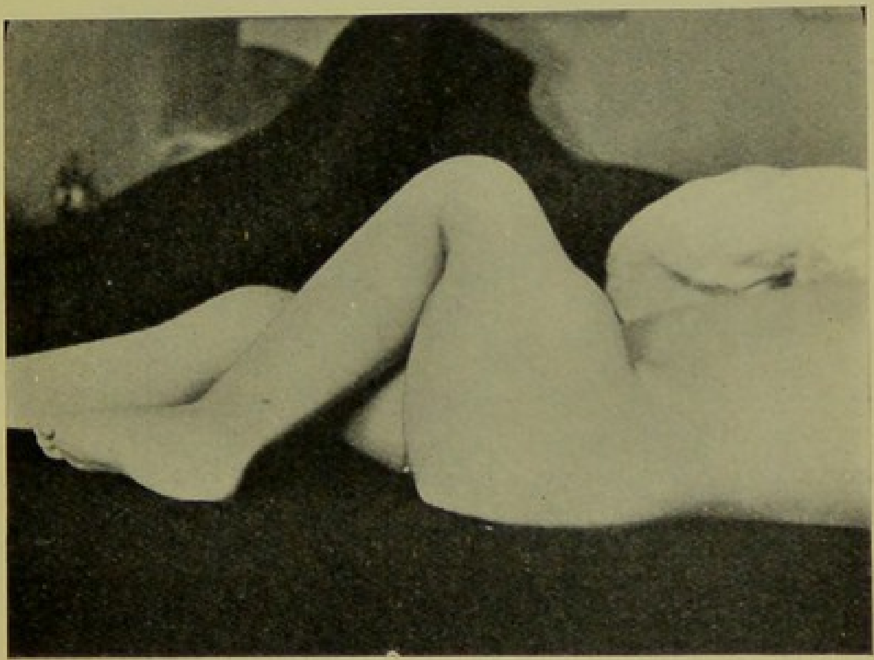


FIG. 64.—Disease of left hip-joint showing large abscesses in the buttock and also at the upper and outer part of the thigh.

is most likely of glandular origin. As regards the other two forms, fluctuation will be felt on the inner side of the joint in the neighbourhood of the lesser trochanter in the third form, but not in the second.

Where the abscesses have burst or have not been opened aseptically sinuses are found, and usually in neglected cases there are several sinuses around the joint, often all leading to the same aperture in the capsule and through that to carious bone (see Fig. 65).

During the formation of these abscesses the temperature is usually somewhat elevated and higher in the evening than the morning, but it seldom reaches 100°, ranging usually between 98·8 and 99·6. When sinuses have formed the temperature may be higher for a time, unless they become quiescent, but usually, once a sinus forms, sepsis takes place and the pus bags in pockets of the original abscess, the skin

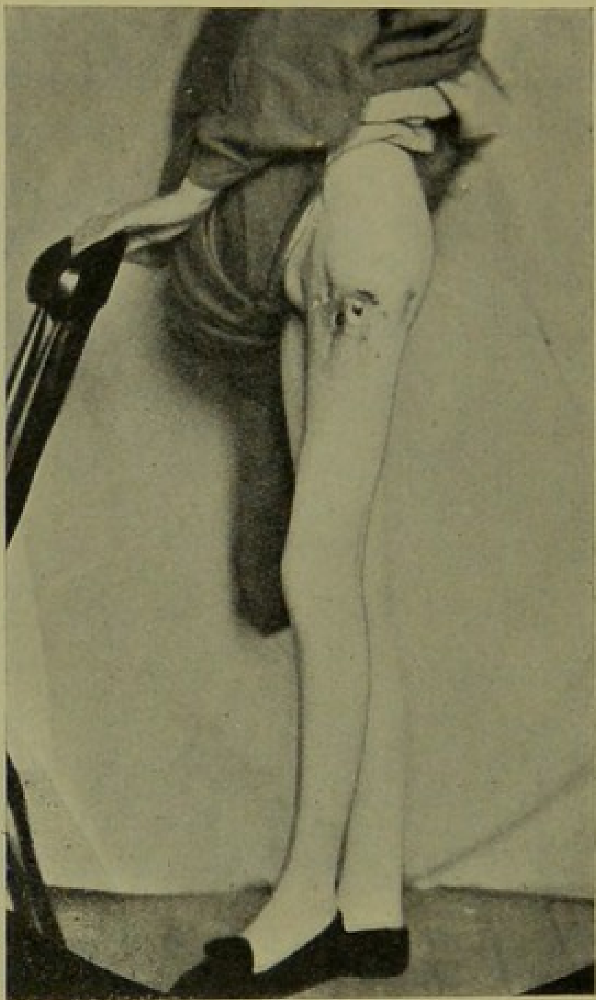


FIG. 65.—Old hip-joint disease with sinuses.

becomes red and thin over them, and fresh sinuses are formed. During the formation of these fresh sinuses the temperature usually goes up, and falls again when the pus escapes. The general condition of the patient during this stage also becomes worse: he loses flesh and strength, various internal organs become lardaceous, and, in many cases, after months or years of suffering, he dies of hectic fever and exhaustion.

4. Symptoms of the Fourth Stage

A fourth stage may also be described, where the disease gradually improves and where a certain amount of anchylosis, sometimes completely bony, takes place. This is usually accompanied with more or less shortening. This stage may follow the previous ones or, while recovery is

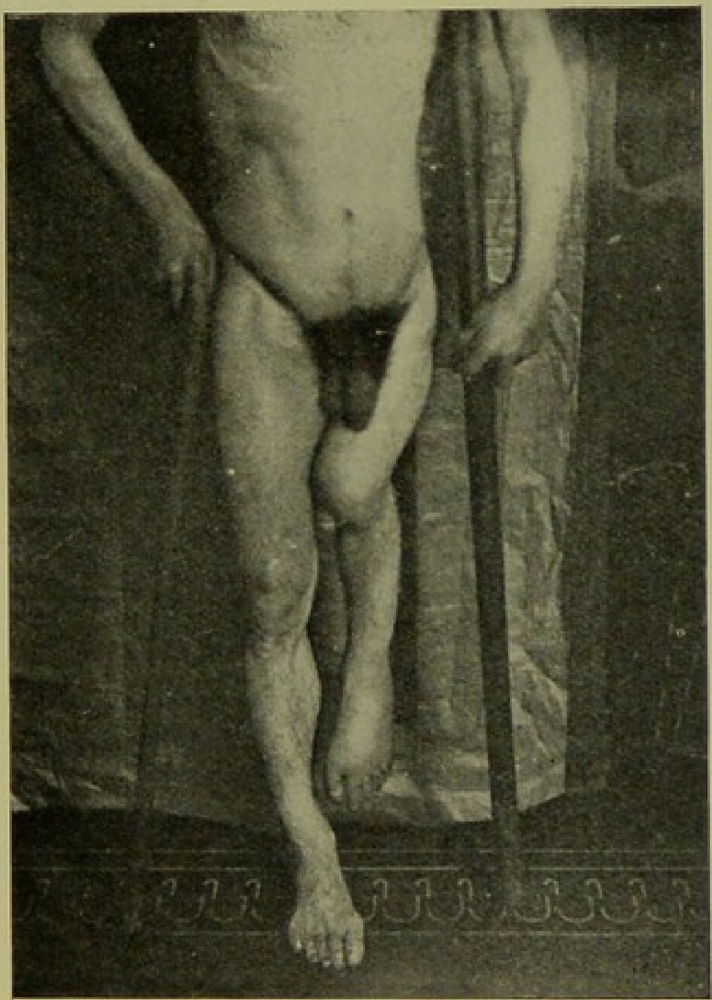


Fig. 66.—Photo of old standing case of hip-joint disease showing very marked deformity, especially an unusual degree of shortening, to a great extent the result of deficient growth of the limb.

taking place in the main, the disease progresses elsewhere and abscesses and sinuses form. Where care has not been taken in the early treatment more or less deformity is usually present in the form of flexion and adduction (see Fig. 66). Where anchylosis is present a slight degree of these deformities is not of very great moment, in fact very slight flexion enables the patient to sit more comfortably than when the limb is quite straight. When carried to any considerable extent, however, great lameness and difficulty in walking is produced. Where flexion is present lordosis is developed in order to enable the foot to reach the ground, and consequently there is great lameness and deformity, and where adduction is at all marked the pelvis is much tilted and the practical

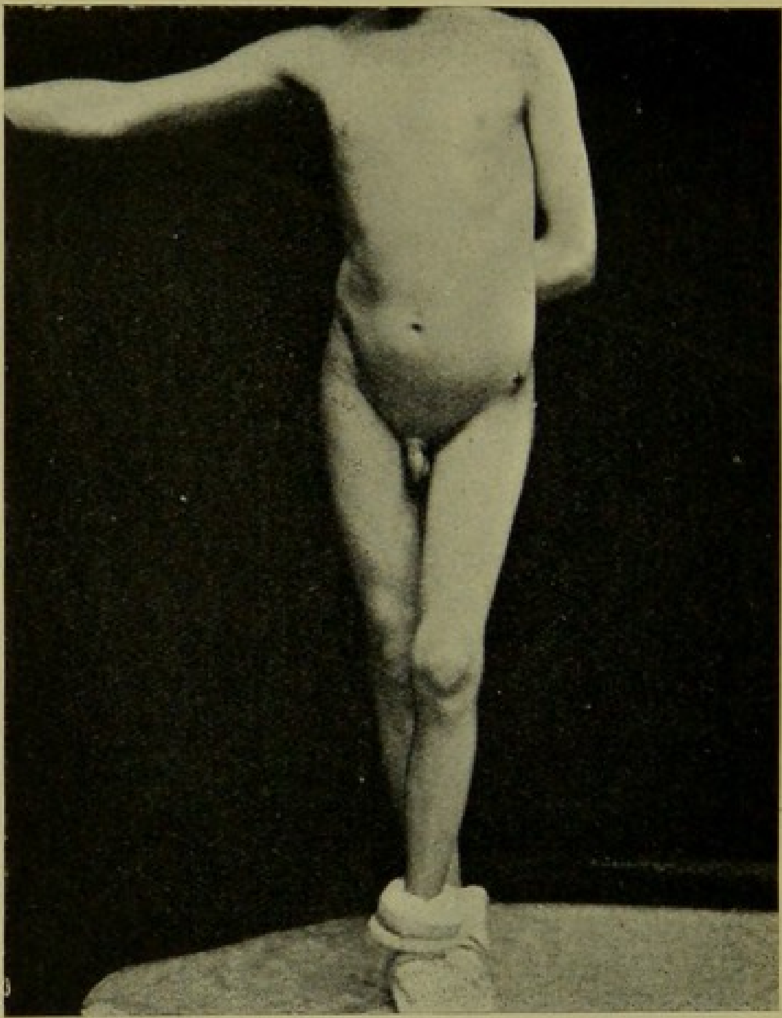


FIG. 67.—Crossed leg deformity, the result of disease of both hip-joints.

shortening greatly increased. The combination of the two deformities cripples the patient, sometimes entirely, and calls for operative treatment.

In some cases, though rarely, both hip-joints become diseased. In that case they do not usually become affected simultaneously but after an interval of some months, and it is stated that the disease in the second joint is not so severe as in the first, especially as regards the question of pain.

This condition, if not properly treated, is very apt to give rise to a peculiar deformity—'crossed leg deformity'—the result of adduction on both sides. The feet are quite crossed, and the patient has great difficulty in standing (see Fig. 67). In some cases, however, where the adduction is marked and the feet well clear of each other, he can progress by a sort of rocking motion.

Prognosis of Hip-joint Disease

Hip-joint disease is without doubt a grave affection, but a great deal depends on the treatment which is adopted and the care with which it is carried out. When the case is placed under proper treatment at an early stage of the disease the chances of ultimate recovery are very considerable, but a long time must elapse (from 3 to 7 years) before the cure can be reckoned complete. In some few cases there is perfect recovery of the joint, but in most instances there is more or less restriction of movement, and where the second stage has been reached before proper treatment was adopted the restriction of movement is usually considerable. Much depends on whether suppuration has taken place or not; if it has, the outlook is decidedly less favourable both as regards the recovery of the joint and of the general health.

Various estimates are given by different authors as to the mortality in hip-joint disease, and most put it at about 30 per cent. Part of this mortality is, however, due to long continued suppuration and septic diseases which are avoided under strict aseptic treatment, and in my experience it is distinctly too high. The essential cause of death is from tuberculous disease elsewhere, usually phthisis or tuberculous meningitis, and, as I mentioned in Chapter VIII, the mortality from these troubles, at any rate within a few years after the commencement of the disease, is under 30 per cent. I have already referred to statistics which I drew up some years ago, and among them there is a record of 77 cases of hip-joint disease which had been admitted to the hospital. Of these 77 cases, 14 had suffered, or were suffering, from tuberculous disease elsewhere when admitted. Of these, 6 died, 4 from tuberculous meningitis, 1 from peritonitis, and 1 from exhaustion from long-continued suppuration (a case admitted with suppurating sinuses). In addition 3 cases were suffering from phthisis. Of the 77 cases, 24 were discharged as cured, and 23 as much improved, or 61 per cent cured or improved. In 15 the final result is not definitely stated, but the last notes mention steady improvement: in 7 the notes are incomplete. The mortality was 6, or almost 8 per cent, but if we also reckon that the cases suffering from phthisis died, we have a mortality of nearly 12 per cent, and probably, also, some of the 7 which are incomplete did not do well.

In this list, however, are mixed up cases with and without suppuration, and also cases treated aseptically and those admitted with septic sinuses. In 31 cases there was never any suppuration, and none of these died, but in 4 there was tuberculous disease elsewhere (in 1 of these cases phthisis). In 3 of these cases the notes were incomplete, but the rest were either doing well, or had been cured when discharged.

In 46 cases suppuration took place, and of these 6, or 13 per cent died, and tuberculous disease existed elsewhere in 10. Of these 46 cases, 1 was admitted in the fourth stage, for the cure of deformity, an abscess having previously healed, leaving 45 cases to be considered. Of these, 29 were aseptic cases and 16 had septic sinuses. Of the 16 septic cases, 3, or 18·7 per cent died, and 8 were excised. Of the 29 aseptic cases 3, or 10·3 per cent, died, all of tuberculous meningitis, and 18 were dismissed cured or much improved.

Had I added more recent results, or included many cases not admitted to hospital, the proportion of recoveries would have been increased, but the above gives a very fair estimate of the prognosis under various circumstances. In any case the treatment must be persevered in for a long time: I have heard Mr. Thomas estimate the duration of treatment as 7 years with his splint, but that is probably excessive, certainly it is so when the more modern methods of treatment are employed. The signs of cure are disappearance of thickening about the joint, loss of rigidity and pain, and, where there is no anchylosis, recovery of a considerable amount of movement. Care must, however, be taken not to leave off retentive apparatus too soon, even after the disease is apparently well, on account of the great tendency to recurrence of flexion and adduction. The amount of shortening left depends on the stage of the disease when treatment was commenced, and is, on an average, 1½ to 2 inches ; of course, cases treated properly in the first stage may have no shortening. The shortening tends to increase after recovery, the growth of the limb as a whole being somewhat retarded.

1. Treatment of the First Stage

In discussing the question of treatment it will be best, even at the risk of some repetition, to consider it in each of the four stages which have been described, rather than as a whole. The treatment naturally falls under two groups in each stage, expectant and operative. Expectant treatment consists in rest both as regards movement and muscular contraction, and in attention to the general health. During the first stage expectant treatment holds the first place, and operative treatment would only be thought of in quite exceptional cases.

In all cases the local treatment consists in a period of absolute rest in bed, fixation of the limb, and, if necessary, the employment of extension ; a second period, where the fixation is still maintained, but where the arrangements permit of the patient being moved into the open, e.g. on a spinal couch, &c. ; a third period, where he can get about with crutches or sticks, wearing a suitable apparatus which prevents him putting his foot to the ground ; a fourth period, where he discards apparatus and goes about on crutches, but where the leg swings free and the foot is not put on the ground ; and a fifth period, where he discards crutches and commences walking, at first with the aid of sticks, and later alone.

During the *first period* the patient is kept rigidly in bed, movements of the hip are prevented, attention being carefully paid to the position of the limb, and, if necessary, extension is employed. The bed should be a narrow one, fracture boards should be placed under the mattress to prevent sagging in the middle, the mattress should be of hair and pretty firm, and it is well to have it divided into three parts, the middle part being narrow and corresponding to the pelvis, and of sufficient width just to admit the bed-pan. When the bed-pan is to be used, one nurse supports the pelvis while the other gradually withdraws the centre portion. While this is being done the first nurse slips in the bed-pan so that it immediately takes the place of the mattress, and in this way the movement is very slight. When the bowels have acted the pelvis is supported, the bed-pan withdrawn, the patient cleaned, dried, and powdered, and the centre piece of the mattress replaced.

Fixation of the Limb. This may be carried out in various ways, the chief point being to control flexion at the joint, which may occur either from the patient raising the trunk or drawing up the thigh. A second point is to prevent rotation outwards at the hip, which is very apt to occur when lying in bed unless steps are taken to prevent it. And the third point is to prevent adduction of the leg, which takes place if the disease progresses and which must be very carefully watched. This adduction is the deformity which is most likely to be left after recovery in the first stage and which is most difficult to guard against : with the view of avoiding it I always fix the limb in the position of slight abduction.

With the view of controlling flexion a long Liston splint is often used, and when properly applied is quite efficient for this purpose, but if applied on the diseased side it of course prevents the abduction of the limb which I believe to be of such importance ; hence if a long Liston is used it should be applied on the sound side to prevent the patient sitting up, and, so employed, it is very efficient. On the affected side the movements of flexion of the limb can be controlled by heavy sandbags. One long fat sandbag is applied along the outer side of the body on the affected side extending from the axilla to beyond the foot. It is bent outwards opposite the hip-joint, so that when the leg is drawn out to the lower part the limb shall be somewhat abducted. A second short sandbag is placed along the inner side of the affected limb, from the perineum downwards to the foot, so as to press the limb against the outer sandbag, and a third large sandbag is placed along the outer side of the long Liston splint on the sound side. To fix the body and limb by means of these sandbags a strong drawsheet is laid in front of the trunk and a second over the limb ; the sandbags are then placed in position over these drawsheets, which are drawn tight and fixed so as to press down the body and limb. Should there be a tendency to rotation outwards it can usually be corrected by the sandbags on each side of the foot, but if excessive it can be avoided by fixing a broad bar of wood transversely behind the thigh by means of plaster of Paris bandages while the limb is held in proper position (the patella looking straight forwards). The sandbags lying on each end of this bar effectually prevent eversion.

In some cases extension is necessary in order to overcome the spasmodic contraction of the muscles about the joint. As has already been pointed out, the muscles around a diseased joint are often in a state of contraction, which produces rigidity of the joint and leads the limb to assume false positions—in the early stage of hip-joint disease, flexion, adduction, and rotation outwards. Under these circumstances the contraction of the muscles around the joint is keeping the head of the femur pressed firmly against the upper and back part of the acetabulum, thus leading to atrophy of the articular cartilages at that part and keeping up the inflammation in the bone, and it is of great importance to diminish this excessive pressure as far as possible.

This rigidity is much more marked when the bone is the seat of the disease than where it is limited to the synovial membrane, and in the latter case extension may not be necessary at all unless there is some deformity present which it is necessary to rectify. The guide to the use of extension is the amount of rigidity and pain which is present, and it must be used judiciously and not applied indiscriminately.

It must be borne in mind that the object of the extension is simply to tire out the muscles and put a stop to their tonic contraction, and not to pull the bones apart. A good deal of the objection which has been made to the use of extension has been founded on the impression that heavy weights must be employed with the view of separating the bones, but such a procedure is both unnecessary and hurtful. As I have already mentioned, extension does harm when employed in cases of pure synovial disease without muscular rigidity by stretching the already inflamed capsule, and

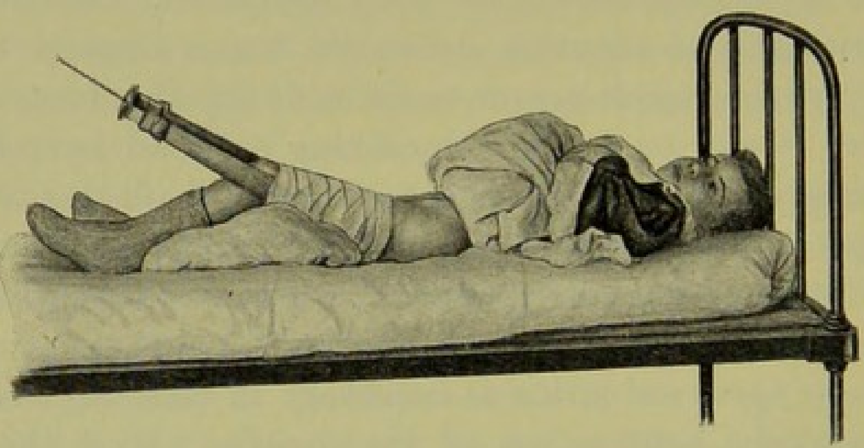


FIG. 68.—Method of applying extension in hip-joint disease. Here there is some flexion and the extension is in the first instance applied in the line of flexion. Subsequently it will be gradually lowered till the leg becomes straight.

therefore, when employed in cases of muscular contraction, the case must be closely watched, and the weight diminished or left off as soon as this contraction is overcome and the weight begins to tell on the capsule. This is generally indicated by increase of the pain or the occurrence of tenderness about the joint.

In applying extension for hip-joint disease, it is best in the first instance to apply the strapping (after shaving the limb) to the thigh from close to the hip-joint to the knee, but to avoid applying it to the leg below the knee. The reason for leaving the leg free is that when the extension is applied to the leg the knee-joint is apt to be damaged, especially if the weight is continued for some time, and more especially if there is any abduction or adduction to be overcome; the ligaments become stretched, and there may be considerable looseness of the joint. Good adhesive strapping is employed, and after a turn of bandage has been placed over it the end is turned down and bandaged over. Where a good deal of weight is to be employed, it is well to fasten the vertical straps in the first instance with a few circular or oblique turns of strapping, and then the bandage outside this. In some cases the skin is too sensitive for strapping, in which case a vertical piece of bandage must be fixed on

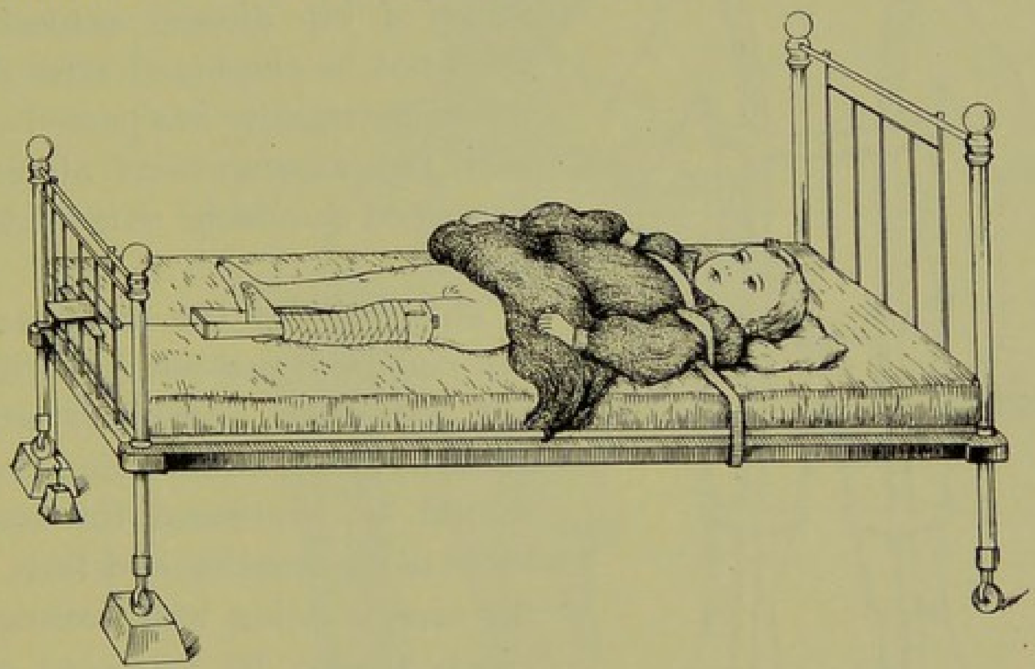


FIG. 69.—Extension applied with the limb in good position; only a light weight.

each side by circular turns of bandage, or, when the transverse bar to be mentioned immediately is employed, the extension may be fastened to it. The foot of the bed is raised and the body is kept at rest by sandbags. The line of extension should at first be in the direction of the deformity, the limb being gradually brought into the proper line (Fig. 68). At a later period, when the limb is in good position and the amount of weight diminished, the strapping may include the leg also, but the essential pull must be on the thigh (see Fig. 69). In the first instance, a weight of three to four pounds is usually sufficient for children, and this may be increased or diminished according to circumstances.

Further, in this stage the extension should ultimately be in the direction of slight abduction. It is well also to apply a broad bar of wood transversely behind the thigh, fixed on to it by plaster of Paris (the patella looking straight forward), so as by its leverage to oppose the tendency to rotation of the limb (see p. 241); where this is employed the friction is of course greatly increased, and more weight must therefore be used. As a rule, in the first stage of hip disease extension need not be employed after the muscular rigidity has passed off, and the arrangement already described should be substituted for it.

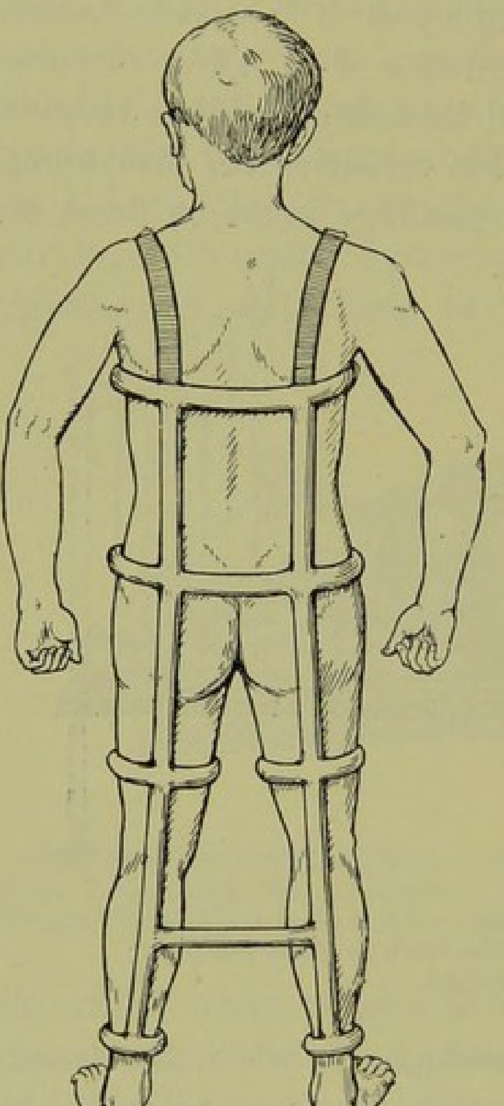


Fig. 70.—Double Thomas's splint.

This stage of the treatment, viz. complete rest with or without extension, combined with good hygiene, tuberculine, &c., should be continued for from three to six months, and then, if the case is doing well, arrangements should be made to get the patient out in the open as much as possible. In young children this is most conveniently done by fixing them in a Phelps box, the arrangement of which is described in speaking of spinal disease. In this arrangement a certain amount of extension can also be kept up if necessary by means of elastic tubing attached to the stirrup at the lower end of the extension plaster. This box can be carried out and placed in a suitable position or put on the top of a spinal carriage, and the child is kept in it day and night.

Another arrangement which is also employed a good deal for children is a double Thomas splint (see Fig. 70). I do not think that this is so comfortable or satisfactory as the Phelps box, but it takes up less space and the child is more easily handled and moved about.

In older children and adults when this stage is reached it is well to fit them with a single Thomas splint, which is then kept on always, only being taken off occasionally for purposes of cleanliness. This splint as commonly supplied by

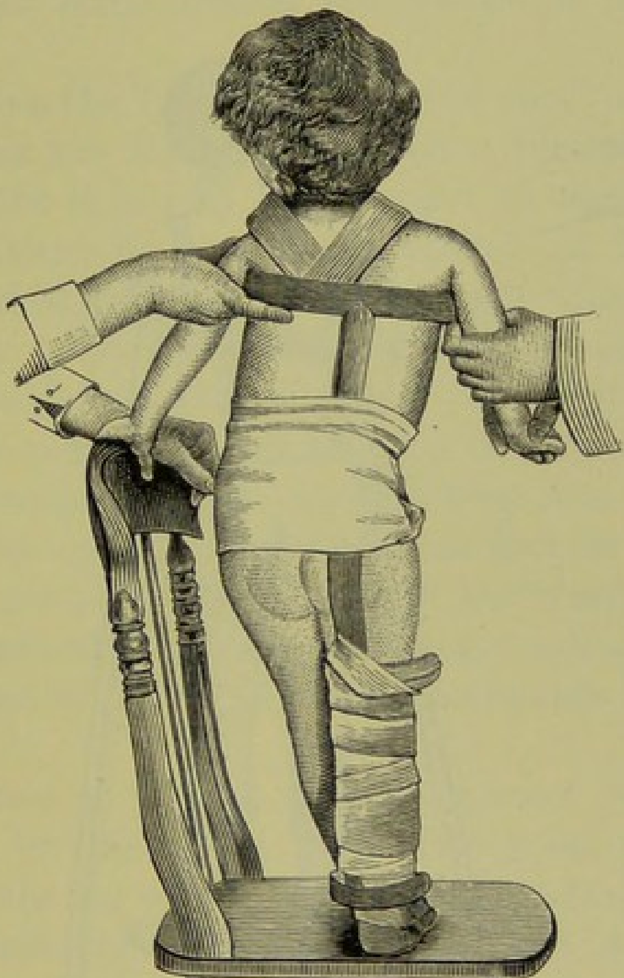


Fig. 71.—Single Thomas's splint applied.

instrument makers is badly made, and I may therefore refer to Thomas's own instructions.

The splint consists of a long flat bar of wrought-iron, which runs straight down the back on the affected side from just below the level of the axilla to the buttock (see Figs. 71 and 72). It then bends gradually forward, forming a concavity in which the buttock lies, and then is continued straight down behind the leg, the leg portion being parallel to the trunk portion, only lying on a more anterior plane on account of the bend forward to fit the buttock. Further, in order that the splint may apply itself properly, it is necessary to rotate the trunk part so that it may lie against the curved thorax; in a right-sided splint the rotation is so that the

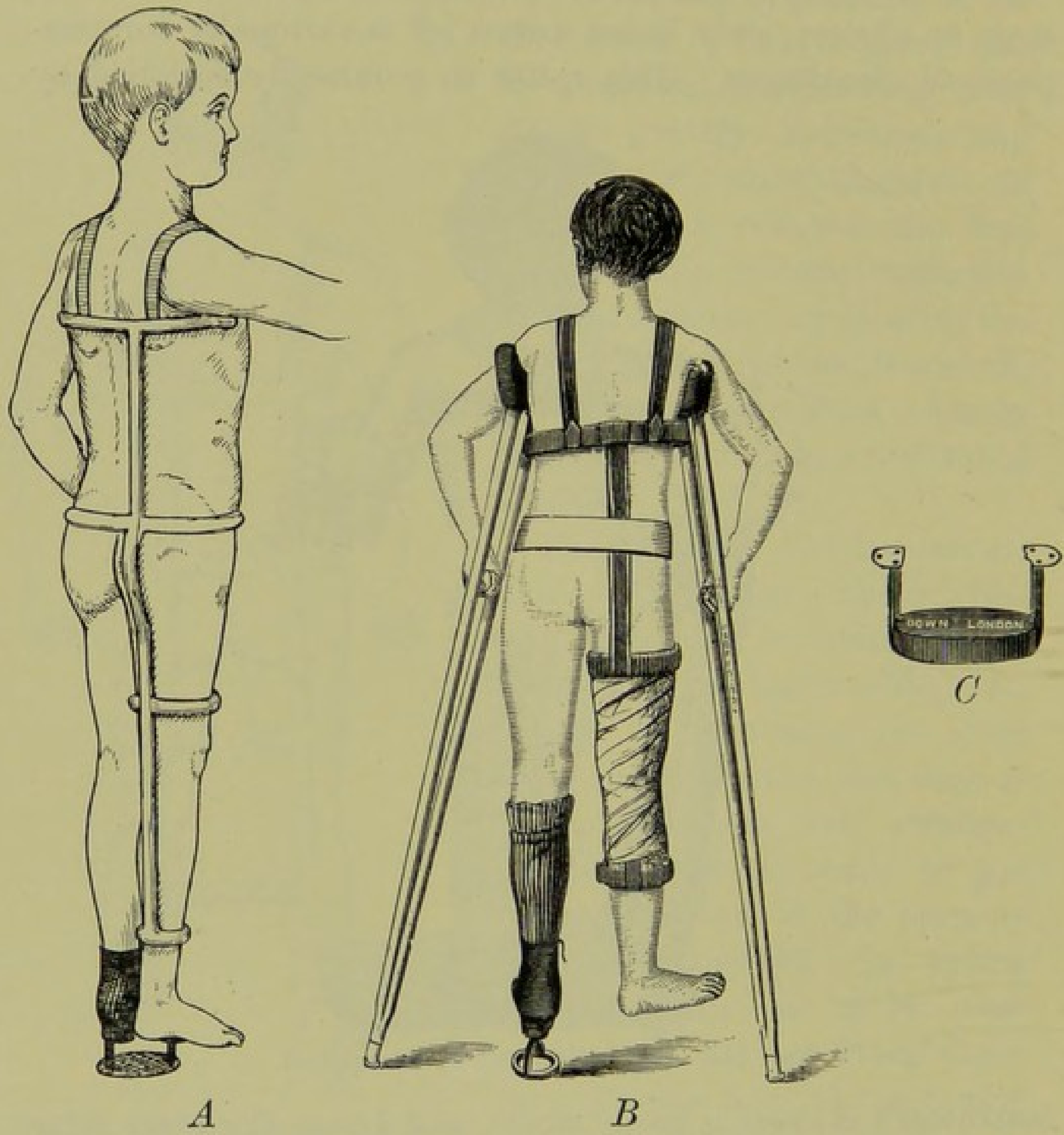


FIG. 72.—Thomas's splint arranged for walking. *A*. Splint applied; *B*. Walking; *C*. Patten for sound foot.

anterior surface of the bar looks towards the left, and vice versa. This rotation is from the commencement of the buttock-bend upwards. In the ordinary Thomas splint there are three cross-bars attached to the vertical bar, the wings on the side affected being shorter than those on the other. The upper wings grasp the body just below the axilla, the middle at the upper part of the thigh, and the lower at the lower part of the calf. On the healthy side the upper wing is applied closely to the body, but on the affected side it is opened out somewhat so as to allow the body to get away slightly from the bars on the other side. The splint is fastened to the body by a bandage at the upper part acting as shoulder braces, and by turns of bandage around the calf of the leg and turns around the middle of the thigh (see Fig. 71).

Thomas gives the following rules for applying his splint: '1. The initial act should be, to place the machine so far posteriorly that it is just out of sight at the buttock part when the patient is lying horizontally. 2. The machine should be pushed upwards until the upper wings are close to the patient's axillæ. 3. An assistant should grasp the patient's leg together with the lower part of the main stem, to hinder the machine from slipping downwards while the operator is manipulating it (i.e. twisting it so as to fit properly). 4. The surgeon should proceed first, to closely fit the wings which grasp the sound side of the trunk, thigh, then leg, and afterwards the other wings are adjusted. 5. The shoulder braces are to be adjusted, afterwards the thigh and leg bandages.'

Where flexion is present, the knee must not be tightly bound down on the splint, otherwise great pain may be occasioned; the leg will, in most cases, gradually sink on to the splint. Indeed, if the flexion is marked, it may be well to place some soft pads in the hollow of the knee to give slight support, taking them away gradually as the leg becomes more extended.

While flexion is overcome by this splint in many cases, and almost always in the first stage, the result is by no means so satisfactory as regards adduction. Although the latter comes, as a rule, under the second stage, it will be most convenient to consider the whole matter of Thomas's splint here. Without some arrangement around the pelvis, the patient is able to move the pelvis from side to side, and thus escape the lateral action of the splint, and where abduction is present, he moves it to the sound side ; where there is adduction, it moves to the affected side. To avoid this, Thomas bends downwards one or other of the uppermost lateral wings so as to get a grasp on the pelvis (the sound side in abduction, the affected side in adduction), and also bends the middle bar upwards, but the result is not satisfactory, and in these cases he has found it necessary to add a half band at the level of the pelvis. In my experience it is best in all cases to employ a pelvic band similar to the other bands. In this way one can fix the pelvis to a certain extent, although it is marvellous what a child can do in the way of wriggling out of a position which is disagreeable.

Even although fitted with this splint, the patient should not, as is frequently done, be at once provided with crutches and a patten on the sound side and allowed to walk about. On the contrary, he should be kept recumbent till the limb has accommodated itself to the splint. Not uncommonly the first result of applying the splint, especially if there is no support under the knee, is a good deal of uneasiness and pain and disturbed nights, which may last for several days. This gradually subsides, and if the splint is readjusted from time to time as the deformity is overcome, the pain soon ceases.

Another splint, which may be used when recovery has progressed to a considerable extent and when there is some movement in the hip-joint, is Hessing's splint shown in Fig. 73, as made by Hoefftcke.

Most cases of hip-joint disease treated carefully at this stage with proper fixation, good hygiene, open air, &c., get well, but one must not be in too great a hurry to let them get about again. Roughly speaking, it may be said that where extension is necessary it will have to be used for, say, three months, and then followed by complete recumbency with one of the arrangements just described for another six months, the patient being taken out on a spinal couch and kept out of doors as much as possible. At the end of nine or twelve months, if things are going on well, the patient may be allowed to get about in his Thomas splint with crutches, a patten being worn on the sound foot so as to keep the other off the ground. No weight should be borne on the affected limb till, as far as one can judge by absence of pain, thickening, and improvement in mobility, the disease has quite passed off. At the best I think this will

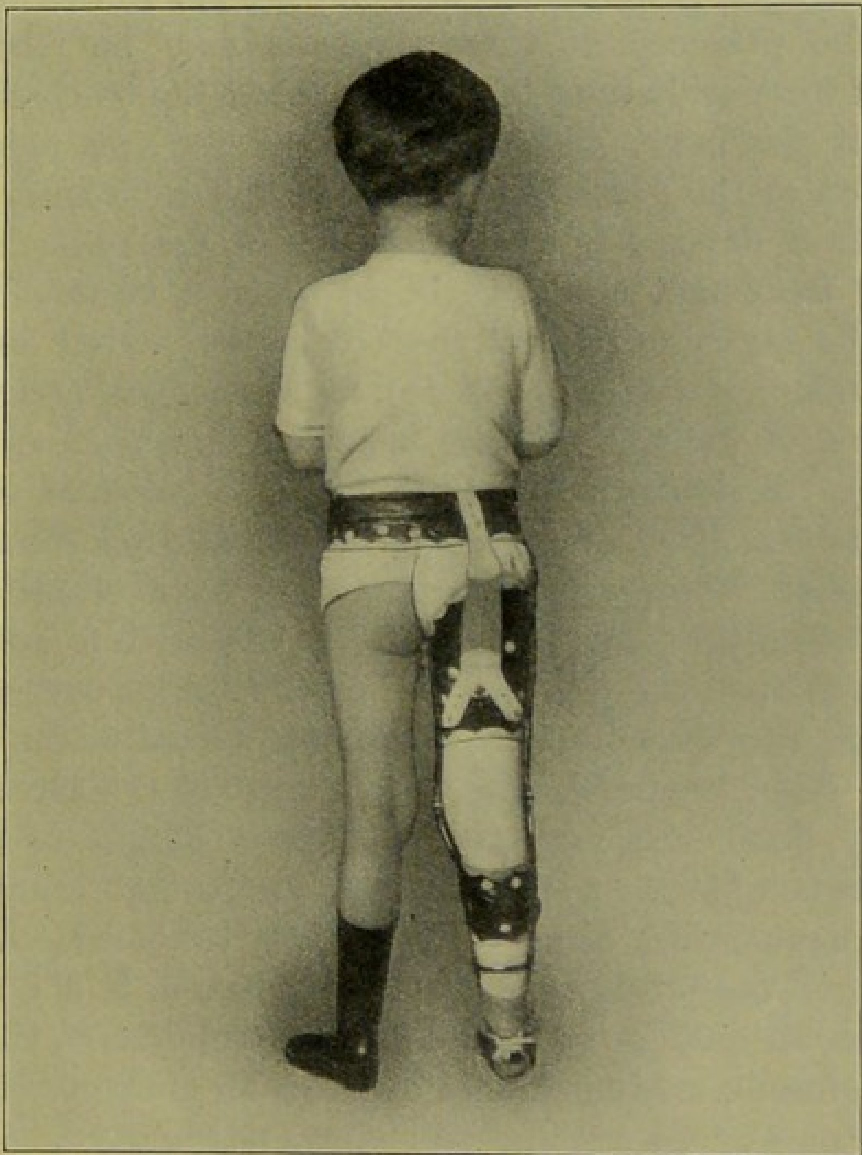


FIG. 73.—Hoeffteke's hip appliance with elastic traction.

seldom be attained under two years' careful treatment, and in most cases longer.

While the majority of cases of hip-joint disease, taken at this stage and treated carefully, recover, the prognosis in a certain number is not so favourable, and the question of early operation has to be taken into consideration. This is the case where there is a deposit in the neck of the femur, especially if it has not as yet infected the joint. The question also arises whether, after the joint has become infected, it might not be well in rapidly progressing cases to perform as complete an arthrectomy as possible. I have already mentioned on page 167 a case in which a deposit was removed from the neck of the femur, and on page 195 I have indicated how the presence of these deposits may be recognized. Where there is distinct thickening about the trochanter and neck of the bone, without, as far as one can judge, any infection of the synovial membrane, the probability is that there is a deposit in the substance of the neck, and the proper treatment seems to be to make a vertical incision over the outer surface of the trochanter, chisel away the dense bone, and then scoop out the cancellous tissue in the direction of the neck till the deposit is reached (see case 3, p. 167). Nowadays the presence and position of such deposits can often be definitely ascertained by stereoscopic skiagrams. Where the deposit is in its usual situation, and has infected the joint, if it is thought desirable to operate, it is best to open the joint by the usual anterior operation for excision, and thus one gets immediate access to the sequestrum. After removing this with a layer of the surrounding healthy bone, the synovial membrane should be clipped away as completely as possible, and an attempt made to get at the ligamentum teres by dislocating the head. In order to remove the posterior part of the capsule, it is necessary to make an oblique incision behind in the line of the fibres of the gluteus maximus, and by utilizing both openings the greater part of the affected tissues can be removed. I doubt, however, if in any case a really complete arthrectomy can be performed in the hip-joint, and therefore I would limit the operation just described to a few cases where the disease is advancing rapidly. The former operation (tunnelling the neck of the femur) is a much more satisfactory one, but it is very rarely that one meets with a case suitable for it. Hence, the field of the operative treatment of the first stage of hip disease is very limited.

2. Treatment of the Second Stage

In this stage, especially in the early period, extension takes the first place among the means of expectant treatment. Wherever the disease may have begun the surface of the bone is now becoming carious, rarefying osteitis and absorption are going on, and are greatly aided by the tonic muscular contraction, and the rigidity of the joint is very much increased. This condition is better treated by extension, with the view of diminishing the muscular contraction and the consequent destruction of bone, than by means which merely aim at placing the joint at rest. The extension is applied in the same manner as has already been described, and it is of still more importance in this case than in the other to see that the extension acts on the thigh and not on the leg. In applying the extension it is of especial importance to overcome the adduction of the limb. In this stage there is already some actual shortening, and if the patient recovers with an adducted limb, the pelvis must be still more tilted upwards on the affected side in order that the leg may not cross the other, and thus the functional shortening is considerably increased. Indeed, it is best not merely to overcome the adduction, but to produce a certain degree of abduction, so that when the patient walks he tilts his pelvis downwards on the affected side so as to bring the two legs parallel, and thus the functional shortening is diminished. This effect must be gradually produced; to place the extension in the line of abduction at once causes too much pain, and it is best for the first two or three weeks to employ the extension in the line of the deformity, and then gradually to carry it outwards. In some cases, where the adductors are very short, it may be necessary to perform tenotomy, at any rate of the adductor longus tendon close to the pubis, in order to permit abduction. Further, it is necessary to fix the pelvis, otherwise it may follow the thigh and the abduction may remain. This is accomplished by means of a perineal band around the healthy side, attached to the top of the bed, or, if necessary, to a pulley and weight, a thick heavy sandbag being also applied to the upper part of the pelvis on the affected side ; or it may be done by fixing a Thomas's splint on the healthy side. While in cases treated in the first stage one may hope for a more or less freely movable joint, this is not a thing to be aimed at in the second stage, and in the later period, where the articular cartilages are destroyed, anchylosis (fibrous or bony) will usually occur, and it is therefore of great importance that this should be in as favourable a position as possible.

It is necessary to keep up the extension for a longer period than in the early stage of the disease, in fact till the acute symptoms have come to a standstill and a certain amount of consolidation has occurred, unless, indeed, any indication, such as increase of pain, &c., has arisen to lead to its discontinuance at an earlier period. The chief objection to extension is the confinement to bed, but even with a Thomas's splint the patients should be kept in bed and not allowed to get about till the disease is in a fair way to recovery. The bad effect of confinement to bed is much exaggerated ; the health of patients confined to bed, but free from pain, and with the disease improving, is a great deal better than that of those who are allowed to get about, who suffer pain, and whose disease does not improve ; and extension, by relieving pain and stopping the destructive process, leads to rapid recovery of appetite and of the general health. Nevertheless, there comes a time when matters will progress more quickly if the patient can get out into the open air without injury to the joint, and therefore the question ultimately arises of substituting some other apparatus for the weight and pulley extension.

The first apparatus that one naturally thinks of is Thomas's splint, and many surgeons advocate its use not merely in the early stage of the disease but at all stages. My experience, however, is that where there is much adduction one cannot overcome it satisfactorily by this splint, and one cannot produce distinct abduction at all. Even where the adduction has been overcome for the time being by extension in the abducted position, unless the extension has been continued till more or less consolidation has occurred, there is still a strong tendency to recurrence of the adduction on leaving it off. If a Thomas's splint is employed, it must have a pelvic band, so as to fix the pelvis, which otherwise shifts on the splint and prevents any action in the way of abduction. Even with a pelvic band, and with the bending downwards of the upper wing, it is remarkable how a child manages to escape from an irksome position. In cases where I have wanted to get distinct abduction, I have had the splint bent somewhat outwards at the hip curve, and though this has answered better, I cannot say that I have been satisfied with the arrangement. Under such circumstances in adults or older children probably the best arrangement is to fix the joint in plaster of Paris with the limb abducted to the required extent. The plaster must have a firm grip of the lower part of the body and the pelvis above, and the thigh down to the knee below. Where the degree of abduction is not marked the patient may get about with crutches and a patten on the sound foot.

Much better than the single Thomas's splint at this stage of the disease in children is the double Thomas with pelvic band. In this way the pelvis can be much more securely fixed and the adduction more easily prevented, and this is an arrangement which I frequently employ at this stage while the disease is active. Perhaps the best of all the forms of apparatus, in children, is the Phelps box, which I shall describe in connexion with spinal disease. By having the leg-pieces 3 to 4 inches longer than the legs, extension can be readily kept up by means of elastic bands fastened to the strapping on the one hand, and the footpiece on the other, the amount of extension being graduated by the degree of tension of the bands. In this way the patient can be taken out in the open air whenever it is deemed desirable without interfering with the local treatment.

During this stage the question of operation also arises, and opinions are very conflicting on this point. I have already referred to the question of arthrectomy in speaking of the first stage of the disease, and my remarks apply equally to similar cases not seen till they have passed on to the second stage. A good deal has been written in favour of early excision in hip-joint disease, and some surgeons advocate it very strongly. The word 'early' applies to operation before visible abscesses have formed, that is to say, operation during the second stage, and not to operation during what I have described as the first stage; very few surgeons would approve of excision at that period of the disease.

The advantages claimed for excision at this stage are rapid recovery, the getting rid of a source of general infection, and the removal of sequestra, especially from the acetabulum. The disadvantages are the risk of the operation, especially of shock, the risk of dissemination of the disease, imperfect recovery, bad functional result, and interference with growth. We may consider these points in detail.

As regards the question of rapid recovery, we must not lose sight of the fact that where the disease is extensive and the patient weakly there is a considerable element of risk in a thorough operation, and, unless the operation is thorough, recurrence is very apt to take place. I have in two instances lost patients from shock after excision, but in both of these the disease was in the third stage, large abscesses being also present, which had to be treated. I also know of similar cases in the practice of others, and therefore the operation of itself cannot by any means be looked on as one free from risk, especially in the later stages of the disease. Where, however, the patient gets over the shock of the operation, the wounds, if kept aseptic, heal by first intention, and in a considerable proportion of cases remain soundly healed. It is, moreover, a very difficult matter to remove the whole of the affected synovial membrane thoroughly, and consequently, in a certain number of cases where the disease is rapidly progressing, the wound, which at first seemed soundly healed, breaks down at some point, and a sinus is formed, which may remain open for a long time, necessitating the use of a splint; or the divided surface of the bone may be again attacked and fresh operative procedures be required.

From this point of view, therefore, while in a considerable number of cases, no doubt, recovery is greatly expedited, there must always remain a certain proportion in which no material advantage is gained.

As to the diminution of the risk of general infection by operation at this stage, I am inclined to think that the advantage gained, if any, is not very great, and that for the reason which I have already mentioned, viz. that it is almost impossible to remove the diseased synovial membrane completely. Indeed, in some cases it seems as if tuberculous meningitis had been precipitated by excision. König states that of 18 cases of tuberculous meningitis, 16 occurred after operation. Metaxas and Verchere, in the statistics of 55 cases of tuberculous meningitis after operation, found that a large number, more than half, occurred after excision or scraping synovial membrane and abscesses. In my statistics I find 7 cases of tuberculous meningitis after operation, chiefly excision of the hip, and of these 1 (commencing ten days after operation), and in all probability 2, were undoubtedly due to the operation. Since these statistics were drawn up I have had another case, and I know of another where tuberculous meningitis directly followed excision of the hip. And if in a certain number of cases tuberculous meningitis may be set up, it follows that there must be a larger number in which a smaller quantity of the tuberculous material gets into the blood and sets up deposits in other parts of the body. The risk of forcing tuberculous material into the blood is greatest where the joint is scraped out, and, owing to the difficulty of removing the whole of the synovial membrane, one is much tempted to scrape the surface. In examining the question of the occurrence of phthisis after operation on tuberculous joints, Middeldorpf found that phthisis was the cause of death in 16 per cent of those amputated, 14 per cent of those excised, and 30·77 per cent of those in which caseous deposits were scraped out. Looking at all the facts, I do not think that the possibility of preventing further infection by early excision need be of itself a great inducement to operation.

The chief objections which I have to excision of the hip at an early period before it is absolutely necessary for the cure of the disease are, the imperfect functional result and the interference with the growth of the limb. After excision of the hip, the patient is in much the same condition as one who has a congenital dislocation of the hip ; the trochanter slides up and down over the side of the pelvis during walking, and the patient does not have the same firm support that he has where anchylosis has taken place in a good position. No doubt the amount of sliding varies a good deal in different cases, and is much less if the patient is not allowed to bear weight on the limb for six or eight months after the operation. Nevertheless, the support is not a strong one, and I hardly think the mobility of the limb after excision compensates for the weaker support. Indeed, some surgeons who advocate early excision take means to obtain anchylosis by pegging the neck of the bone to the acetabulum, or to get the support of a buttress of bone in cases where the margin of the acetabulum is removed, by raising a piece of bone and periosteum from above the acetabulum and making it project above the neck of the bone.

The other objection is the interference with the growth of the bone. Opinions vary considerably as to the amount of shortening after excision as compared with that following recovery without operation, but it is generally admitted that there is more shortening after excision. Where the disease has gone on to the second stage, there is almost always a certain amount of shortening after recovery without operation, due to enlargement of the acetabulum, to absorption of the head and neck of the femur, to destruction of the epiphysis between the head and neck, to deficient growth of the limb from premature ossification of the upper epiphyses, to imperfect use or some reflex trophic disturbance, or to several of these causes combined. Where the disease has begun say about seven years of age, and has passed on to the second stage, it will generally be found, when the patient has reached his full growth, that there is an average of 1½ to 2 inches of shortening. Where, under similar circumstances, excision has been performed, the shortening is greater, from 2 to 3 inches, and sometimes more. It seems to be greatest in those cases where the trochanter has also been removed, and, in one instance which I have seen, where the head and trochanter had been removed in a child *æt.* 4½, there were no less than 11 inches of shortening at the age of 16, growth having apparently been much interfered with throughout the whole of the extremity. It is difficult to say why the shortening should be greater after excision than in cases which recover without operation, but in which, without doubt, the epiphysial line between the head and neck of the bone has been much injured by the disease. I believe that it is a trophic effect, and that in excision with removal of the synovial membrane there is some more serious interference with the trophic nerves of the femur than results from the disease alone. I have already pointed out that in all probability the rapid atrophy of the muscles around an inflamed (not necessarily tuberculous) joint is the result either of a neuritis or of some reflex phenomenon, and that similar trophic disturbances are intensified after operation is well seen after excision of the elbow-joint, where we not uncommonly find that the pulse on the excised side is weaker than on the other, that there is increased growth of nails and hair, increased secretion of sweat, &c.

Taking all these facts into consideration, and bearing in mind the large proportion of recoveries at this stage by suitable non-operative measures, I think that excision ought only to be an exceptional method of treatment, and not by any means the rule. There are certain cases, however, in which I think it is right to intervene during this stage by excision. For example:—(1) Where the disease is evidently progressing rapidly, where tenderness does not subside under treatment, where the fulness in the groin increases, where starting at night continues, and where the shortening rapidly extends. (2) Where with increase or persistence of the symptoms it is evident that there has been primary acetabular disease, as shown especially by thickening of the tissues on the inner surface of the acetabulum as felt per rectum. In such a case the head of the bone must be removed before sufficiently free access can be got to the acetabulum. (3) Where true dislocation has occurred, especially where the head of the bone cannot be subsequently kept in the acetabulum satisfactorily.

3. Treatment of the Third Stage

The essential feature of this stage is the presence of unopened abscesses or of sinuses, and these, as I have already mentioned, may arise in various ways. Taking first cases with unopened abscesses, I may remark that the presence of pus complicates matters very considerably, and necessitates the employment of some form of operative treatment. The time has passed when abscesses may be left in the hope of their absorption; they should always be treated as soon as detected. The main question to be considered is whether we should treat the abscess alone on the principles previously referred to, or whether we should, as is the opinion of a good many surgeons, at once proceed to excision of the joint. In this we must, of course, be guided by the condition of the individual case, and no doubt in a certain number of these cases excision will be necessary, but, as a rule, I believe it is best where the abscess is in the thigh or buttock—extrapelvic in fact—to treat it alone without excising the joint in the first instance, and that for various reasons. In the first place, the presence of an abscess does not render the case by any means so hopeless as some surgeons think, provided it is treated aseptically. I have already mentioned a list of 29 cases of unopened abscesses connected with the hip-joint which were treated in the first instance by aseptic drainage a good many years ago. Of these, 4 were excised before the wound had healed, and of the remaining 25, 18 or 72 per cent were cured without further operation, 5 others were doing well but still under treatment, and 2 were not doing well, having become septic.

Since the introduction of the more recent methods of treating chronic abscesses (see p. 158 et seq.) the results have been very much better, and almost all the cases which I have treated in this way have healed. We get this advantage by treating the abscess alone in the first instance, that the cases are brought back again to the second stage, and a considerable number recover without excision. Even where excision is subsequently necessary the operation is less extensive, and therefore less dangerous from shock if the abscess has been got rid of in the first instance. Where, in addition to excision, especially where there is extensive disease of the pelvis, one has to remove large abscesses, the patients, who are often at this stage in a feeble condition, suffer greatly from shock, and may even die of it, as has happened in two instances in my cases.

I have already discussed the treatment of chronic abscesses on p. 156 et seq., and I need only say here that in most cases it is well to give a thorough trial to these measures in the first instance, before employing operative procedures.

Where, however, we have to do with abscesses which have originated in the pelvis in connexion with disease of the acetabulum the case is different, and excision of the head of the bone at once is not infrequently the best practice. After removal of the head of the bone the acetabulum is perforated, and a free opening made through it into the pelvic abscess. Where the abscess is also projecting in the iliac fossa, it is well to begin by making an incision into it at that point, because in that way one gets better access to the cavity to scrape it out. After the operation iodoform and glycerine solution is injected and all the wounds stitched up, pressure being applied over the region of the hip. In abscesses in this situation one must make every endeavour to get rid of them because they burrow in various directions, among others towards the ischio-rectal fossa, and if they burst in that situation sepsis takes place and the condition of the patient becomes practically hopeless.

By treating the abscesses alone and employing the other methods recommended for the second stage, further operation becomes unnecessary in a considerable number of cases, but the instances in which excision is required are more frequent than in the second stage of the disease. A good many of the cases which come under observation at this period have been neglected and allowed to get into very bad positions, which can only be properly remedied by excision. Again, the destructive changes about the joint are frequently more extensive, loose sequestra are present, and the diseased tissues tend more to caseation and less to recovery. In a certain number of cases with abscesses which have been treated without excision, the wound which in the first instance may have healed by first intention breaks down at some part, a sinus is established, and excision may be necessary. Here the operation of excision is much less extensive, and consequently less dangerous, if the great bulk of the abscess is first got rid of in the manner just described than if it is performed at first.

Where septic sinuses are present the conditions are altogether less favourable. No doubt, even although there are sinuses, a certain number of cases recover if they are properly drained, and if the joint is thoroughly fixed for a sufficient length of time. But, under these circumstances, suppuration is very apt to go on, and lead to waxy degeneration of internal organs, or death from hectic fever or exhaustion, or fresh abscesses form, and some septic complication may occur. Further, as I have already pointed out, the presence of sepsis interferes with the recovery of the tuberculous disease, and in fact leads to its extension locally, and also aids its dissemination throughout the body. Hence, where septic sinuses are present, I believe that in most cases it is advisable to adopt some form of operative treatment.

The mildest treatment, which is sometimes successful, is to enlarge the opening of the sinuses, scrape and wash them out, removing at the same time any sequestrum of bone which may be felt, sponge the surface with undiluted carbolic acid, and put in a drainage tube. By adopting these measures some of the cases heal without further trouble, but unfortunately this is not very often the case.

Sometimes very remarkable improvement follows the injection of these sinuses with bismuth. This was first done with the view of obtaining a skiagram showing the direction of the sinus, and it has happened in some instances that the sinus has dried up and closed very quickly. I have had several successful cases by this method. The prescription is

Bismuth oxychlorid	pt. j
Vaseline	pt. ij
Liquid paraffin	pt. j

This is mixed and sterilized, and before use is liquefied by heat and well shaken up. The sinus is thoroughly syringed out with saline solution so as to get rid of the pus, and the above emulsion is then injected under considerable pressure. The skin around the sinus is also disinfected by carbolic lotion and the ordinary dressings of cyanide gauze and salicylic wool are applied. These injections can be repeated every ten days or so if necessary.

At the present time vaccine treatment is much employed, and in some few cases with a certain amount of benefit, especially when combined with Bier's suction method. Cultivations of the pyogenic organisms present in the sinus are used as well as tuberculin, and with the view of increasing the flow of serum from the wall of the sinus suction by means of Bier's glasses is added.

Where healing does not occur, or where other reasons exist, excision will be required. The incisions for excision must in some cases be irregular, so as to give easy access to the sinuses, but I prefer, if possible, either the anterior incision or a vertical one over the centre of the outer surface of the great trochanter. Where there is marked displacement, or much disease of the acetabulum, a curved incision behind the trochanter is often the most useful, and may not infrequently be combined with the anterior incision in order to get better access to the synovial membrane.

The anterior incision begins just below the anterior superior spine of the ilium (Fig. 74), and passes downwards and slightly inwards along the anterior border of the tensor fasciæ femoris for 3 to 4 inches. After dividing the skin and fascia the sartorius is drawn inwards, and the tensor fasciæ femoris outwards, and then a branch of the external circumflex generally crosses the middle of the wound, and must be divided. Separation is then effected between the gluteus minimus and the psoas and iliacus muscles, and the outer part of the capsule of the joint is exposed. On dividing this the neck of the bone is reached, and sawn through. Usually after dividing the neck there is no difficulty in children in removing the head of the bone, and fairly free access to the cavity of the joint is obtained. By carefully pushing forward

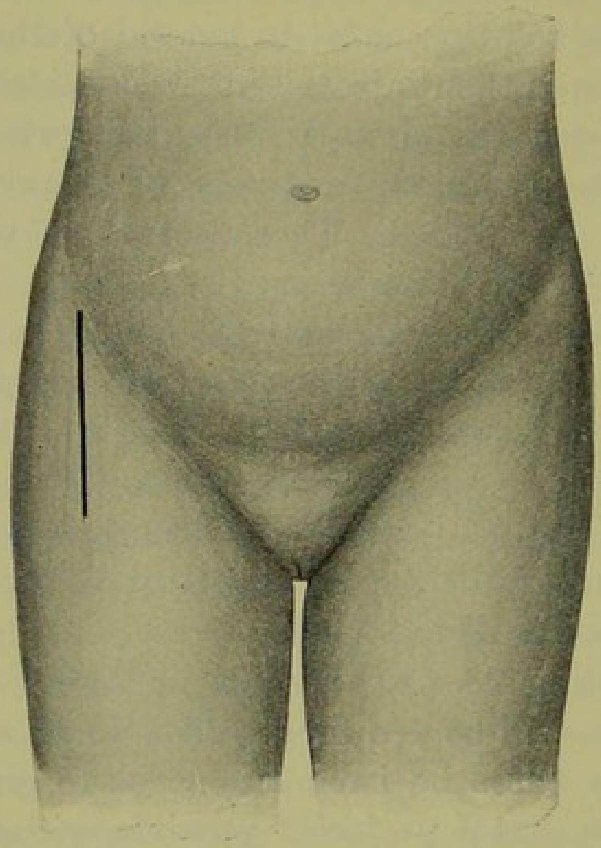


FIG. 74.—Line of incision for the anterior operation.

the vessels and the tendon of the psoas and iliacus the anterior part of the synovial membrane can be clipped away. The remains of the ligamentum teres and any soft tissue in the acetabulum are then removed, and any carious portions of the pelvis attended to. As regards the posterior part of the capsule, it is difficult to clip it away without a posterior incision, and if only the anterior incision is employed resort must usually be had to the sharp spoon. It is better, however, to make a second incision behind the trochanter so as to remove the posterior part of the capsule

(Fig. 75). As portions of tuberculous tissue must in most cases be left, I fill the wound with the 10 per cent iodoform and glycerine emulsion, and, where the skin was previously unbroken, stitch it up without a drainage tube, and apply pressure especially over the anterior part of the joint. All antiseptic precautions must of course be taken, and it is well to take measures to prevent eversion of the limb. This is conveniently done by taking a flat splint about 10 inches long, placing it transversely behind the thigh, so that when it lies flat on the bed the patella looks directly forward. This splint is attached to the thigh by plaster of Paris, and has such a long leverage that the leg cannot rotate. The limb should be placed in a distinctly abducted position, partly to bring the neck of the bone into the remains of the acetabulum, and partly in order that, should anchylosis occur more or less completely, it will be necessary for the patient, in placing the foot flat on the ground, to tilt the pelvis downwards on the affected side, and thus diminish the practical shortening. When the wound has healed the patient should be kept in bed for six or eight weeks, and then fitted with a Thomas's splint and crutches, and not allowed to bear any weight on the limb for at least six or eight months.

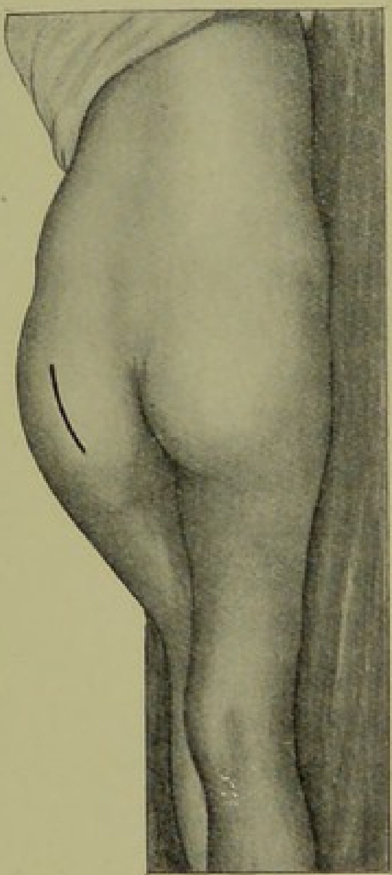


Fig. 75.—Additional incision to give access to the posterior part of the capsule.

Another way of gaining access to the joint in children where the trochanteric part of the neck is affected, is by a vertical incision over the middle of the outer surface of the trochanter, commencing about $1\frac{1}{2}$ inches above its tip, and extending downwards for about 4 inches. The incision passes straight down to the bone, and through the cartilaginous trochanter, which is split into two parts and, the periosteum being divided transversely on the outer surface at the lower part, turned to each side. The neck of the bone is then sawn through obliquely at the outer part, and the head and neck extracted. By this incision, however, it is not possible to deal thoroughly with the capsule, and the epiphysial line of the trochanter is injured.

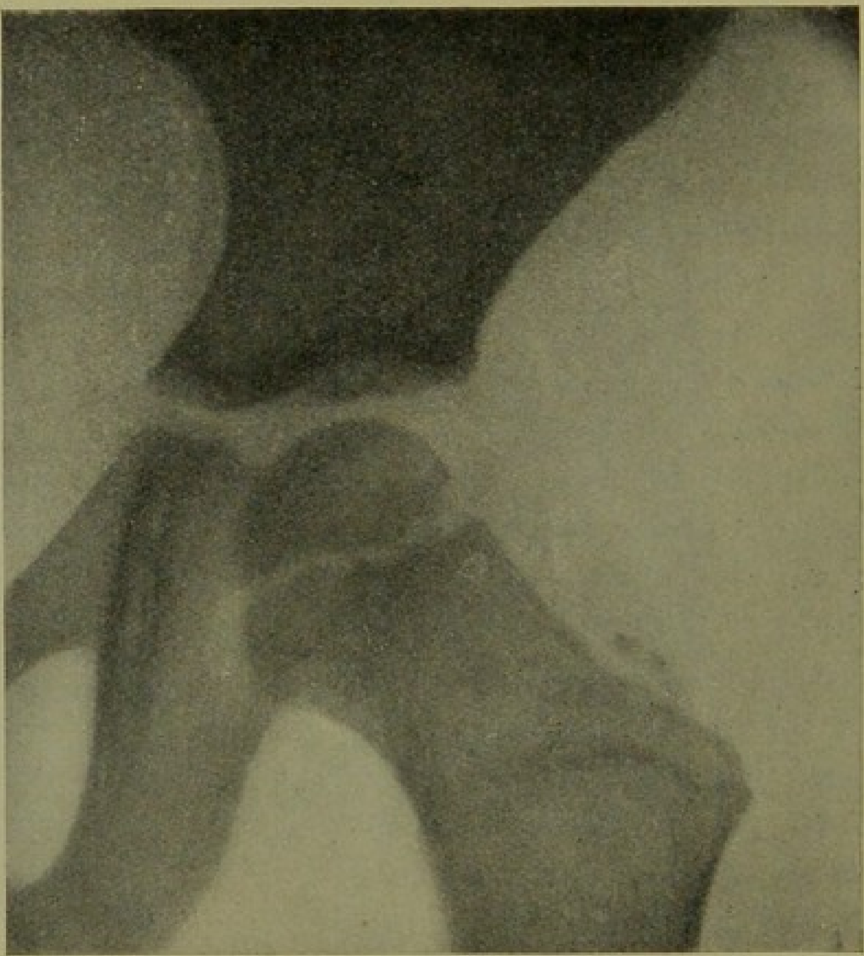


FIG. 76.—Epiphysial lines of the hip-joint in a child aged 5.

A third incision which gives good access is that introduced by Sayre. It commences just above the trochanter, curves backwards over its posterior surface, and then forwards again on to the outer surface of the femur. The semilunar flap is then dissected forwards, and the posterior part lifted from the bone. The posterior surface of the neck is thus exposed, and can be sawn or chiselled through, and good access is obtained to the acetabulum, better than by the anterior incision. If it is necessary to remove the trochanter, then in turning the anterior flap forwards, the periosteum with the attached muscles is peeled off the trochanter, the periosteum having been divided transversely at the point where the bone is to be sawn. The removal of the trochanter is, however, a serious matter, and should not be done unless absolutely necessary on account of disease.

Fig. 77.—Epiphysial lines of the hip-joint in a child aged 9.

In all cases where the skin was previously unbroken, the wound may be completely stitched up as before described, and pressure applied by means of sponges incorporated with the dressing, but where septic sinuses are present, I think it is best, after thoroughly scraping out the sinuses, to apply undiluted carbolic acid to the whole surface of the wound, and to stuff the wound for some days with cyanide gauze, impregnated with iodoform. After a few days (say ten days), when granulation has taken place, if the wound is not suppurating, the stuffing may be left out and the wound allowed to close, or if suppuration is going on a drainage tube should be used instead of the stuffing. This stuffing of tuberculous wounds and sinuses with gauze is a distinct advance on former methods of treatment, and wounds which previously would not heal at all often show marked improvement on adopting this method. It must, however, only be used while the wound is wide open externally, and the bottom can be seen. Once the wound has been converted into a sinus stuffing is bad, as it only forms a septic plug and prevents escape of discharge. At this stage either a drainage tube should be used instead of the stuffing, or else the sinus should be left alone.

In some bad cases of hip disease at this stage, where the patients are going down hill, where the sinuses are numerous, and where the bone disease is evidently extensive, amputation at the hip-joint has been recommended. I think that such treatment is very rarely indeed indicated, for even though the limb is removed, the pelvic disease still remains and may require treatment by subsequent operations. No doubt there is the advantage that the removal of the limb takes away a great source of pain and trouble to the patient, and, should he survive the operation, enables him to get about on crutches and thus get the benefit of exercise and fresh air. Mr. Howse has advised that in the first instance amputation at the knee should be practised, with the view of getting rid of the weight of the limb and enabling the patient to get about, and then the subsequent amputation at the hip, if necessary, would be less dangerous. I have not yet come across a case where I have deemed it advisable to perform either of these operations.

Herewith I give two skiagrams to show the position and condition of the epiphysial lines in children *æt.* 5, and 9 respectively (see Figs. 76 and 77).

4. Treatment of the Fourth Stage

During this stage recovery with anchylosis is occurring, and generally nothing more requires to be done than to continue the expectant treatment with suitable retentive apparatus. Nevertheless, it sometimes becomes necessary to intervene at this stage on account of the occurrence of abscesses, of the presence of sinuses, or of deformity which cannot be overcome without operation.

Where abscesses are present at this stage, they should be treated as described before, either by aspiration or by washing out, great care being taken not to strain the joint, nor break up any anchylosis.

Where sinuses are present, they may usually be left alone unless there is much discharge from them, boracic ointment and lint being used as a dressing. This treatment may be combined very advantageously with the bismuth injections already mentioned. If, however, there is much discharge, the sinuses should, as a rule, be laid freely open, thoroughly scraped out, any sequestra removed, sponged with undiluted carbolic acid, and packed for a time with cyanide gauze impregnated with iodoform, or later with balsam of Peru.

Where there is much deformity (usually either adduction or rotation outwards), which, if anchylosis is, or has been, taking place, cannot be overcome with apparatus, we must do something in the way of operative treatment. Where there is marked adduction and no bony anchylosis, it is sometimes sufficient to divide the adductors and pull the leg outwards, keeping up and increasing the abduction afterwards by extension, so arranged as to pull the thigh and leg outwards. Where anchylosis has occurred, then the deformity may be remedied by excision, by dividing the neck of the bone, by taking a wedge out of the neck of the bone, or by Gant's method of dividing the bone below the trochanters. Where only one hip-joint is affected, I think the most satisfactory result is obtained by taking a wedge out of the neck of the bone, the base of the wedge being upwards in adduction or forwards in rotation outwards, this is most easily done by the anterior incision for excision. Afterwards it is best to try for bony union again. In some cases, however, Gant's plan is the best. Where both hip-joints are affected, and we have the condition of cross-legged deformity, then I think the best result is obtained where one joint is excised in order to get a movable joint, and allow the patient to sit, &c., and where a wedge is taken on the other side or the femur divided, so as to leave one side firm for walking. No doubt the immediate result after excision of both hips is not altogether unsatisfactory, but as time goes on the same troubles are apt to arise as in congenital dislocation of both hip-joints.

I have here only spoken of the local treatment, and I need hardly say that there is no one method which is suitable for all cases. Each case must be carefully studied by itself, and treatment adopted according to the way in which it goes on. As to general treatment, I have already spoken of that sufficiently in Chapter XI, and need not repeat what was said there. In all cases I at present employ the vaccine treatment with tuberculin on Wright's lines in addition to the other methods described, though my faith in it is gradually dwindling away.

CHAPTER XVII

DISEASE OF THE KNEE-JOINT

Pathology

In patients of all ages affected with tuberculous diseases of bones and joints, the knee-joint is the second most frequent seat of disease, the spine coming first with 23·2 per cent of the whole, the knee-joint second with 16·5 per cent, and then the hip with 14·8 per cent. In childhood, however, the hip takes the second place with, in my statistics at Paddington Green Children's Hospital, 23·1 per cent, and the knee-joint third with 12·6 per cent, the ratio altering afterwards in favour of the knee. Disease of the knee-joint, therefore, is more a disease of adult life than that of the hip, but nevertheless it commences most frequently in the first decade. Thus, in my statistics of the total number of cases of knee-joint disease 42 per cent commenced during the first decade, 26 per cent during the second, 14 per cent during the third, and 10 per cent during the fourth. Compare this with the periods of commencement of hip-joint disease. The comparison is more striking when we consider that, of the total number of cases of tuberculous disease of bones and joints commencing during the first decade, 30 per cent were cases of hip-joint disease, and 29 per cent cases of knee-joint disease ; during the second decade, 20 per cent hip, 23 per cent knee ; during the third decade, 5 per cent hip, 18 per cent knee ; during the fourth decade, no case of hip-joint disease, 37 per cent knee (p. 111).

In this joint the disease commences more frequently in the synovial membrane than is the case in the hip-joint, but the frequency apparently varies at different ages. The following table, constructed from Willemer's paper, shows the results obtained as to the primary seat of the disease at various ages, and the nature of the osseous deposits :—

	1 to 10 Years.	11 to 20 Years.	Above 20 Years.
	Per cent.	Per cent.	Per cent.
Sequestra, ...	19·4	19	49
Caseous bone deposits,	41·6	32	16
Pure synovial disease,	38·8	49	33

I need not go into other statistics, as these represent fairly the results obtained. The important points are the great increase in the frequency of sequestra as compared with soft deposits in bone in advanced life, the conditions over 20 years of age being practically the reverse of those under 10. Another important point is the diminution in frequency of pure synovial disease in advanced life as compared with the second decade, where it attains its maximum.

The situation of the osseous deposits varies considerably, but they occur by far most frequently in the epiphyses of the femur and tibia (see Figs. 8 and 9, and also 78, 79, and 80). In none of the specimens of which I made sections some years ago was the deposit present on the diaphysial side of the epiphysial line, but I have seen several cases of this kind, and König states that it sometimes occurs in children, especially in the form of soft deposits. As to the parts most commonly affected, these deposits occur generally, as in the case of other bones and joints, in the most exposed parts of the bone, and also in the neighbourhood of the points of attachment of tendons. In the knee-joint the lower end of the femur, more especially the internal condyle, is most usually primarily affected, then the head of the tibia, and very much more rarely the patella. It is not at all uncommon for the primary osseous deposit to be quite small, and situated immediately beneath the articular cartilage, which it destroys and thus effects a communication with the joint; in these cases, also, the deposits are often multiple. The more deeply placed deposits may also make their way into the joint, or they may, especially in the tibia when extra-epiphysial, and also when situated towards the posterior and upper part of the condyles of the femur, form a com-

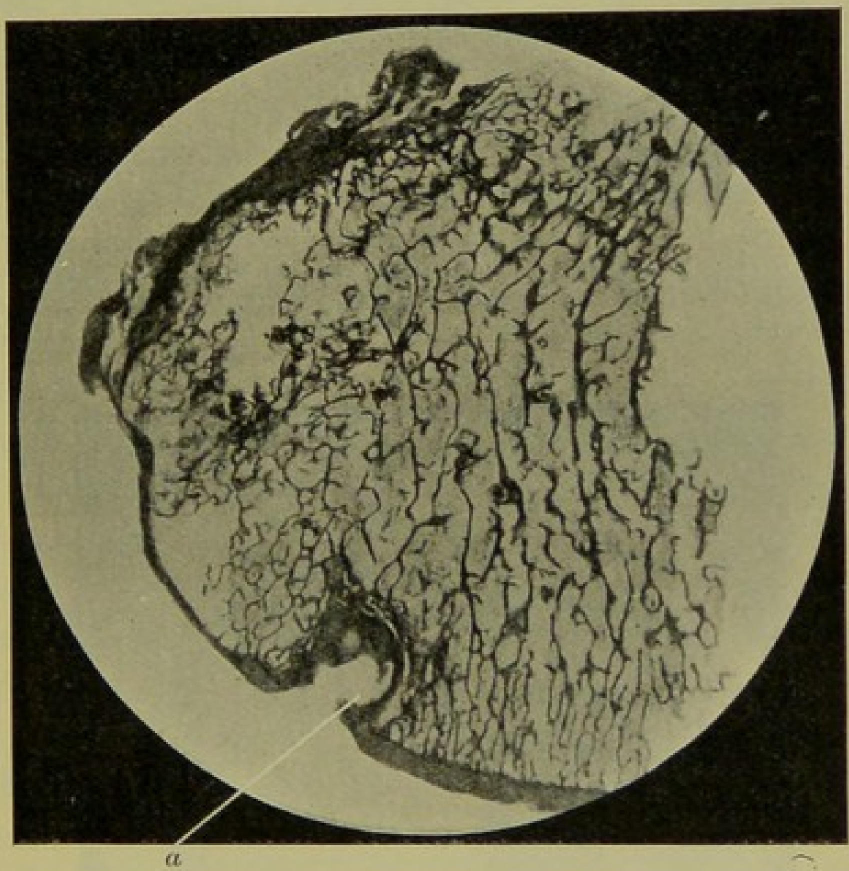


FIG. 78.—Section of the internal condyle of the femur showing at (*a*) a small tuberculous deposit under the articular cartilage which has burst through into the joint. Cartilage undergoing destruction, especially on the left side.

munication with the surface outside the capsule, and lead to the production of extra-articular abscesses. It is in this joint, also, that Kocher thinks that he has observed primary disease of the fibro-cartilages.

I have so frequently referred to the knee-joint in describing the tuberculous diseases of synovial membrane and bone that it would only be repetition if I were to go into details here. I have already described the results which follow the bursting of these abscesses into joints, the various forms of disease of the synovial membrane, the changes in the bone as the result of the deposits, the caries, &c. We have also, as in the hip, pressure effects and tendency

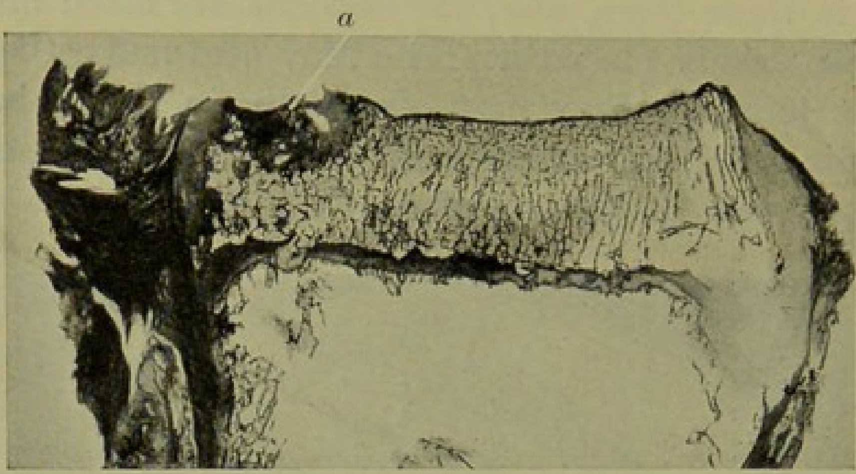


FIG. 79.—Vertical section of the upper end of the tibia showing a small caseous deposit (*a*) which has opened into the joint. Complete destruction of the cartilage.

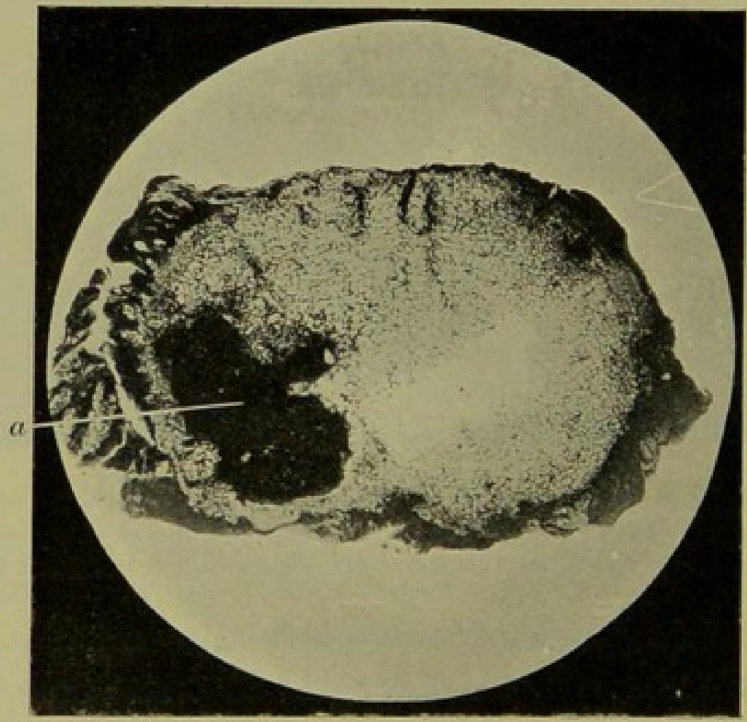


FIG. 80.—Transverse section of the head of the tibia showing at (*a*) a dense tuberculous sequestrum of the outer part of the bone. (See also Fig. 19).

to displacement, more especially flexion, rotation outwards, and backward displacement of the leg. This is the joint in which some of the rarer forms of the disease most frequently occur, such as the localized tuberculous growths, hydrops tuberculosus, &c. Caries sicca is rare in the knee-joint, but König states that he has met with it, especially in young individuals, and that it presents all the characteristic appearances formerly described.

Symptoms of Knee-Joint Disease

The symptoms vary, of course, according to the pathological condition, and as this can be more easily made out in the knee-joint than in the hip, it is best, instead of dividing the symptoms into various stages, to consider them in reference to the actual state of matters in the joint.

1. Localized Synovial Disease

A rare condition, but one which it is well to bear in mind, is the presence of localized tuberculous deposits in the synovial membrane. This may occur in two forms :—(1) a localized thickening of the synovial capsule, and (2) one or more pedunculated tuberculous tumours hanging into the joint. The former condition is very rarely seen, because though no doubt a good many cases begin in that way, advice is seldom sought till the disease has spread over the whole or the greater part of the capsule. I have seen one such case some years ago before I realized the value of early operation, and I then watched the thickening rapidly extending over the whole joint. The pedunculated tumours are not so uncommonly met with, because the disease seems to be more localized, but here also after a time the whole synovial membrane becomes affected, and it is not at all uncommon to meet with these pedunculated masses in operating on advanced cases. The symptoms which these swellings give rise to are inconvenience in moving the joint, the sensation of a foreign body inside it sometimes causing sudden pain and, where the nodule is in the usual place, viz.—the supra-patellar pouch, the presence of a swelling. Very commonly, also, if the patient has been using the joint much, there is effusion into it, and it is only when this fluid has become absorbed by rest or been removed by tapping that the nodule is felt. Under such circumstances it is not always easy to make the diagnosis from an attached loose cartilage, but as regards the local condition, the most important points are—first, the size of the swelling, the tuberculous nodules being larger than the attached cartilages; and secondly, the presence of some thickening of the synovial membrane in the vicinity. One is further guided in making the diagnosis by the history of previous tuberculous disease elsewhere, or the co-existence of other tuberculous lesions. Here Von Pirquet's or Emery's reaction may help.

2. Diffuse Primary Synovial Disease

Generally, when the patient comes under observation, the synovial membrane has become affected all over, though, perhaps, more in one place than in another. In describing the characters of primary synovial disease, it is well to consider it under two stages, the first where the disease is still limited to the synovial membrane, and the second where other structures in the joint have become secondarily involved.

1. In the early stage of synovial disease the patient usually makes very little complaint. He limps a little, but his chief complaint is that his leg feels tired after slight exertion and is somewhat stiff, and on looking at his knee he notices that it is swollen (see Fig. 81). As time goes on the swelling increases, and also the stiffness, but it is often remarkable what an amount of movement may remain in this stage of the disease in spite of marked synovial thickening. On examination of the joint the synovial membrane is found diffusely thickened, sometimes more at one part than another, the thickening varying much in different cases. The thickened membrane has a boggy, elastic feel, and the swelling is most marked at the point of reflexion of the synovial membrane on to the bones, where there is of course a double thickness of synovial membrane, and consequently a thick mass of tissue may be felt rolling under the fingers. On looking at the knee also the condyles of the femur appear to be enlarged, especially the internal condyle, and on superficial examination one is very apt to think that the

bone is affected. This is due to the thickening of the lateral pouch of the synovial membrane, which spreads over the inner side of the internal condyle nearly to the back, and it will be found, on removing the whole of the synovial membrane, that the apparent thickening of the internal condyle has disappeared. It is sometimes, however, difficult to be quite certain, without operation, in these cases whether or not there is disease in the internal condyle, but the following

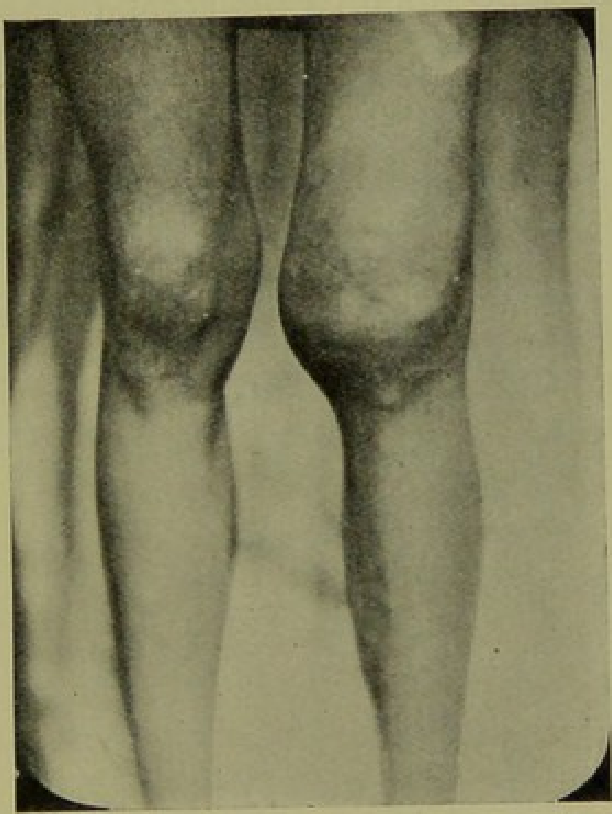


FIG. 81.—Synovial disease of the left knee-joint, showing marked swelling co-extensive with the synovial capsule.

are the leading points in the diagnosis. In the pure synovial thickening, though there may be a little tenderness on pressure over the condyle, this is not usually marked, and the whole synovial membrane is thickened, but without much pain on movement or marked rigidity. In the case of primary disease in the internal condyle in the early stage, there is usually no general synovial thickening, while the pain and tenderness about the internal condyle are more distinct. At a later stage of the bone trouble, where the synovial membrane has become diffusely thickened, there is usually marked tenderness over the condyle, chiefly at some one spot, and great pain on attempting to move the joint and marked rigidity. In the early stage there is not uncommonly some serous effusion into the joint, and when that disappears it is noticed that the synovial membrane is becoming thick. During this stage the general health does not materially suffer, though the patient may be somewhat pale.

2. As time goes on the disease spreads to other structures of the joint, and we come to the second stage. As I have

FIG. 82.—Case of advanced disease of the left knee-joint, showing the flexion. Knee large and the disease active.

pointed out in the general pathology of synovial disease, the tuberculous synovial membrane attacks the articular cartilage at the edges, and gradually spreads over the surface, and also to a slight extent underneath it. Spreading in this way, it destroys the cartilage, more at some parts than at others, leading to a perforated appearance, while at the same time the bone beneath becomes inflamed, and the cartilage becomes eroded from beneath and loosened. Corresponding to these changes we have symptoms indicating the presence of inflammation of the bone. The previous mobility of the joint diminishes, and is soon practically lost, partly on account of muscular rigidity, both voluntary to prevent pain, and involuntary from tonic contraction of the muscles, and partly on account of thickening and shrinking of the synovial membrane. Accompanying this rigidity there is, if no treatment has been adopted, gradually increasing

FIG. 83.—Old standing disease of the right knee, showing the flexion and rotation at the knee-joint and the tibia drawn up behind the femur. The disease has passed off.

flexion of the joint, ending in further deformity, to which I shall presently allude (see Fig. 82). There is now pain on attempting any movement, on pressing up the bones of the leg, and on pressing the patella backwards on to the femur, and there may be painful starting of the limb at night. The synovial thickening often increases somewhat at this stage, and the ends of the bones become enlarged.

As the disease goes on, the ligaments of the joint become softened, so that the tibia can be moved laterally on the femur, and as the result of this softening of the ligaments, the tibia becomes rotated outwards on the femur. Further, as the flexion goes on, the tibia becomes drawn up behind the femur, and the posterior part of the capsule shrinks, and thus the leg cannot be brought into a line with the thigh without considerable violence, or after division of the hamstrings or complete removal of the capsule by arthrec-

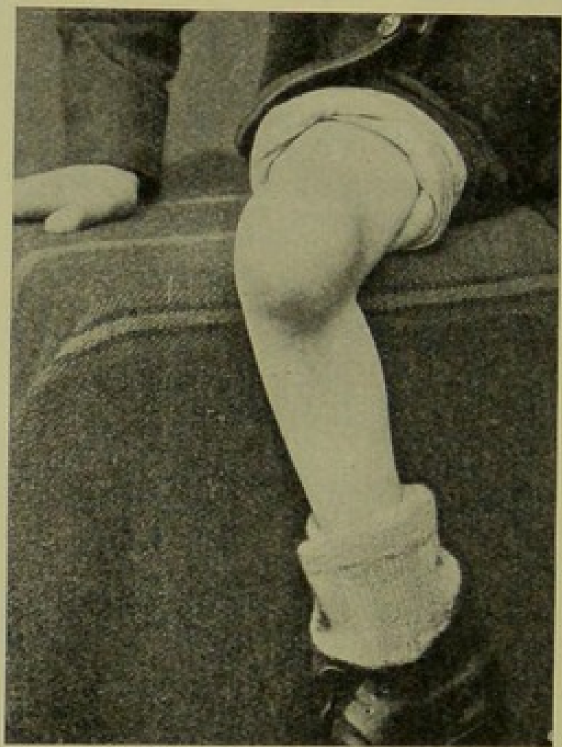


Fig. 84.—Old standing disease of the knee-joint, showing the typical deformity, viz.—flexion, drawing up of the tibia behind the femur, and rotation outwards of the leg.

tomy or removal of a portion of the bone (see Fig. 83). The typical final deformity of knee-joint disease is flexion of the leg to about a right angle, drawing up of the tibia behind the femur, and rotation outwards of the leg (see Figs. 84 and 85). At the same time the muscles of the thigh atrophy, and the leg shows signs of wasting and, where the deformity has occurred early in life and lasted some time, the growth of the limb is imperfect. On looking into the joint towards the end of this stage, it will be found that the articular cartilages have in places completely disappeared, leaving the inflamed and carious bone exposed, and in other places thinned and perforated shreds remain often loosely attached to the subjacent bone. The fibro-cartilages have also been more or less destroyed. Further, destructive changes are noticeable in the bones, more especially in the head of the tibia, the external portion of which is often deeply excavated from pressure against the femur.

3. As in the case of the hip-joint, we may place in a third group those cases where suppuration has occurred. Suppura-

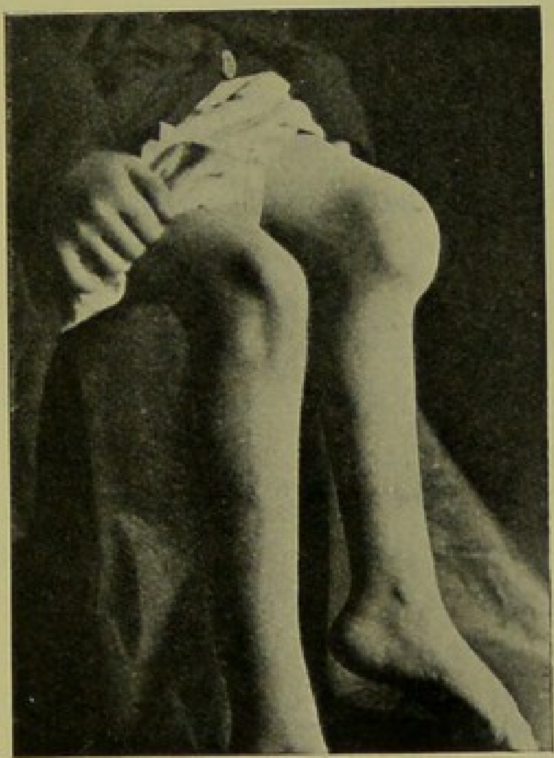


FIG. 85.—Another case of old standing disease of the knee-joint, showing the way in which the tibia is drawn up behind the femur.

tion may occur early in the disease before the changes in the cartilages have gone on to any marked extent, or it may occur later where deformity has taken place. With the exception of the rare condition of empyema tuberculosum, described by König, abscesses occurring in the early stage of primary synovial disease of the knee-joint do not, as a rule, in the first instance communicate with the joint, but originate in the substance or the external portion of the affected synovial membrane. The most common seat of these abscesses is in front of the lower part of the femur, especially towards the inner side, beginning in connexion with the synovial membrane of the supra-patellar pouch. When suppuration occurs during the second stage, it may either be in the form of caseous pus in the joint or of abscesses around it and originating in the synovial membrane, but not necessarily communicating with the joint. Most usually when there are abscesses not communicating with the joint there is also a little pus inside, in fact, in most cases where one opens a joint at a late stage, one finds a little fluid with

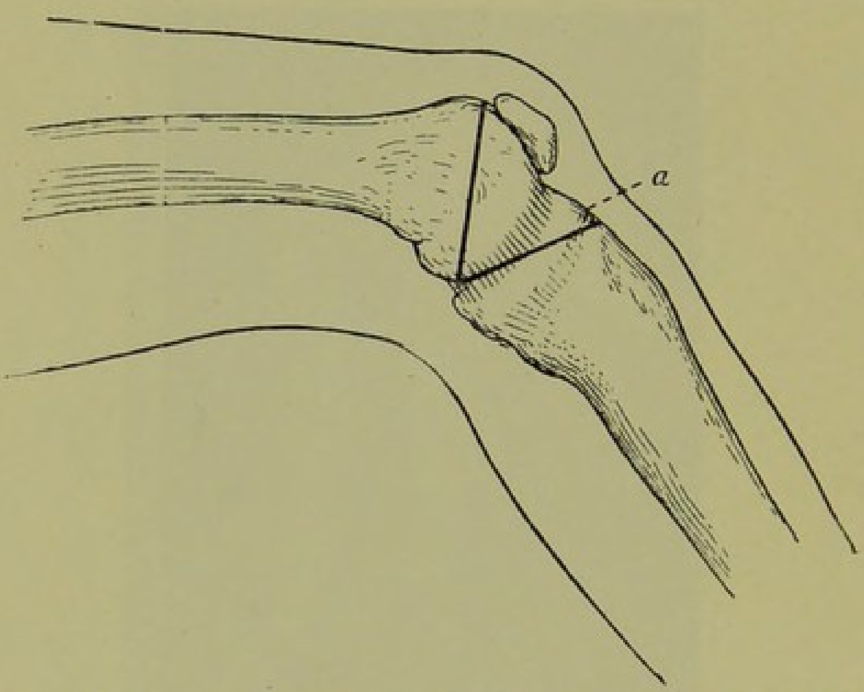


Fig. 86.—Anchylosis of bones forming the knee-joint. To remedy this. a wedge of bone (a) would have to be removed.

flaky material in it. In the case of these abscesses arising in connexion with the synovial membrane, after being opened a communication may form with the joint, but this is not generally the case if treated aseptically. On the other hand, if the wound is septic the slight barrier between the abscess and the joint usually breaks down, and a probe can then be passed through these sinuses directly into the joint.

4. From the point of view of treatment, we may consider a fourth stage, in which the disease is evidently on the road to recovery, and where anchylosis, fibrous or bony, is taking place. Unless the disease comes to an end at an early stage there is always more or less complete stiffness, due not

merely to cicatricial shrinking of the capsule with adhesions between adjacent portions, but also to actual union, either fibrous or osseous, between the bony surfaces. The earliest part to adhere is, as a rule, the patella with the surface of the femur. Whether fibrous or osseous anchylosis occurs depends on the degree to which the articular cartilages are destroyed. Where the disease has ceased before they are completely destroyed at the opposed points the union will be fibrous; where, however, both bones are denuded, and the limb kept at rest, there will be osseous anchylosis (Fig. 86).

3. Primary Bone Disease

In the early stage, where the primary osseous deposits have not yet reached the surface, it is often most difficult to recognize them, indeed, where they are small and close to the surface, the first indication of disease may be when or just before they have formed a communication with the joint. Where they are larger, and situated in the substance of the epiphysis, they generally give rise, in the first instance, to a feeling of tiredness and aching, sometimes worse at night, and stiffness of the knee. On examination of the part, one finds some enlargement of the bone at the seat of disease, with a little tenderness on tapping, usually as time goes on becoming more marked at some one point. At this early stage, the synovial membrane is not thickened, and the area of bone affected can be easily made out. A good deal of information as to the exact seat of the disease may also be obtained by percussion. On percussion of healthy superficial spongy bone, a comparatively resonant note is obtained, but if the cancellous spaces are filled up at any one place with bone or caseating tissue, the tone at that part is distinctly less resonant. The tapping must be pretty firm, and is, I believe, best done by means of a pleximeter. Of course, once the synovial membrane has become thickened, percussion does not yield a satisfactory result, for the bone must be quite superficial, otherwise the resonance is imperfect.

As time goes on, the osseous deposit tends to make its way to the surface, and as I have already pointed out, it may reach the surface in three situations. Where it comes to the surface outside the synovial capsule, the bone becomes more tender on pressure at that part, and at the most tender point it softens, and very soon an abscess appears, at the bottom of which, when opened, the defect in the bone is found. At first the movements of the joint may only be imperfect, and the patient may have pain on standing on it from the pressure on the inflamed bone, but the capsule remains without material thickening, and the cavity of the joint is sound. If the abscess is not properly dealt with, however, at an early period of the case, the synovial membrane of the joint is very apt to become thickened, and then the sequence of events formerly pointed out follows with the addition that an abscess exists from an early period outside the joint and that part of the bone is thickened and inflamed.

In other cases the deposit reaches the surface at the point where the synovial membrane is reflected on to the bone, and it at once infects the synovial membrane. The result is that following the early symptoms which lead one to suspect that there is disease going on in the bone, thickening of the synovial membrane begins in the neighbourhood of the thickened bone, and rapidly spreads over the whole surface. The disease then follows the course of ordinary synovial disease, with the exception that it is more stubborn, that it usually goes on more quickly, that there is more pain and rigidity at an early period, and that abscess is very apt to form soon in the synovial membrane at the point where the osseous deposit has reached the surface.

In the third form the osseous deposit reaches the surface beneath the articular cartilage, leads to destruction of the cartilage over it, and then communicates with the joint. In this case the joint infection is usually preceded for a short time by more acute symptoms. The bone beneath the cartilage at the affected part becomes inflamed, and hence any movements which lead to pressure on that part cause pain, there is often a considerable amount of rigidity of the limb, and, where the deposit is large, there may be starting of the limb at night, and this without thickening of the synovial membrane. The perforation into the joint generally occurs pretty suddenly, and there is rapid increase in the symptoms. Not uncommonly the patient experiences sudden severe pain, probably at the time of perforation, followed by swelling of the joint, and in some cases by fever, the whole joint becomes rapidly affected, the surface of the synovial membrane undergoes caseation, and the cartilage is quickly destroyed. In fact, the condition is that described in the older text-books as acute ulceration of cartilages. In this condition some cheesy pus is generally formed at an early period in the joint, the patient suffers much pain, especially on the slightest movement, there is starting pain at night, the knee is rigid and flexed, the ends of the bones are enlarged, but in the first instance the ligaments are not softened, and lateral mobility is not present. When abscesses form and are opened, they are found to communicate with the joint, and the probe passes into the soft, carious, and very sensitive bone. If recovery takes place after this condition there is bony anchylosis.

Cases of the kind just referred to where the onset of the acute symptoms is sudden and probably coincident with the formation of a communication between a deposit in the bones and the cavity of the joint, are not so uncommon as one might at first sight suppose, and I have notes of several instances. For example, a female, *æt.* 25, was the subject of chronic phthisis, and for two winters had suffered from occasional pain in the knee. One night she woke with sudden violent pain in the knee, which soon became swollen and extremely painful, and rapidly acquired the appearance of typical tuberculous disease with pus in the joint. In this case the tuberculous nature of the disease was confirmed on microscopical examination, and a primary deposit was found in the head of the tibia which communicated with the joint. The previous uneasiness in the joint was, no doubt, due to the presence of this deposit, and the development of the acute symptoms coincided with the formation of a communication between the deposit and the joint cavity. I could mention other similar cases not only in connexion with the knee-joint but in other joints, and while some of them might be referred to the sudden deposit of a tuberculous embolus in some of the structures of the joint, the majority are dependent on the rupture of a deposit into the articular cavity.

Diagnosis of Tuberculous Disease of the Knee-joint

Acute synovitis. The only cases in which acute synovitis and tuberculous disease of the knee-joint are difficult to distinguish from each other are either where the tuberculous disease begins acutely or where an osseous deposit has burst into the joint. In some cases tuberculous disease begins quite acutely, and, in the first instance, presents the appearance of an ordinary acute synovitis, and cannot be distinguished from it, especially where it follows on an injury. In such a case the suspicion of tuberculosis may not be aroused till it is found that, in spite of thorough treatment, the joint remains swollen and the synovial membrane becomes thickened, or that suppuration is occurring without any of the acute symptoms characteristic of suppuration due to the ordinary pyogenic organisms. I speak of such cases as this: a boy fell and hurt his knee; this was followed by acute synovitis, which soon lost its acute character but left the knee swollen, and a chronic abscess shortly afterwards developed; this child subsequently died of tuberculous meningitis. In other cases the acuteness of the symptom is preceded for some time by discomfort or actual aching in the knee and perhaps by some enlargement of the bones. Such was the case referred to in the last paragraph; in these instances there is not usually much difficulty in the diagnosis.

Hydrops articuli. Here also there is not, as a rule, much difficulty in diagnosis; in the one case (hydrops) the joint is full of fluid and the synovial membrane is not thickened; in the other the essential part of the swelling is due to thickening of the synovial membrane. The cases which are difficult to diagnose are those where the tuberculous disease begins with a hydrops of the joint or with the development of pus in it without much thickening of the synovial membrane in the first instance; Volkmann's hydrops tuberculosus and empyema tuberculosum. These cases are rare, but they do occur, and the possibility should be borne in mind. Here the disease begins with distension of the joint with fluid, but as time goes on the synovial membrane becomes thickened and the diagnosis becomes evident; where, on aspiration, curdy pus is drawn off the diagnosis is, of course, made at once. Suspicion would also be aroused in cases where there is tuberculous disease elsewhere, and where the swelling of the joint occurred without any evident cause.

Loose cartilage. The cases where the question of loose cartilage would arise are those where pedunculated tuberculous tumours are attached to the synovial membrane, cases to which I have already referred. In these instances, however, the swelling is usually much larger than the typical loose cartilage; at any rate, a simple loose cartilage which had attained that size would have become detached. The difficulty in these cases is not so much to distinguish them from cases of loose cartilage as from tumours, fatty or otherwise, outside the joint. These tuberculous tumours are, however, generally associated with effusion into the joint, and they can usually be moved in such a way as to show that they are hanging free in the joint cavity. A difficulty may arise where there are numerous rice bodies in the joint, as I have seen in other joints, which may be mistaken for simple loose cartilage, but their number, and the fact that on cutting into them they are seen to be composed of fibrin and not of the ordinary structure of loose cartilage, shows the difference. Further, in these cases the synovial membrane is usually thickened, fleshy, and coarsely villous.

Rheumatoid arthritis. This difficulty arises chiefly in older patients, and it is not always easy, on first seeing the case, to be quite certain whether one has to do with an early rheumatoid arthritis or an early tuberculous disease; of course in the later stages there is no difficulty. In rheumatoid arthritis the joint is usually sensitive to wet and cold, and is subject to attacks of pain and tenderness, which subside; creaking can be felt in the joint; the synovial membrane is not markedly thickened, and very often enlarged villi can be felt rolling under one's finger over the bone; there is early enlargement and deformity of the bones, and great tendency to stiffness. Very often the disease is poly-articular.

Charcot's disease is so well known and its features so characteristic that it need not be considered here. *Hysteria* in the knee, as elsewhere, is characterized by the absence of local signs, the exaggeration of pain, and other symptoms.

Syphilitic joint diseases are not likely to be confounded. The synovitis which occurs in secondary syphilis is transient, is intimately associated with other lesions, and in no way resembles tuberculous disease. Gummatous disease might perhaps lead to difficulty. As a rule, gummata form in the subcutaneous tissue, and lead to the characteristic ulceration of the skin, which can hardly be mistaken. Where they are formed deeper, there is not generally diffuse thickening of the synovial membrane, but the presence of isolated nodules, softening in the centre, and the absence of other symptoms of knee-joint disease are diagnostic points. The matter is sometimes complicated, however, where there have been periosteal gummata which have broken through the skin and also formed a communication with the joint, and where the probe passes down to bare bone. This condition, however, is, I believe, rarer than has been supposed, and most of the cases which have been taken for it have in reality been cases of tuberculous disease. Diffuse gummatous infiltration of the sub-synovial tissue is excessively rare. Wasserman's and von Pirquet's reactions will also help. The possibility that the thickening may be *tumour* growth must also be borne in mind, and I have seen a tumour of the lower end of the femur which had burst into the joint opened on the impression that it was a case of tuberculous joint disease. In tumours in the interior of the bone, the swelling of the bone is usually more general than in the case of a tuberculous deposit, and extends beyond the region of the joint. Care must also be taken to distinguish an *acute epiphysitis* in children with effusion into the joint from tuberculous disease. This is not so likely to cause difficulty during the acute stage as afterwards, where one may have to depend on an imperfect history.

Treatment of Knee-joint Disease

The treatment of knee-joint disease varies according to the pathological condition and the stage of the disease. In the first class of cases, where we have the localized synovial disease either sessile or pedunculated, the proper practice clearly is, in view of the safety with which joints can now be opened aseptically, to cut down and remove the whole affected area as soon as possible. This was done in the case to which I have referred, with the result that there was perfect recovery, with a freely movable joint. I have in one or two instances also obtained similar results in localized synovial deposits in other joints, and in Germany König and others have in several cases removed these pedunculated tumours successfully. They state, however, that in a certain number of the cases gradual thickening of the synovial membrane has subsequently occurred.

The treatment of the general synovial thickening varies, of course, according to the condition of the joint, the means we have at our disposal being the various forms of expectant treatment, arthrectomy, treatment of abscesses alone, excision, and amputation. We must consider shortly the circumstances under which these various forms of treatment are applicable.

1. In the early stage of synovial disease, where the thickening is not great, and where there is absence of pain, and no marked interference with movement, the essential part of the treatment is complete fixation of the joint. There are a number of methods by which this may be accomplished, but whichever be employed, it is in my opinion advisable that in the first instance the patient should be

kept in bed and in the recumbent posture. I advise the recumbent position, because every time the patient sits up he contracts the extensor cruris, and thus pulls up the patella; and, further, the circulation in the limb is also better when the leg is not much below the level of the heart. Hence it is well, while the disease is progressing, and while very little may interfere with the commencement of recovery, to prevent the patient from sitting up by means of heavy sand-bags applied along each side of the body with a sheet passing over the chest. At the same time, the ankle should also be supported and fixed at right angles. Patients constantly complain of uneasiness and pain if this is not done, and the muscles of the calf are apt to become contracted and lead to a certain degree of talipes equinus and subsequent difficulty in getting the foot flat on the ground. Besides, if the ankle is not supported it tends to fall outwards and produce the rotation outwards of the leg at the knee-joint which is so characteristic of a badly treated case.

In the first instance, I think it is advisable to employ an apparatus which can be readily opened without disturbing the joint, so as to enable the surgeon to see from time to time what is going on. The various forms of rigid apparatus, however useful, are for this reason best limited to later stages, when it is evident that the disease has come to a standstill or is improving, but if desired, they can be used at this stage by cutting them down the front, and then using laces.

Of the various forms of splints, I prefer a trough of Gooch's splint during the early stage (Fig. 87). The splint should reach from the fold of the buttock above to about four inches beyond the sole of the foot, and should surround the thigh and knee for about two-thirds of their circumference. It is cut obliquely at its upper end upwards and outwards to correspond with the fold of the buttock, and in the case of adults, a horse-shoe space should be cut away at the lower part, so as to avoid pressure on the heel; in this way, two prongs are left, which grasp the instep and steady the ankle. In young children, however, where the splint is short, this weakens it, and the heel can easily be kept from pressure by pads. The splint is covered with a layer of jaconet, and then with a folded sheet turned over the upper end, and at the lower part folded up just above the horse-shoe defect. A layer of cotton-wool is placed in the ham, so as to give support to the knee, and prevent over-extension, and the leg above the heel is properly supported on wool or pads, so as to prevent the heel from touching the splint. The splint being then turned up, and pressed against the limb, pads are pushed in all along the side, so as to wedge the leg and thigh, and also prevent pressure on bony points,

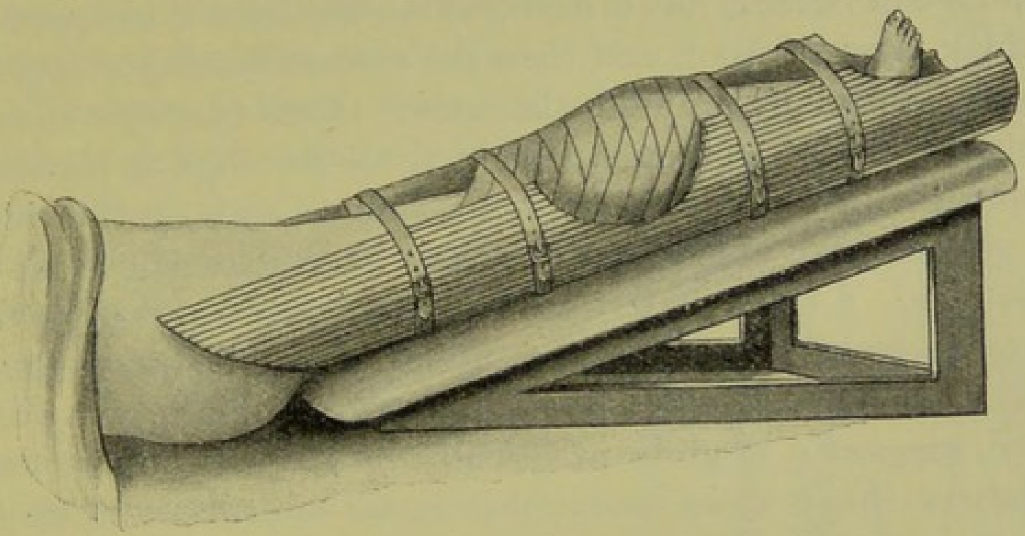


Fig. 87.—Trough of Gooch's splint applied in a case of knee-joint disease: the external bandage is not shown. This splint is also very suitable after operations on the joint, as indicated in this figure, and in such cases the splint may be cut away on each side of the knee-joint.

more especially the internal condyle of the femur and the malleoli. To avoid the latter, the pads do not reach further than the bases of the malleoli, and in order to fix the foot a number of pads are placed between the prongs of the splint and the sides of the foot; the knee and the front of the leg are now covered with pads, so that the bandage, in passing round, may get a purchase on the limb. A bandage is now firmly applied, and then at the upper part a layer of mackintosh is pinned along the inner side of the splint to prevent wetting of the bandage with urine. The limb is then placed on an inclined plane. In some cases it is well to apply a layer of starch to the bandage to prevent it from slipping. The bandage should be renewed whenever it gets loose, generally about once a week. This form of splint is, I believe, much better than a plain flat-back splint, or than Thomas's knee-splint. A plain back splint gives no lateral support either to limb or ankle, and the mode in which it is commonly fixed by strips of strapping above and below beneath the bandage is most objectionable, because it leads to constriction of the circulation.

After six or eight weeks, if the thickening is diminishing, or at any rate not increasing, it is best to apply a water-glass or plaster of Paris bandage, preferably the former. A bandage of boracic lint is first put on, the knee is wrapped in a thick layer of wool, and then the silicate bandages applied firmly, especially around the knee. This bandage should include the foot, and extend as high up the thigh as possible. One must be careful to carry the case as high up the thigh as possible, for unless this is done, movement will occur at the knee. I think it is well not to trust altogether to the water-glass bandage, but to combine with it Thomas's knee-splint. Thomas's splint alone does not, I think, give sufficient support; it gives practically no lateral support, and I believe this is most essential in order to prevent strain on the ligaments of the joint. On the other hand, it is difficult to get a proper grasp of the thigh with the silicate bandage, while this is done by Thomas's splint. Hence, I believe, the combination is a most satisfactory arrangement, and that it is by far the best method of using Thomas's splint.

Thomas's knee-splint consists of a groin ring, lateral rods running down the inner and outer sides of the limb and attached at the bottom to a boot, and three broad leather bands behind to support the limb. The groin ring is of an ovoid shape, the narrowest part being at the outer side, the inner part, which rests on the tuber ischii, being thickly padded. This ring lies obliquely in the fold of the groin, the inner rod being attached to it at an angle of 120°, the angle on the outer side varying with the shape of the limb. In the case of the bed-splint the lateral rods are attached at the longest diameters of the ovoid; in the walking-splint the inner rod is attached further back. At the lower end the foot is enclosed in a boot, which is cut away in a V-shaped manner at the back part, and the lateral rods are bent at right angles, and passed into holes in the heel. The posterior leather bands are three in number, one about the middle of the thigh, one behind the knee, and one behind the lower part of the leg. The splint is fixed to the leg by two broad straps passing in front, one above and one below the knee. If flexion is present, these straps are employed to overcome it. If there is a tendency to knock-knee, the thigh is pulled outwards by a band attached to the outer rod, while the inner rod is bent inwards, so as not to press on the inner condyle.

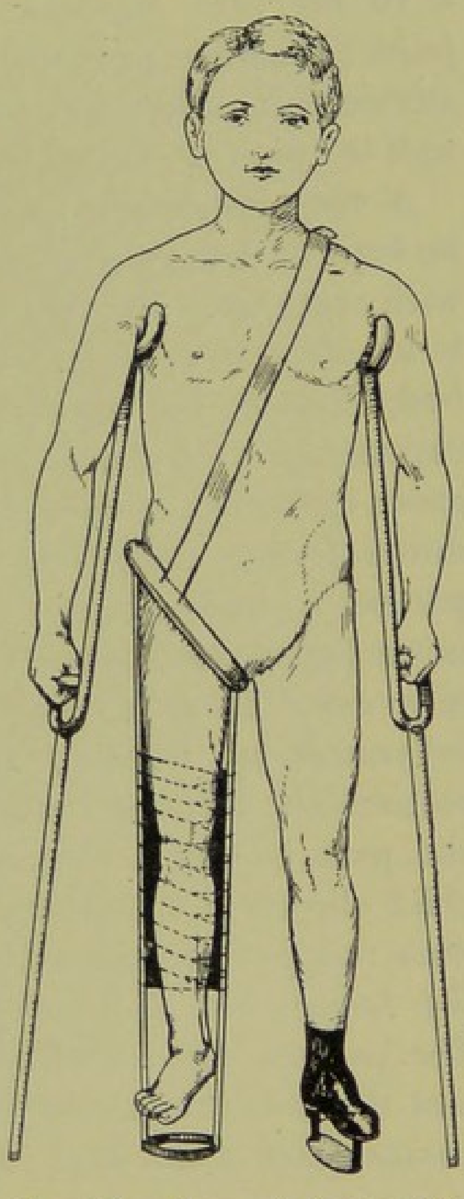


FIG. 88.—Thomas's knee-splint arranged for walking.

In all cases, in addition to these expectant measures, tuberculine certainly ought to be used in small doses about every ten days. I do not think that the use of tuberculine will replace to any extent our ordinary lines of treatment; at the same time nothing which may help the tissues in their fight with the parasite should be neglected.

Another plan which sometimes shows good results is Bier's congestion method. An elastic band is placed round the thigh sufficiently tightly to obstruct the venous circulation considerably, but not to interfere with the arterial supply. This band is kept on at first for half an hour to an hour, but later, as the patient gets accustomed to it, it may be left on for several hours. I cannot say that I have seen such marked improvement as has been obtained by some, but where a case is not progressing well it may be worth while trying.

Another method of treatment has been much employed in Germany during the early stage of tuberculous joint disease, viz. repeated injections of small quantities of a 10 per cent emulsion of iodoform in glycerine into the joint (of course properly sterilized). I would not, however, advise this unless in cases where things were not going on well in spite of careful treatment on the above lines.

A very important question is whether the patient should be kept in bed, or whether he should be allowed to get about with crutches. My own opinion is that so long as the disease is at all active, the recumbent posture, not necessarily in bed, should be rigidly maintained. We have constant experience that ulcers on the leg will not heal, or only with great difficulty, so long as the patient walks about or hangs down the leg, while they begin to heal at once on placing the patient in bed. Even in young people, we see that wounds in the leg are long in healing while the patients run about, and may even ulcerate. The same must apply to a deep-seated inflammatory trouble, and I believe, therefore, that the recumbent posture should be kept up in knee disease till the part is well advanced on the road to recovery. The chief objection urged against this course is that the patient does not get enough exercise, and is too much confined to the house, but these objections can be readily overcome. The patient can be wheeled out in the recumbent posture, and if a warm country place is selected, he can lie out the greater part of the day. As regards exercise general massage is an excellent substitute, and by its use the patient's nutrition can be maintained at a high level.

When the patient is allowed to get about, Thomas's walking knee-splint (Fig. 88), slung from the shoulder by a strap, is the apparatus most commonly employed. By means of it no pressure is brought to bear on the joint, the lateral rods are continued down to a foot-piece below the boot, and thus the weight of the body is borne on the tuber ischii against which the upper ring rests. The other foot is raised to the same level by a patten on the sole of the boot, and the patient gets about with crutches.

Still better in many cases than Thomas's walking knee-splint at this stage is Hessing's apparatus, as made by Hoefftcke (see Figs. 89 and 90). The patient gets about

FIG. 89.—Hoefftcke's splint applied in a case of flexion of the knee with the view of straightening it.

more freely with it, and when the time comes some movement may be permitted at the knee-joint, still without any pressure being brought to bear on the limb. The following is Hoefftcke's description of this splint:

'Instead of having an iron ring (as in Thomas's splint) padded thickly under the tuber ischii and in the groin, I mould a thigh-piece to the exact shape of the ischial tuberosity and surrounding gluteal muscles, taking care to leave the crutch quite free, thus preventing the chafing so painful to the patient.

'In addition to removing the weight of the body from the limb, extension is produced by means of an anklet consisting

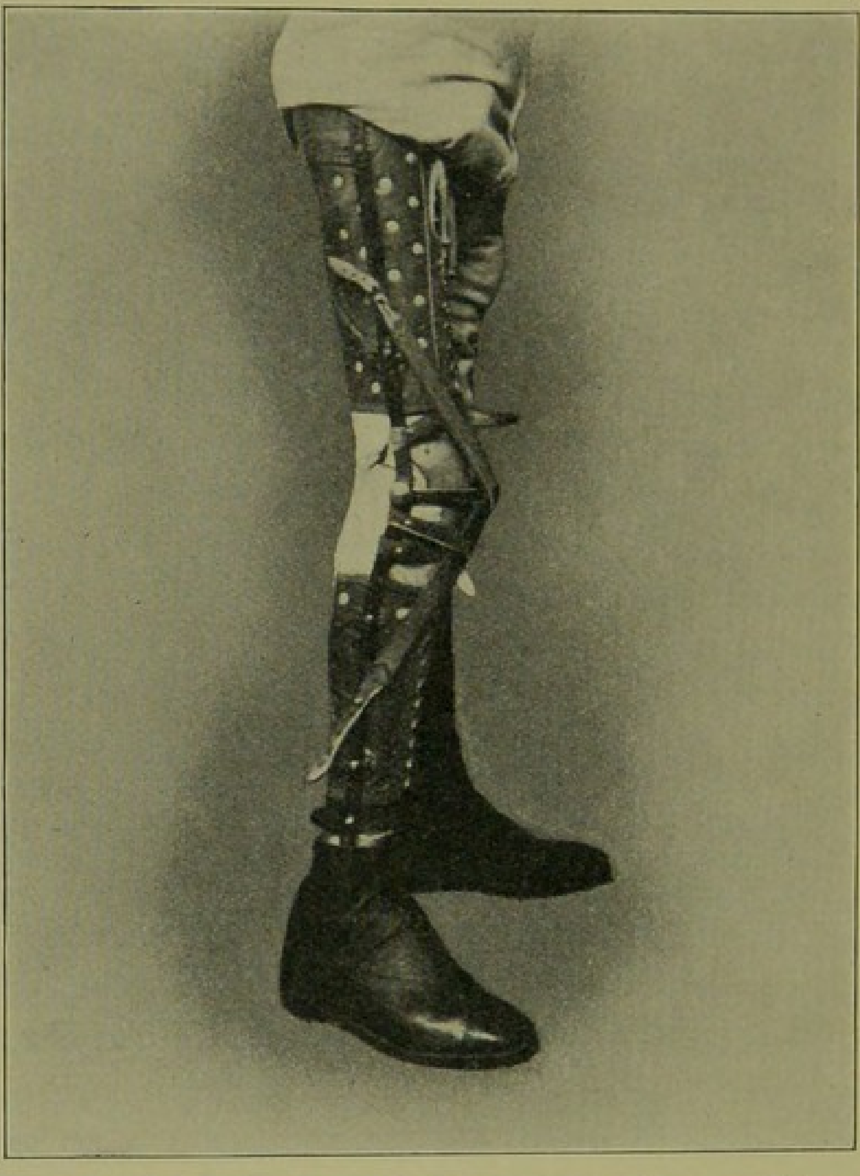


Fig. 90.—Hoefftcke's splint arranged for walking when a certain amount of flexion is permitted.

of a moulded piece of leather which fits the ankle-joint like a glove, and fastens underneath the foot-piece of the apparatus by means of a strap and buckle. The thigh-piece is furnished with adjustable lateral bars jointed at knee ; below the knee-joint the apparatus is furnished with an adjustable leg-piece which is also moulded exactly to the shape of the calf.

"On the lower end of the lateral bars are a series of holes into which the steel pins, which are mounted on the lateral side bars of the foot-piece opposite the ankle-joint, can articulate. By pushing the thigh-piece upwards against the tuber ischii and pulling the foot-piece with anklet downwards the joints are extended, and extension is maintained by inserting the two pins of the foot-piece into the corresponding holes in the lateral bars, so that when the patient puts the weight of the body upon the apparatus there is an opening of a quarter of an inch between the heel of the foot and the sole of the foot-piece."

Additional means of treatment which, however, I do not think of much value in knee-joint disease, are pressure and counter-irritation. Pressure is a very old method of treating all chronic inflammatory affections, and if carefully and judiciously applied it may do good, but if too strong and irregular it causes a great deal of harm. The essential points in the application of pressure are, therefore, that it should be equable and moderate. Perhaps the best way in which this can be done is by surrounding the joint by a large mass of cotton-wool or silk-waste, and then applying a bandage firmly. The mass of wool distributes the pressure equally over the part, and what at first sight seemed likely to be a very bulky mass becomes reduced under an evenly and firmly applied bandage to a comparatively small size. The limb is then placed on a splint, care being taken to pad the thigh and leg so as to correspond with the bulk of the knee. Another favourite way in which pressure is applied is by means of Scott's dressing, and here also there is a certain amount of counter-irritation as well. I must say that I do not see any advantage in Scott's dressing over pressure by means of a mass of cotton-wool; indeed, the pressure is not so firm and equable.

As to counter-irritation in the early stage of synovial disease of the knee-joint, it is very much the fashion to apply strong iodine and blisters at this stage. My own opinion is that this is not good practice. The synovial membrane of the knee is very superficial, and blisters applied to the skin may increase the congestion, and thus rather favour the inflammatory action than otherwise. It is different where the disease is improving, there the application of a few blisters may hasten matters, but, on the whole, great care must be exercised in using counter-irritation at any stage.

As regards extension, from what I said in speaking of hip-joint disease, it will be evident that extension will not come into play in the treatment of the earlier stages of pure synovial disease, and it need not, therefore, be considered here. If there is any flexion at this stage, that is easily overcome without any necessity for extension, by gentle pressure without any violence.

Operative treatment in the early stage of synovial disease of the knee-joint is only necessary when it is found that the disease is rapidly advancing in spite of careful treatment. At one time arthrectomy was frequently performed in children during this period, but of late it has been falling into the background because it is found that a large proportion of cases get well when treated on the above lines, and with better functional results. When, therefore, the disease is limited to the synovial membrane it is only where, after prolonged and careful trial of the various methods of expectant treatment, the disease is evidently advancing and there is a tendency to breaking down that operation is called for. The operations are arthrectomy in children and excision in adults.

Arthrectomy.—By this is meant the complete removal of the synovial membrane and any diseased cartilage or bone which may be met with. It must be remembered that this is an operation by no means devoid of danger and, therefore, not to be lightly undertaken. The danger is chiefly shock, possibly in some cases aggravated by loss of blood. On the whole, I believe that less blood is lost if no tourniquet is used, and if the main bleeding vessels are clamped as they bleed, and certainly the removal of the disease is much easier.

I have already described this operation on p. 172 and need not therefore repeat the description here (see Fig. 91).

If the operation has been done aseptically, and no drainage tube has been inserted, it will not usually be necessary to touch the dressing before from four to six weeks, when the wound will be found healed, and the stitches may be taken out. I think it is well to prevent the patient from walking for about three months after the operation, and subsequently a Thomas knee-splint or a Hessing splint must be worn, to prevent flexion of the joint. This splint must be altered from time to time, and may, after a time, be changed for a poroplastic splint lacing in front. Some form of retentive apparatus should be continued for two or three years, or, if left off sooner, with the view of allowing movement, resumed at once on any appearance of flexion.

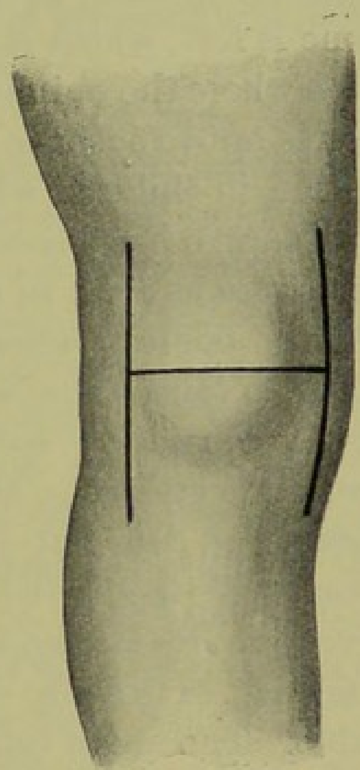


FIG. 91.—Incisions for arthrectomy of the knee. Vertical incisions on each side of the patella, joined, if necessary, by a transverse incision over the centre of the patella, which is sawn through at that part.

In no case do I advocate early arthrectomy and in adults the operation is altogether unsuitable. It is but rarely that one can get a useful movable limb, usually there is more or less complete stiffness of the knee, but never the perfect rigidity obtained by excision. Hence, the knee is apt to give, and the adhesions being stretched become tender, and the patient does not walk comfortably. I believe that in adults excision will yield a better result on the whole, and, therefore, unless where there is some special reason for getting a rapid cure, I should not, as a rule, consider the question of operation in adults until a later stage.

2. In the later stage of primary synovial disease, where the cartilage has become affected and the surface of the bone carious, the relative frequency of operation in the old and young becomes altered. In the first stage operation is more frequent in the young than in the old ; in this stage I think

operation should be more frequent in the old than in the young. While, so long as the cartilages are unaffected or but slightly attacked, a cure of the disease and a good functional result may be looked for from early operation in children, the conditions are not the same where the cartilages are destroyed, and the surfaces of the bones carious. In that case, in order to get rid of the disease by arthrectomy, portions of bone have to be removed, a large surface of soft bone is left, which is very apt to become infected again, and even where the epiphysial cartilages are not touched, ossification is apt to occur in them, with consequent arrest of growth. Hence, in children where the stage of destruction of cartilage and caries has become established, I think it is wisest to persevere as long as possible with expectant treatment, and only to operate when it is evident that no improvement is going to take place, when there is much flexion which cannot be overcome by splints, when the general health of the patient is suffering, and when the third stage, that of abscess formation, has set in. While carrying on the expectant treatment, it might be worth while to use the iodoform and glycerine injections, and in some cases, where there is much starting, extension carried out, as in the hip, will be of value. The use of tuberculine, &c., must, of course, be carried out on the lines already laid down.

As regards operations during the second stage in children, arthrectomy is still the proper procedure, excision, in which the epiphysial cartilages are almost unavoidably injured, being in my opinion very rarely, if ever, justifiable in children. Some have advised an intra-epiphysial excision, the lines of division of the bone being so arranged as to fall inside the epiphysial lines, but even after this operation the condensation of the bone which accompanies the healing process is very apt to extend to the cartilages and lead to their ossification, and consequently to arrest of growth. Where operation becomes necessary, it should be an arthrectomy, viz. complete removal of the synovial membrane in the manner formerly described, and removal of all affected bone with as little of the sound bone as possible. This means that there is no sawing off of the ends of the bones, the removal of bone being quite irregular; as a rule, the original shape of the end of the bone is more or less preserved. In removing the carious surface, it is important to remember what has been previously pointed out, that the tuberculous disease in the case of caries of the surface does not extend more than $\frac{1}{8}$ to $\frac{1}{4}$ inch into the substance of the bone, so that it is not necessary to take away much. The best way of proceeding is, after the synovial membrane has been thoroughly removed, and the joint thoroughly cleared out, so as to diminish the risk of infection, to take a strong knife and shave off about $\frac{1}{4}$ inch of the whole surface of the bone. Even though cartilage be still adherent in parts, it is best to take it away with a thin piece of the underlying bone. Care is taken as far as possible not to infect the cut surface while dealing with other parts of the bone. One must remember that congested bone is not necessarily infected bone, otherwise one would remove far too much, and also that the rarefying osteitis is not uniform, but tends to be in patches. The ultimate result of this operation in the knee-joint, where the cartilages of both femur and tibia are affected and removed is, in most cases, bony anchylosis, and the only objection which can be raised in favour of a typical intra-epiphysial excision over an atypical arthrectomy, is that in the former the surfaces of the bone are broader and fit better than in the latter. No doubt this is true, but as a matter of fact the union after arthrectomy is quite good, and the risk of interference with growth is decidedly less.

In the case of adults the best result to be hoped for by expectant treatment, once the articular cartilages have undergone destruction, is bony anchylosis, and this means devoting a long time to treatment, running the risk of general disease and of local suppuration with all its troubles, and even where apparent recovery takes place, portions of tuberculous tissue are very apt to have become encapsuled, and give rise to fresh trouble at a later period. By excision the progress of the disease is cut short, the patient gets well quickly, and has a sound and useful limb, while, as he has attained his full growth, the shortening is not serious. The only objection to operation in this stage is that there is a certain risk of shock in feeble individuals, but if the cases are selected from this point of view, excision as now performed is a much more satisfactory method of treatment than long-continued perseverance in expectant measures. The former objection to excision was founded partly on the septic dangers, which were very considerable, and partly on the frequency of recurrence. Nowadays, with unbroken skin the risk of sepsis after operation may be disregarded, while, by the present method of operating, the diseased tissues are completely taken away, and in the case of primary synovial disease which we are discussing at present, the chance of recurrence is very slight. The following is, in my opinion, the best method of performing excision of the knee-joint :—

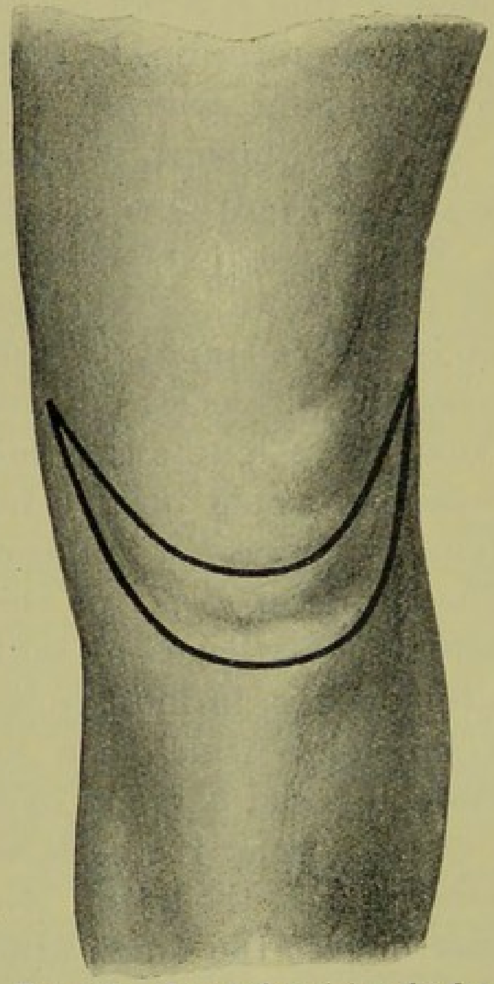


FIG. 92.—Line of incision for excision of the knee-joint for tuberculous disease.

An incision is made from the upper and back part of one condyle downwards, and then, curving round the front of the upper part of the tibia, at the level of the tuberosity, it passes up again to a corresponding point on the other side (Fig. 92). If the knee is movable this is best done with the leg bent at a right angle. From the same points a second curved incision is made, passing over the upper part of the ligamentum patella, the convexity being also downwards, and in this way a crescent-shaped portion of skin is enclosed and removed, otherwise the front flap is redundant, and has to be cut down subsequently. The flap consisting of skin, fat, and fascia, at the lower part, and of muscle as well at the upper part, is then raised, the patella being left, and care being taken not to cut into the synovial membrane, especially in the suprapatellar pouch. The flap is then held up, and the suprapatellar pouch is grasped and pulled down, till the point of reflection on to the cartilage of the femur is seen ; it is then detached along that line, and, following the lower incision, at the sides and lower part of the joint. In this way the whole of the anterior synovial membrane, the patella, ligamentum patellæ, and fatty pads are removed. I think, however, that it is well to leave as much as possible of the ligamentum patellæ to be subsequently stitched to the divided parts of the quadriceps. The knee is now forcibly bent, the crucial ligaments divided at their tibial attachments, and the ends of the bones cleared and sawn off in the usual manner. All other portions of carious bone, or of cartilage-covered bone, are sawn or chiselled off, and then the remainder of the synovial membrane is removed in the manner described under arthrectomy. Having made sure that all the diseased tissues have been removed, the bleeding-points are secured, and the bones united by clamps and screws, one at each side. In approximating the cut ends of the bone it is of great importance to remember that the cut surface of the tibia is broader than that of the femur, and that if the anterior edges are brought level, the posterior part of the upper end of the tibia will project back into the ham, and press on the vessels, causing, in some cases gangrene, in others imperfect circulation in the lower extremity and consequent deficient nutrition and growth. The posterior edges must, therefore, be brought level, and the anterior part of the tibia allowed to project forward. Having fixed the bones, it is well to stitch the divided extensor to the remains of the ligamentum patellæ ; or, if that has been taken away, to the periosteum of the tibia, so as to get better leverage on the limb afterwards. The skin is then stitched up, a drainage tube being rarely required, the usual antiseptic dressings in large quantity applied, and the limb securely fixed in a trough of Gooch's splint, which is laid on a wooden inclined plane. I do not usually dress these cases for from four to six weeks when it is found that bony union is pretty firm, and a case of silicate or plaster can be applied for another six weeks. No harm is done by leaving the stitches, there is no tension on them, and they cause no irritation if the aseptic measures have been properly carried out, while the blood which oozes into the dressing during the first twenty-four hours dries up into a hard crust, so that in a few days the neighbourhood

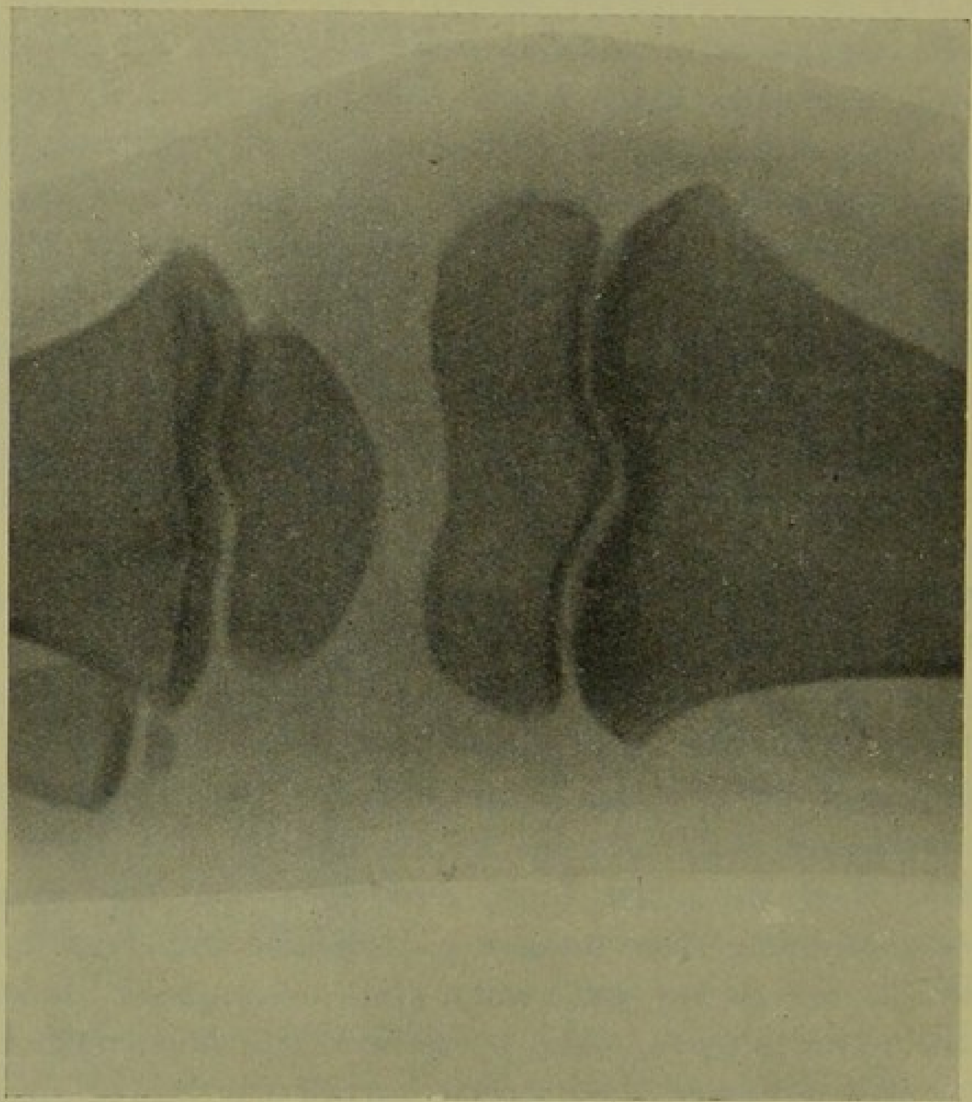


Fig. 93.—Skiagram showing the epiphyses in a child aged 5 years.

of the knee is surrounded by a hard dry mass, which grasps it most firmly, more so than a plaster of Paris case, and thus very complete steadiness is obtained. From time to time during the first six weeks a fresh external bandage may be firmly applied if the other tends to get loose, and special care must be taken to keep the foot at right angles by a turn of bandage passed round the sole, and pinned to the bandage in front of the leg. As before, I show the epiphysial lines at the ages of 5 and 9 (Figs. 93 and 94), as their position and extent should be borne in mind especially in performing arthrectomy.

The question of amputation during this stage may also arise, but it will hardly concern the young. Some years ago,

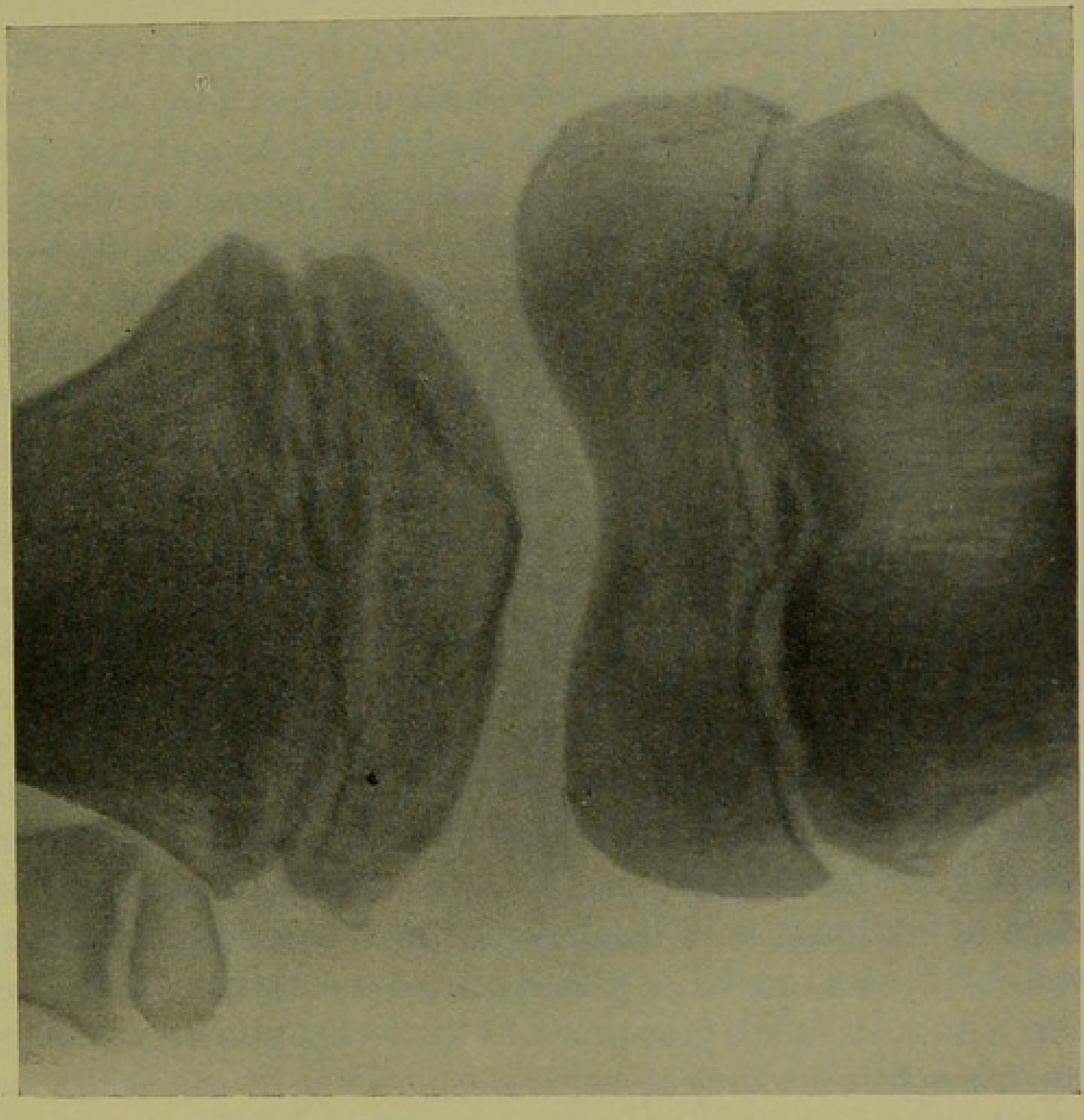


FIG. 94.—Skiagram showing the epiphyses at the age of 9 years.

and even by a good many surgeons at the present time, it was held that after forty years of age excision was impracticable on account of the immediate risk to life, of the great chance of recurrence, and of the bad effects of confinement to bed. As a matter of fact the answer to the question has now changed, and these are not the chief reasons which make one prefer amputation to excision in certain cases.

Thus the risk to life formerly spoken of was the risk of septic disease, but as there are no sinuses in the cases we are discussing at present, this risk is with proper precautions extremely slight. The chance of recurrence was of course great formerly where the whole disease was never removed; certain incisions were made, certain portions of bone were cut off, but no attempt was made to remove the whole of the synovial membrane, hence the disease went on in the soft parts often for a long time, sinuses remained or fresh abscesses formed, and portions of the freshly-cut osseous surfaces became infected and carious. With the present method of operating the greatest care is taken to remove all the diseased tissues, and the chance of recurrence after operation is very much less. As regards the confinement to bed, no doubt a patient can get up much sooner after amputation than after excision, but if the bones are well clamped together and the limb firmly fixed, he can usually sit up in two or three weeks after excision. This is no doubt a very important point, and the general condition of the patient, and the risk of confining him to bed for some weeks, must be carefully considered in deciding between the two operations.

For the above reasons, therefore, I would not necessarily exclude older people from the benefits of excision, for it must be remembered that a limb after excision is very much better than an artificial one, however well made, and at this stage of the disease, I think, even after forty years of age, excision is as a rule to be preferred to amputation. Amputation, however, is the best practice where the patient is suffering from tuberculosis elsewhere, especially in the lungs, or where the synovial thickening is great and soft, and much starting-pain is present, indicating considerable inflammation of the bone. When amputation is performed, I do not approve of such operations as Carden's, where the incision passes through diseased tissue. I think the bone should be divided through the lower third of the femur, the soft parts being dissected up without opening the joint, and the synovial capsule pulled down out of the way.

3. The third stage of primary synovial disease is that

where suppuration has taken place, and where we have either unopened abscesses or sinuses.

(*a*) *Unopened Abscesses.* Here, again, we must speak of children and adults separately.

In children it will depend very much on the condition of the joint as a whole what form the operative interference should take. Where there is a single abscess, and the condition of the joint is not otherwise bad, it is often sufficient to deal with the abscess alone, and afterwards employ suitable expectant treatment. Under such circumstances or if the abscess is extensive, it may be either aspirated or washed and scraped out and injected with iodoform and glycerine in the manner previously described. In some cases where the abscess is small and outside the joint, and probably originates from a deposit in the bone, it may be possible to dissect it out and at the same time remove the diseased area of bone. Where, however, the suppuration is more extensive and the condition of the joint is bad the question of operation will arise, and in children the decision will lie between arthrectomy and amputation. While amputation is, of course, to be avoided in children if at all possible, an anthrectomy of the knee, where the abscesses are multiple or extensive, is a very serious matter on account of the necessarily prolonged nature of the operation, and consequently on account of the risk, and therefore, especially if there be tuberculous lesions elsewhere, amputation may be the preferable procedure. Here again, however, where the joint disease is the only lesion, and where the general state of the patient is good, one may begin by aspirating or washing out the abscesses, and then if it becomes necessary at a later period to perform arthrectomy, it will not be nearly such an extensive and dangerous operation.

In adults, similarly, excision becomes a more serious operation where abscesses are present around a joint, and in a good many cases amputation is preferable, especially when the patient is old, where the disease is progressing rapidly, or where there is tuberculosis elsewhere. Where the abscess is single, and the synovial thickening not markedly soft, it may be desirable to be content, in the first instance, with aspirating or washing out the abscess, and where excision of the joint seems advisable and the abscesses are large or multiple, one may reduce the extent of the subsequent operation by preliminary treatment of the abscess.

In these, as in many other points in the treatment of tuberculous diseases, it is impossible to lay down definite rules to fit every case, one can only indicate the principles which guide one in coming to a decision.

(*b*) *Sinuses.* The presence of septic sinuses complicates the case very much, both because the presence of sepsis interferes with the recovery from the tuberculous trouble and also because it increases the risk of any operation except amputation.

In children where the limb is in good position, the discharge from the sinuses moderate in amount, and the constitutional condition good (absence of temperature, of albuminuria, of tuberculosis elsewhere, &c.) we may devote a considerable time to local treatment in the hope that healing may occur. This local treatment consists in fixation of the joint, suitable clean dressings (eucalyptus ointment, boracic lint, cyanide gauze, &c.), the bismuth injections previously referred to (p. 238), and Bier's congestion method. This may be carried out at first, if improvement follows, in the recumbent position, and then by the use of a Thomas's walking knee-splint, or, if the patient can afford it, Hoefftcke's apparatus. This local treatment must, of course, be combined with general treatment as well. The patient must be placed under the best hygienic conditions, he must be in the open air as much as possible, sleep with open windows, &c., good nutritive diet, and possibly vaccine treatment (not only tuberculine, but also vaccine for the pyogenic organisms present). Under this treatment a very considerable proportion of cases with septic sinuses (provided they do not go to deposits in the bone) will heal up.

Where the discharge is more profuse or constitutional symptoms (fever, &c.) are present, or where the sinuses lead down to bone deposits, free drainage must be secured, and if possible the bone deposit must be removed in the first instance. The sinus should be laid very freely open, the wall clipped away, any bone deposit gouged out, and undiluted carbolic acid freely applied to the whole surface in the hope of eradicating the sepsis. The wound is then packed with cyanide gauze and the ordinary antiseptic dressings applied over it, but as the wound gets smaller the packing should be left off and a drainage tube substituted for it. Of course, careful general treatment must also be carried out.

Where deformity is present and the discharge from the sinuses slight it may be advisable to perform arthrectomy. At one time I was very doubtful as to the advisability of this operation, on account of the risk of sepsis in the wound, but where suitable measures are taken this risk is not so great as might be expected. In performing the operation the procedure (disinfection of skin, &c.) must be carried out just as if one were dealing with unbroken skin. The sinuses must be freely scraped out in the first instance, and then thoroughly sponged with undiluted carbolic acid and stuffed with strips of gauze, the skin must be thoroughly disinfected, and all ordinary antiseptic precautions taken. In performing the operation the greatest care should be taken to avoid cutting into the sinuses, if possible, the incisions being planned so as to enclose the orifices of the sinuses in elliptical incisions and to remove them. Subsequently, drainage tubes should be left in the wound in case sepsis should occur.

In adults, one may, in some cases where the sinuses do not communicate with the joint, do as I have just said, viz. open them up, clip them away, sponge with pure carbolic acid, and stuff with iodoformed gauze. In most cases, however, one performs excision, taking the same precautions as regards the sinuses as I have just mentioned under arthrectomy ; but if the discharge is profuse, the pain great, or tuberculosis is present elsewhere, amputation is often the best practice.

4. Cases of primary synovial disease, where recovery is taking place with anchylosis, fibrous or bony, in a bad position.

Here, again, the age of the patient is the most important point, and we shall take first patients who have not yet reached their full growth. Where the union is fibrous and the position bad an attempt may be made to rectify it by the use of Hoefftcke's apparatus, for it is rarely that extension by weight and pulley will succeed at this stage. The most common deformity is flexion of the knee, the head of the tibia being also drawn up behind the femur. As the hamstrings and structures behind the joint are shortened, it is

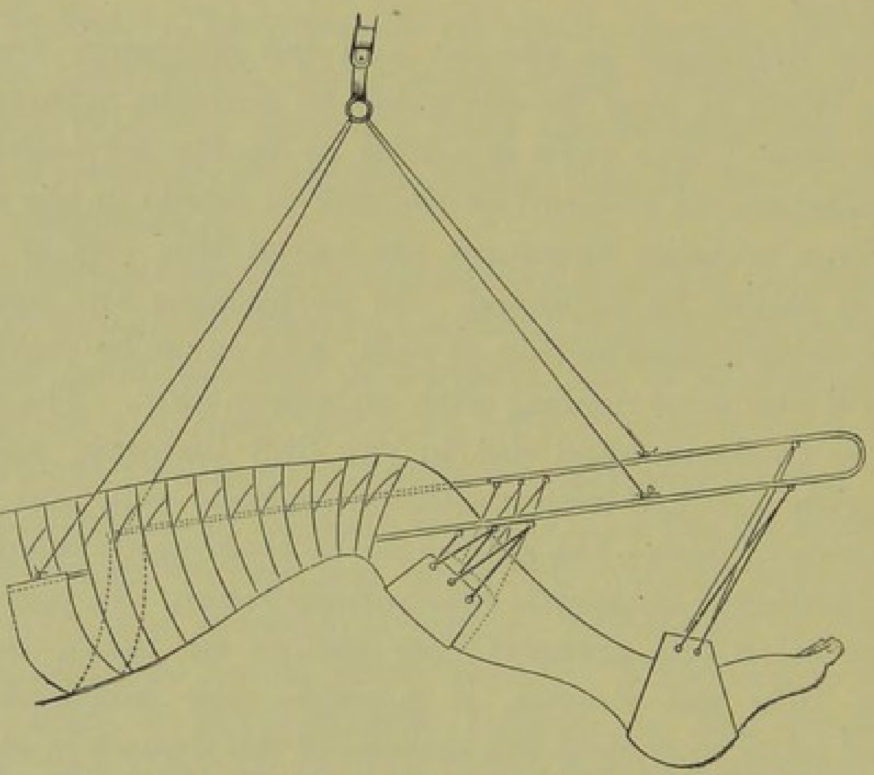


FIG. 95.—Arrangement for straightening a bent knee. (After BRADFORD and LOVETT.)

seldom possible, either by extension or by force, to get the leg into proper position. It is a serious matter for the development of the limb that it should not be used, while on the other hand, to cut off portions of the bone, so as to allow the ends to come into good apposition is still more serious. Where the fibrous union is not very firm the extension kept up by Hoefftcke's apparatus will often improve the position greatly. A very good wire splint is described by Bradford and Lovett, which will be sufficiently explained by the accompanying figure, taken from their book (see Fig. 95). There also will be found mentioned more elaborate forms of apparatus for straightening the joint, and at the same time preventing dislocation backwards of the tibia.

In some of these cases one can get the leg straight by performing a systematic arthrectomy, dissecting away all the synovial membrane and new fibrous tissue, and especially removing the capsule posteriorly, in the systematic manner previously described ; if necessary, the hamstrings may be divided, but after the posterior capsule has been removed the limb can generally be got straight without this. Where this is impossible, or where the anchylosis is bony, I believe it is better, on the whole, to leave matters alone till the patient is sixteen or seventeen years of age, i. e. till he is approaching his full growth, and then remove a wedge of bone or perform a typical excision. If this plan is adopted, it is well to apply an apparatus which will prevent the flexion from increasing, and possibly straighten the limb somewhat. The apparatus must take a firm and extensive grasp of both the thigh and the leg, and be connected at each side of the knee by strong bars with rack and pinion joints, which can be altered from time to time, so as to cause extension.

In the case of adults there is no objection (except where there are sinuses or some other grave constitutional condition) to bringing the limb straight at once by operation, either by a typical excision or, if the disease has quite recovered, by removing a wedge of bone of suitable size and shape.

Treatment of Cases where the Disease has commenced primarily in the Bone

1. *In the early stage, before the joint has become affected, or the deposit reached the surface.* It is very seldom that one gets a case before the deposit has reached the surface, but sometimes patients come complaining of uneasiness and stiffness about the joint, with enlargement of some part of the bone. A skiagram may show the presence of the deposit. In cases where there is reason to suspect a tuberculous deposit (tuberculous disease elsewhere, pain not a marked symptom, absence of much aching at night, the appearance

of skiagrams, &c.) the best plan is to cut down on the thickened bone without delay, avoiding opening the joint, chisel away a portion of the outer shell of the bone, and scoop out some of the cancellous tissue. If cheesy material or a sequestrum is found, this must be thoroughly removed, the cavity filled with iodoform and glycerine, and the skin wound stitched up, space being left at one end between the stitches for the escape of discharge. Should the wound not heal, and evidently become tuberculous, it should be opened up again, scraped out, and stuffed with iodoformed gauze. Of course, in the case of children, special care would be taken to avoid injury to the epiphysial line as far as possible.

2. *In cases where the deposit has reached the surface outside the joint and led to the formation of an abscess in the soft parts* the abscess should be dissected out, or if too large, laid open freely and the wall clipped and scraped away. The bone deposit should then be cleared out and the wound treated as in the former case.

3. *Where the deposit has reached the surface at the point of reflexion of the synovial membrane, and infected that membrane.* Where the thickening of the synovial membrane is limited to the neighbourhood of the deposit, then I think early removal of the whole affected area of synovial membrane, along with the bone deposit, is indicated. This, if done early, thoroughly, and aseptically, may ultimately leave the patient with a good knee-joint.

Where the whole membrane has become affected one may, for a time, persevere with expectant measures, but if suppuration occurs, or the disease continues to progress, operation will be necessary, and the usual operations will be complete arthrectomy in children, the bone deposit being thoroughly cleared out as well, and excision in adults. Of course in bad cases, where the bone disease is extensive or multiple, and abscesses are present, amputation may be necessary, but this will depend on the individual case, and the decision must be made on the lines already laid down.

4. *Where the deposit has opened into the cavity of the joint and infected the whole interior.* In this case the symptoms

are more acute, and generally accompanied by pyarthrosis, and this condition is most intractable. In the early stage, especially in children, one may wash out the joint and inject iodoform emulsion and, if necessary, employ extension. In these cases, however, unless it is a small, superficial, soft deposit, the chances of cure by these means are not good, and once it becomes evident that the bone deposit is larger, and especially that it is of the nature of a sequestrum, it is only losing time and running unnecessary risk to delay operation. This operation would be arthrectomy in children, great care and patience being devoted to picking out all the bone deposit, and complete excision in adults, subject of course, to the possibility that other circumstances might necessitate amputation in either case.

Disease of the Tibio-Fibular Joint

This condition is very rare and I have only met with one case. The accompanying photo from a complete section of

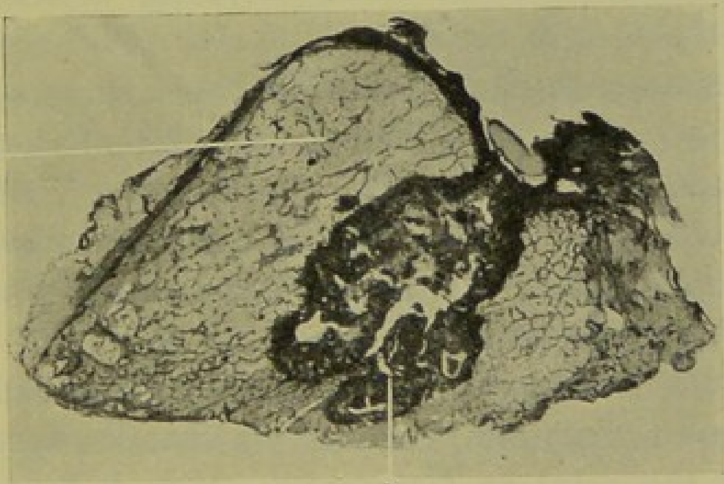


Fig. 96.—Section of the head of the fibula (*a*) showing the tibio-fibular joint (*b*) filled with a tuberculous mass which is completely destroying it.

the joint shows the condition. The symptoms are swelling in that region, pain on pressing the head of the fibula against the tibia and also on walking, and possibly the presence of abscess.

As regards treatment the simplest and quickest plan will be to excise the joint without, if possible, taking away the whole head of the fibula.

CHAPTER XVIII

DISEASE OF THE ANKLE, TARSUS, AND METATARSUS

Pathology.

In adults the ankle and tarsus combined come fourth in the list of frequency of tuberculous bone disease, forming from 10 to 14 per cent of the total number. If the ankle and tarsus are separated in my list, disease of the tarsus occurs more frequently than that of the ankle in the proportion of 40 to 23. In childhood, disease of the tarsus and ankle is not so common in relation to the other joints as it is in adults, and it is more evenly distributed over the first three decades than those formerly mentioned. We may, therefore, look on disease of the ankle and tarsus as mainly a disease of adolescence (10–30 years of age).

As to the parts of the foot usually affected, the disease most commonly occurs in those parts which transmit the weight of the body to the ground, viz. the ankle-joint, the os calcis, the head of the astragalus, and the proximal end of the first metatarsal bone.

In the case of the ankle-joint, primary synovial disease is by no means uncommon, but the statements vary considerably as to the relative frequency. Münch found that, in 28 cases of disease of the ankle-joint alone, the disease was primarily synovial in 23, affected the tibia in the first instance in 1, and the astragalus in 4. Erasmus, on the other hand, found that, in 11 cases of disease of the ankle-joint, 2 were purely synovial, in 6 there was both synovial disease and caseous deposits in the bone (tibia alone in 2, astragalus alone in 2, astragalus and scaphoid in 1, and more extensive in 1), and in 3 sequestra were present. My own opinion is that primary synovial disease occurs more often in the ankle than primary osseous disease, and that, of the various bones, the disease occurs most frequently in the astragalus, and next in the inner and upper part of the malleoli, especially the internal.

In the case of the tarsus, except in young children, the disease commences most often in the bone, but as regards the frequency with which the various tarsal bones are the primary seat of deposits, statements differ very much, and it is by no means easy, in an advanced case, to say where the disease commenced, as several bones generally show destructive changes. Czerny found, in 52 cases, that the astragalus was affected 15 times, the os calcis 13 times, the cuboid 16 times, and the scaphoid and cuneiforms 8 times; but, as before stated, more than one bone was usually affected, and it was not always certain in which the disease commenced, or whether more than one bone may not have been attacked at the same time.

The following are some other statements :—Münch found, in 53 cases, that the astragalus was affected in 2 instances, the os calcis in 19, the scaphoid in 5, the cuboid in 3, the cuneiform in 2, the end of the first metatarsal bone in 12, and other metatarsal bones in 10. In 10 cases Dumont found 3 of primary disease of the astragalus, 4 of the os calcis, 1 of the scaphoid, and 2 of the cuboid.

Of the various bones, the os calcis is undoubtedly most frequently attacked, and then the base of the first metatarsal; probably the cuboid comes next, then the astragalus, and the scaphoid and cuneiforms last. In the os calcis, soft caseous deposits are more frequent than sequestra; they usually occur towards the posterior part of the bone, but, as a rule, though not invariably, the projection of the heel escapes.

Another point which is worth attending to is the fact that in the tarsus, almost more than elsewhere, bones which are not actually affected with the tuberculous disease become much softer, in fact, are very apt to become affected with rarefying osteitis, but this condition usually recovers when the diseased tissues are removed.

The results of tuberculous disease in the tarsus and ankle are the same as elsewhere, allowing for the difference of locality, &c., and need not be gone into minutely here.

Disease of the Ankle

I have already, in the case of the hip and knee-joint, gone very fully into the symptoms and course of the disease in relation to the pathological changes in a deeply seated and a superficial joint respectively, and it would only be un-

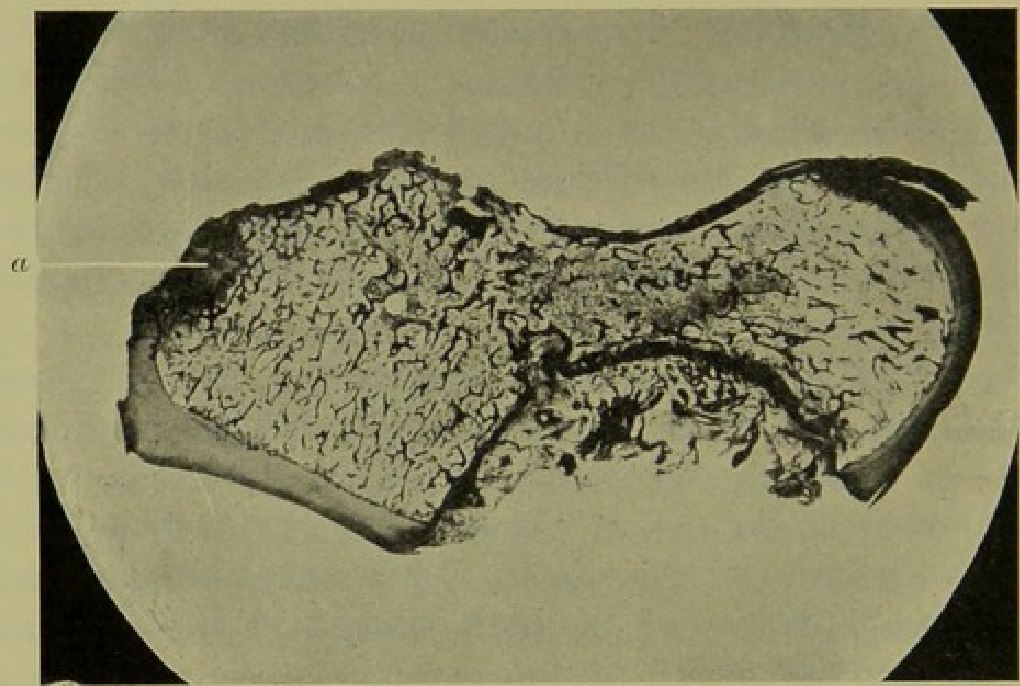


Fig. 97.—Astragalus from a case of disease of the ankle-joint, showing at (*a*) a tuberculous deposit which has burst into the joint at the posterior part and set up the disease.

necessary repetition were I to follow the same lines in the ankle. I propose, therefore, merely to indicate the chief characteristic points.

The synovial thickening is most evident in front of the joint, and more especially in front of the external malleolus, where the synovial membrane is not so much bound down by tendons as on the inner side. The extensor tendons are also projected forward, and the swelling extends downwards for quite an inch on the front of the foot. Behind the ankle also, on each side of the tendo achilles, fullness can usually be made out. There may also be fullness below the malleoli when the disease is advanced, and the lateral ligaments softened and bulged out by the thickened membrane; but in the early stage, before the lateral ligaments are softened, there is no or only a very slight fullness below the malleoli. The character of the synovial thickening and the course of events is similar to what has been already described in the knee.

Where the disease commences in the bone, there is marked thickening of the part, especially noticeable when one or other malleolus is affected; and where the synovial membrane is

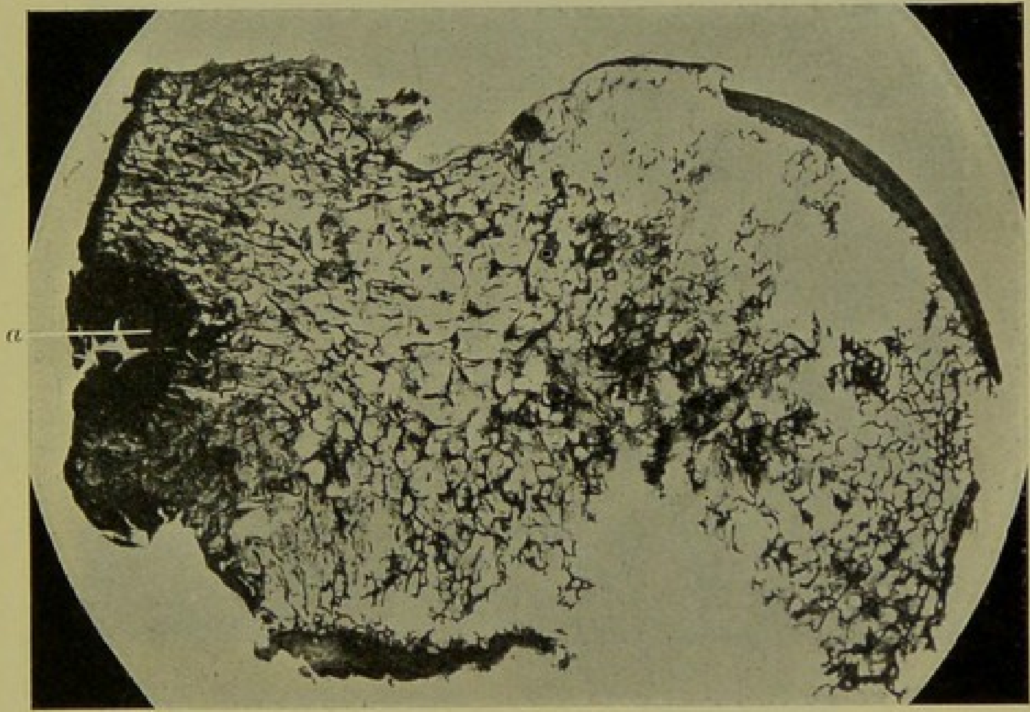


Fig. 98.—Astragalus from a case of disease of the astragalo-scaphoid articulation, showing at (*a*) a tuberculous deposit in the head of the bone which has set up the disease.

not at the same time thickened, the appearance at first sight is as if the foot had been displaced to one side, presenting in cases where the internal malleolus is involved an appearance not unlike a Dupuytren's fracture. The primary deposits in the astragalus are not so easy to diagnose; the thickening of the astragalus is obscured by the synovial swelling, and, besides, as a rule, the deposits in the astragalus are small, and situated immediately beneath the cartilage, and do not give rise to much swelling of the bone (see Figs. 97 and 98). In some cases, however, one can make the diagnosis by the pain and rigidity and marked localized thickening of the synovial membrane at the part where the deposit has reached the surface, usually in front of one of the malleoli, and of course an X-ray photograph will often show it.

Where no retentive apparatus is employed, the chief deformity which occurs is pointing of the toes (see Fig. 99). A condition of inversion or eversion, especially the latter, is also sometimes produced where the lateral ligaments have

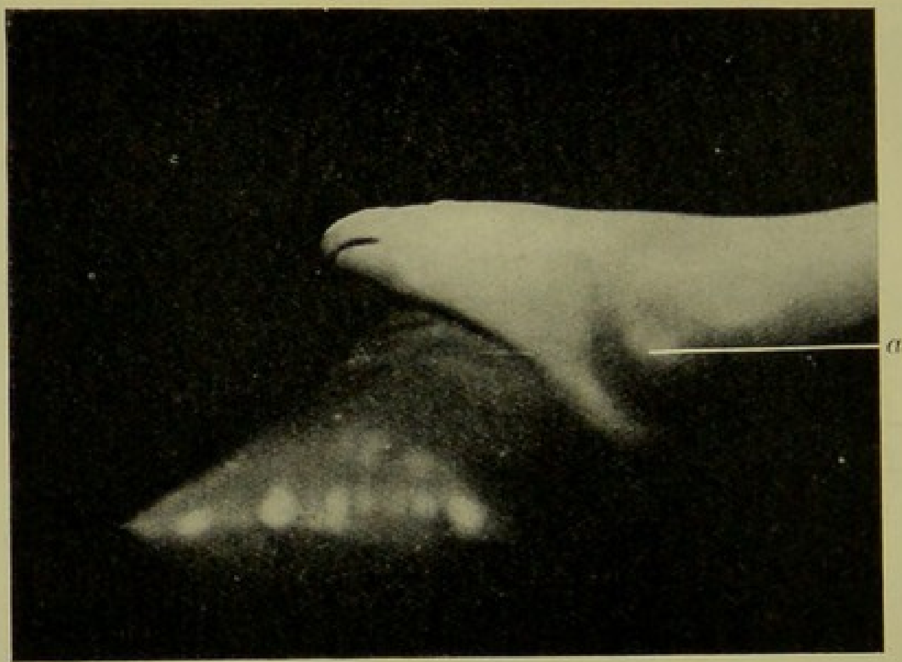


Fig. 99.—Disease of the ankle-joint, showing especially at *a* tuberculous tenosynovitis of the sheath of the peroneal tendons.

become softened, permitting lateral mobility, or where one or other malleolus has become much thickened, pushing the foot to the opposite side.

The pain depends, of course, on the degree of inflammation of the bone, and, when there is much caries, it is very marked when the foot is allowed to hang down or is moved or pushed up.

If we see a case of synovial disease of the ankle-joint in the early stage, we find fullness under the extensor tendons and on each side in front of the malleoli, especially the external; there is also swelling behind the ankle; there is a tendency to pointing of the toes, but the movements of the joint are fair, and pain is not a prominent symptom. In the early stage of bone disease, we have enlargement of one or other malleolus without thickening of the synovial membrane: or a more or less localized thickening with pain on movement of the joint, and tenderness on pressure (where the deposit is in the astragalus): or a more acute affection of the joint with great pain on movement and rigidity, but without marked synovial thickening in the first instance; fluid (serous or purulent) may also be present in the joint at an early period.

Fig. 100.—Photograph of an advanced case of disease of the ankle-joint, showing the spindle-shaped swelling.

In the later stages of joint disease, in whichever way originating, the whole region of the joint is swollen and spindle-shaped (see Figs. 100 and 101), the toe is pointed, the muscles of the calf are much atrophied, there is great pain on hanging down the foot, and on any movement or pressure; and abscesses or sinuses are very generally present, usually on the antero-lateral aspects of the joint (see Fig. 101). It is not uncommon also at this stage for the extensor tendon sheaths to become affected, and then we have a tuberculous tenosynovitis.

Where recovery takes place, unless at an early stage, there is usually fibrous or bony anchylosis in the extended position. In some cases where the disease has occurred in children, and has been in the form of a deposit in one or other malleolus, the epiphysial line becomes destroyed, and as growth goes on that bone lags behind, and consequently the foot becomes

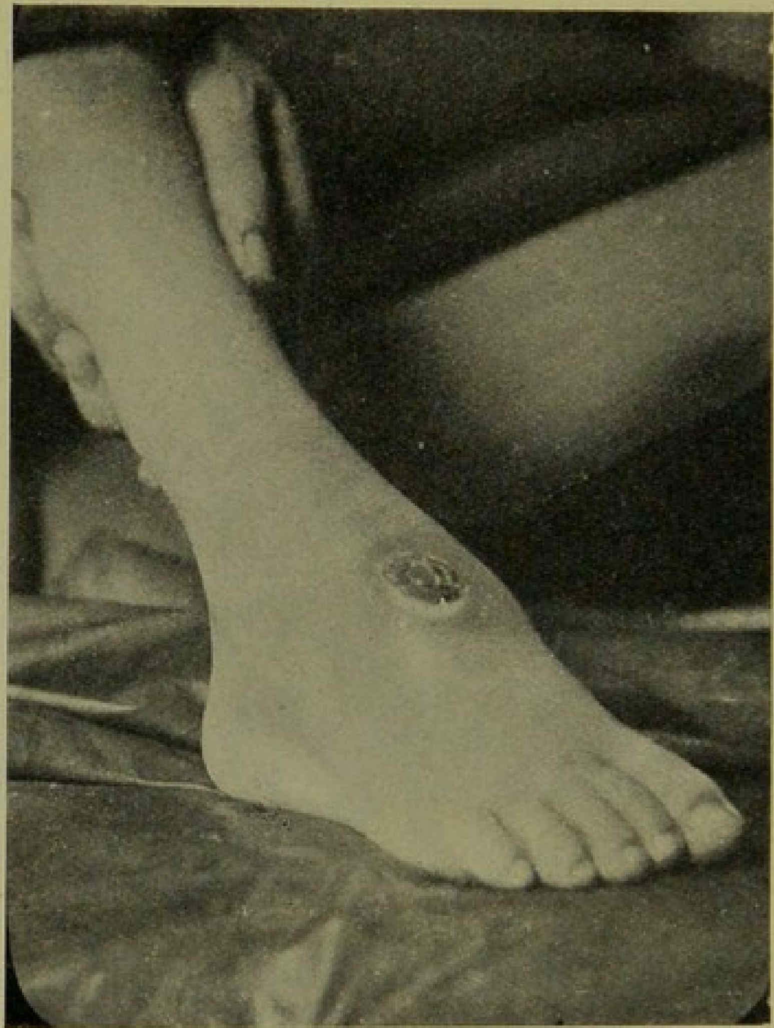


Fig. 101.—Disease of the ankle-joint with sinus.

pushed over to the inner or outer side by the other bone in which the growth is more or less normal.

Disease of the Tarsus

Os calcis. As I have already said, the os calcis is probably the tarsal bone most frequently affected, and it is also the most favourably situated in that the disease very often remains limited to it, or to its immediate joints, especially the astragalo-calcanean, and does not spread to the tarsus generally. The part of the bone most commonly affected is the substance of the bone in the neighbourhood of (in front of) the posterior epiphysial line, but the posterior epiphysis to which the tendo achilles is attached usually escapes (see Fig. 102). It may, however, begin near the astragalo-calcanean joint, and open into it or under the periosteum,

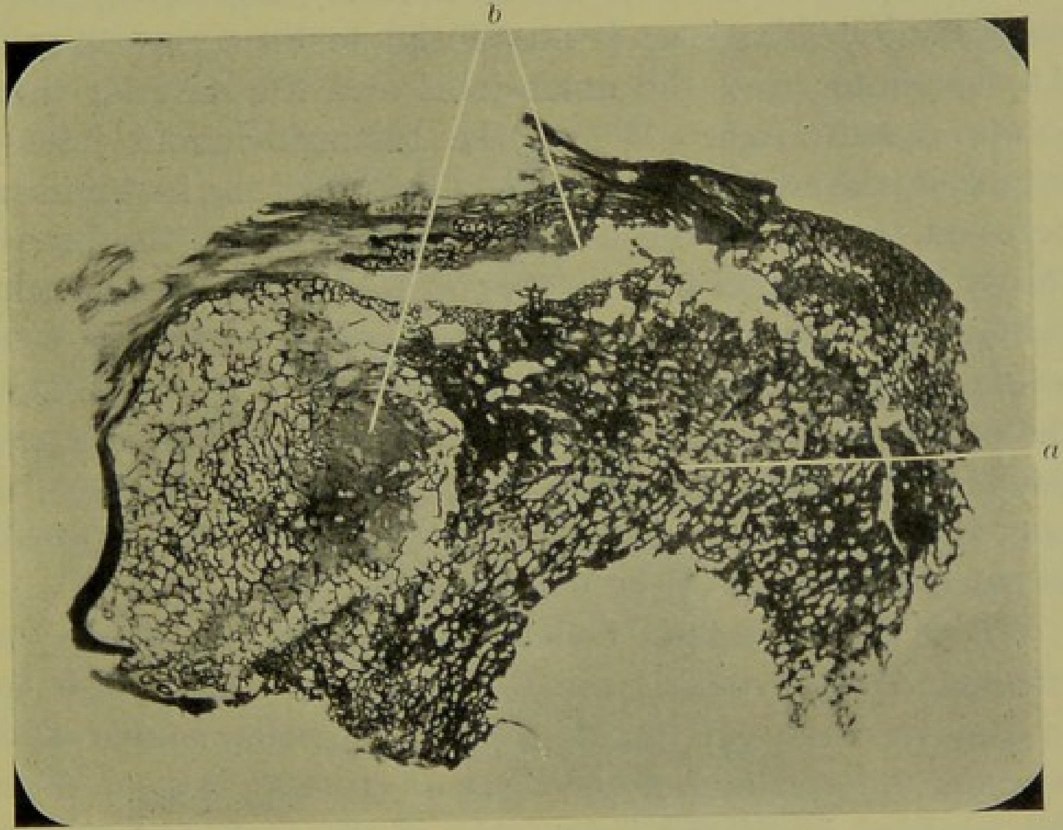


FIG. 102.—Section of the os calcis, showing the greater part of the posterior and lower part of the bone converted into a tuberculous sequestrum (*a*). At (*b*) we have the line of separation, and there it can be seen that the separation is as yet imperfect. The sclerosis of the trabeculæ in the sequestrum is well seen at places.

giving rise, in the latter case, to a tuberculous periostitis, with abscess and caries of the surface of the bone. It is rare for the disease to begin in connexion with the calcaneo-cuboid joint. The disease is comparatively easily diagnosed by the position of the swelling. Where the substance of the bone is affected, the whole bone is swollen, and there is some aching pain in it, though not usually of the severe and constant nature characteristic of abscess in the bone. By and by the deposit reaches the surface somewhere, and an abscess forms over it, and the subsequent sinus leads into the interior of the bone. Where the disease begins in connexion with the periosteum, there is only a localized thickening, over which an abscess forms, and here the probe simply leads to the carious surface of the bone. Where the astragalo-calcanean joint is involved, there is swelling at the level of that joint and of the adjacent bone to a greater or less degree according to the depth of the deposit, with pain on grasping the os calcis, and pushing it up or attempting to displace it laterally. At the same time, the ankle-joint and the anterior tarsal joints remain free. Where the calcaneo-cuboid joint is attacked, the swelling is on the outer side of the foot midway between the tip of the external malleolus and the base of the fifth metatarsal bone, with thickening over the os calcis behind, and there is pain on moving the transverse tarsal joints, and absence of swelling elsewhere. In cases where the midtarsal joints, as a whole, are involved, there is a great tendency to abduction of the anterior part of the foot, the arch is lost, and there is marked enlargement, and especially increase in breadth of the middle of the foot.

Where the midtarsal bones, *scaphoid* or *cuneiforms*, are affected or the synovial membrane between them, it is not so easy to make out the chief and originating source of the mischief unless one sees the cases at an early stage. Where the swelling is on the inner side of the foot, and extends from in front of the ankle to the metatarsus, then the scaphoid is probably the bone primarily at fault ; absence of swelling about the ankle-joint shows that that part is not affected ; the absence of swelling on the outer side of the foot shows that the cuboid and the calcaneo-cuboid joints are unaffected ; while the presence of swelling, both in the astragalo-scaphoid joint and in the region of the cuneiform bones, makes it extremely probable that there has been disease in the substance of the scaphoid, which has infected the joints on each side of it.

Where the head of the astragalus is the primary seat of disease, the swelling is limited to the astragalo-scaphoid joint in the first instance. Where one or other cuneiform, or the synovial membrane in relation with them is affected, the swelling is on the distal side of the scaphoid. Where the disease has commenced in the proximal end of the first metatarsal bone, that part is the seat of thickening which soon tends to spread to the region of the cuneiform bones.

It is not always easy to say without a skiagram whether the disease is primarily osseous or primarily synovial, because the bones are small, and the synovial membrane generally early affected. Where the synovial membrane is

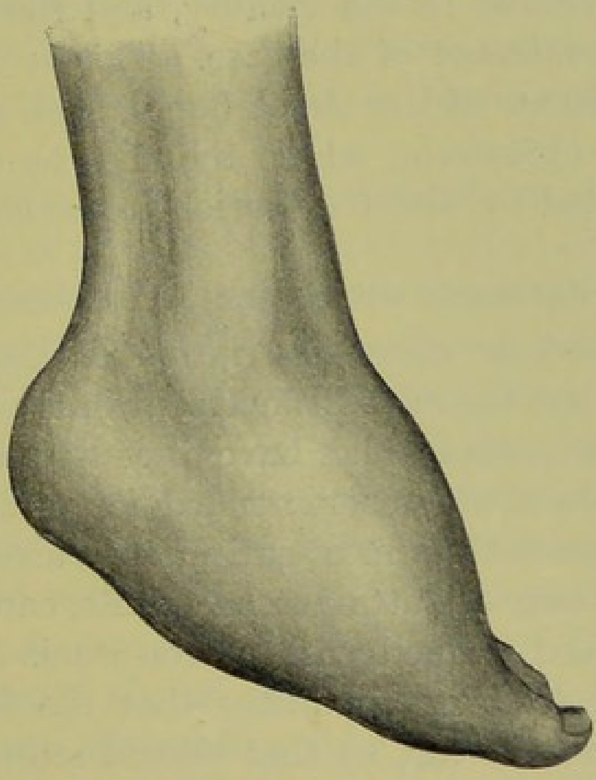


FIG. 103.—Disease of the midtarsal joints.

affected primarily the swelling is usually more diffuse in the first instance, and pain is not a marked symptom.

So far, I have described the disease as it begins when limited to one part of the tarsus, and it is most important from the point of view of treatment, to look for and recognize the early manifestations of the disease. As a rule the commencement is as I have described, but in a certain number of cases the disease begins in the form of a diffuse osteomyelitis, affecting apparently several of the bones, and this is a very grave form. I believe that it most often follows sprains or other injuries to the foot, and its seriousness depends both on the extent of the bone lesion, and on the great tendency to secondary disease elsewhere. As a matter of fact phthisis follows or accompanies disease of the ankle and tarsus more frequently than disease of any other part, with the exception of the wrist, and it is not improbable that it is this diffuse infection of medullary tissue which has to do with the spread of the disease.

One other point is of importance in connexion with disease of the tarsus and ankle, viz.—that the disease is apt to attack the tendon sheaths in the vicinity, and thus gravely complicate the treatment of the case. This is more especially the case in disease of the tarsal bones, such as the scaphoid and internal cuneiform, where the sheaths of the tendons become infected by direct extension from the periosteum.

Treatment of Ankle-Joint Disease

A comparatively short description of the treatment of disease of the ankle-joint will suffice, after the full discussions on the various points which have already been given.

Various splints are recommended for giving rest to the joint, but I believe the most satisfactory arrangement is by lateral poroplastic or gutta-percha splints, carefully moulded to the part and padded with cotton-wool. Care must be taken in any form of apparatus that the foot is kept at right angles to the leg, so that should stiffness occur, the sole can be placed flat on the ground. A paper pattern of the foot and leg are taken, and the poroplastic splints are cut out to match; they should not quite meet. At the anterior angle corresponding to the front of the ankle, a small additional angular piece must be cut out, so as to allow proper moulding, and if it is necessary to soften any part to avoid pressure, this can be done by chloroform or benzole. The splint should extend as high as the tuberosity of the tibia, and as far as the toes, and should get a good grasp on the heel and sole of the foot. The poroplastic material is softened before application either by dry heat (before a fire) or by steam (in a bacteriological sterilizing apparatus) not by hot water. A layer of wool is applied around the leg, and the splints rapidly moulded and bandaged on, one at a time, and re-softened by heat where necessary ; subsequently any points of pressure on bony prominences can be softened by chloroform, but this is seldom required if the parts are properly padded. Bier's treatment may also be combined with this if thought desirable.

Thomas recommends a flat iron stem moulded to the back of the leg and the sole of the foot, with three sheet-iron wings, one broad one at the calf, one grasping the heel, and one grasping the metatarsus, and if the patient is to be allowed to walk about, a Thomas's walking knee-splint and crutches. I do not think this is so good as the arrangement just referred to.

Where the disease is fairly quiescent the use of immovable apparatus, such as plaster of Paris, or, better, silicate, is good. Where silicate is used one may sometimes employ pressure on Saxtorph's plan with benefit. The affected part is enveloped in a very large mass of cotton-wool or silk waste (the latter is the more elastic), and the boracic lint bandage which extends as far as the silicate is put firmly over this. The silicate bandages are then applied as tightly as possible over the cotton-wool area ; if a sufficient amount of wool has been used this pressure will not be excessive. These bandages are renewed every six or eight weeks, but if they cause much aching and discomfort they should be discontinued at once. Rest, tuberculine, country air, &c., must also be employed if possible.

Arrangements have also been introduced with the view of employing extension in ankle-joint disease. They consist essentially in sandals fastened to the foot and heel, and attached to pulley and weight ; but they are inefficient, and where the symptoms are such as to demand extension, operation, which is free from danger and satisfactory, is preferable.

The cases suitable for operation are similar to those described in the case of the knee-joint, viz.—distinctly localized deposits, advancing synovial or bone disease, and cases where suppuration is present.

Practically the only localized deposits which come under observation are those in the malleoli, which have made their way outwards instead of into the joint. By some these are considered under a separate heading, as disease of the malleoli; but, as a matter of fact, they really belong to the ankle-joint, it being merely an accident of position of the deposit that it has spread outwards instead of into the joint. Where one has made the diagnosis, from the thickening of the malleolus and the absence of acute signs and of involvement of the joint, and a skiagram, that there is a deposit in the bone, the proper treatment is to cut down, remove the outer shell of the bone, and gouge out the diseased tissue, taking care not to go through into the joint. Where an abscess is also present, the matter is, of course, easier, because the hole in the bone guides one at once to the seat of the disease. In this case the abscess wall is taken away and the bone deposit cleared out. If a sinus has been previously present, it is excised, the bone deposit cleared out, and the cavity stuffed with iodoformed gauze and made to heal from the bottom.

Where the joint is affected with or without a deposit in the bone, and where the disease is rapidly progressing, the usual operation for childhood is arthrectomy. There are numerous ways of performing arthrectomy of the ankle-joint, but I think they may be reduced to two. In both, longitudinal incisions are made in front of each malleolus, and in the one the malleoli are divided at their bases, in the other the astragalus is removed. These methods are suitable in different cases, but I believe the latter is the more generally useful. The excision of the astragalus is best where there is a primary deposit in the bone, where the disease of the synovial membrane is extensive and rapidly breaking down, or where there is extensive caries of the surface of the astragalus. The division of the malleoli may be employed in the earlier stages of the disease, and especially in cases where there is no deposit in the astragalus, and where the cartilage is still intact, or only slightly destroyed. The chief objection to division of the malleoli is the risk of interference with the epiphysial lines, and this is a real risk. Against the excision of the astragalus is urged the bad effect of removal of one of the chief bones, subsequent shortening of the foot, and possible lateral deformity. I have now removed the astragalus on several occasions, and the results have been very satisfactory. The os calcis has been drawn up between the malleoli, and a movable joint has been obtained without any laxness, and I have as yet seen no sign of shortening of the foot, and in cases where it has been observed by others,

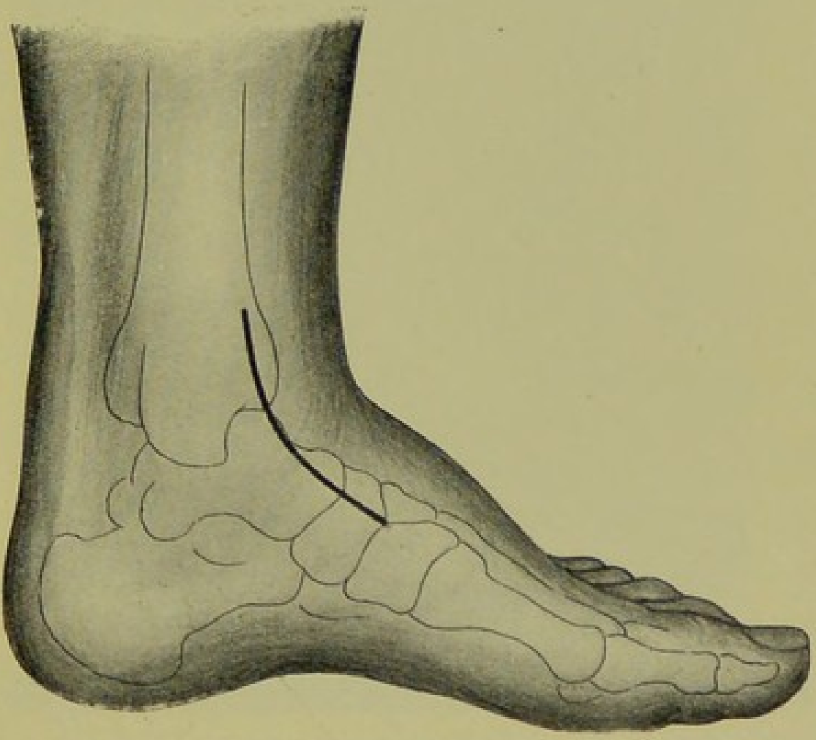


FIG. 104.—Internal incision for arthrectomy of the ankle.

it has not been great. In one or two cases I had to take considerable pains to guard against inversion of the foot, but that tendency passed off after some months.

The following are the steps of the operation where the bases of the malleoli are divided. The incisions commence from 1 to 2 inches above each malleolus, run downwards along their anterior borders to the bend of the ankle, and then forwards along the inner and outer borders of the foot respectively, as far as close to the midtarsal joint (see Figs. 104 and 105). The various structures in front of the ankle are then detached from the thickened synovial membrane and held forward, while all the thickened membrane in front of the joint is removed. The bases of the malleoli are then divided obliquely from above, downwards and inwards, the periosteum being left intact, and then, by pulling the foot forcibly downwards and rotating it first in one direction and then in the other, the lateral and posterior portions of the synovial capsule are clipped away. The bones are then carefully examined, and any deposits or suspicious spots removed; finally, the divided malleoli are brought into position, and secured by pegs or wire. It is difficult, in most cases, to

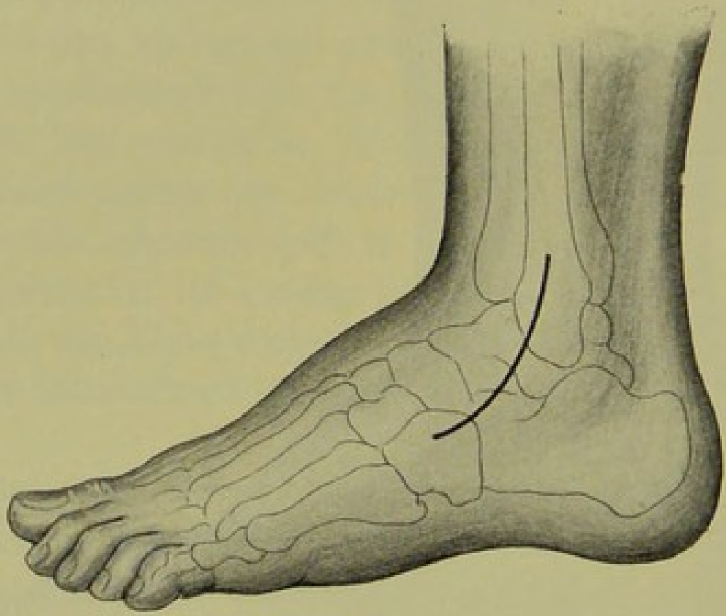


Fig. 105.—External incision for arthrectomy of the ankle.

clear the posterior part of the joint thoroughly by this method, but advantage may be gained by a vertical incision along the outer border of the tendo achilles into the posterior part of the joint. In the other plan the incisions are the same, but instead of cutting through the malleoli, the lateral ligaments are divided, and without any trouble, the astragalus can be removed entire, and the interior of the joint much more accurately dealt with. After the operation the wounds are stitched up and treated as before described, and it is well to employ a lateral splint, or, if the patient is walking about, irons fitted into the heel of the boot, to prevent eversion or inversion of the foot for some months, till, in fact, the parts have thoroughly consolidated.

While arthrectomy of the ankle-joint is an operation especially of childhood, it succeeds very well also with adults, especially when combined with removal of the astragalus. I believe that on the whole the results are better in adults than those of excision which, though formerly much practised, did not yield particularly good results in cases of tuberculous disease. Where excision is performed without removal of the astragalus, the incisions and procedure are

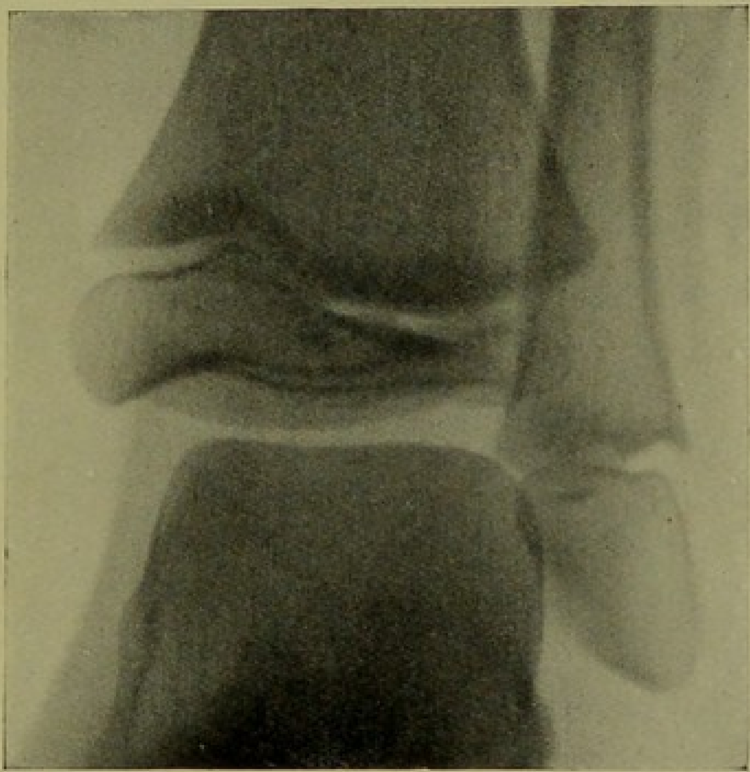


FIG. 106. Skiagram showing ossification at the ankle-joint at the age of 9.

practically the same as in the first of the operations of arthrectomy. After the joint has been exposed by division of the malleoli, and as much of the synovial membrane as possible removed, a layer of the surface of the bones is chipped away by a chisel and hammer, leaving the arched shape of the lower end of the bones of the leg, the remains of the malleoli being subsequently wired to the tibia and fibula. The tibio fibular articulation is also chipped out. By retaining the shape of the ankle-joint, there is less tendency to lateral displacement should a movable joint be obtained, and the retention of the external malleolus is of especial importance. Excision of the ankle, as formerly performed, that is, without thorough removal of the affected synovial membrane, was not at all a successful operation in tuberculous disease, and most surgeons preferred amputation where operation was necessary.

Where amputation becomes necessary on account of the extent of the disease, the destruction of bone, involvement

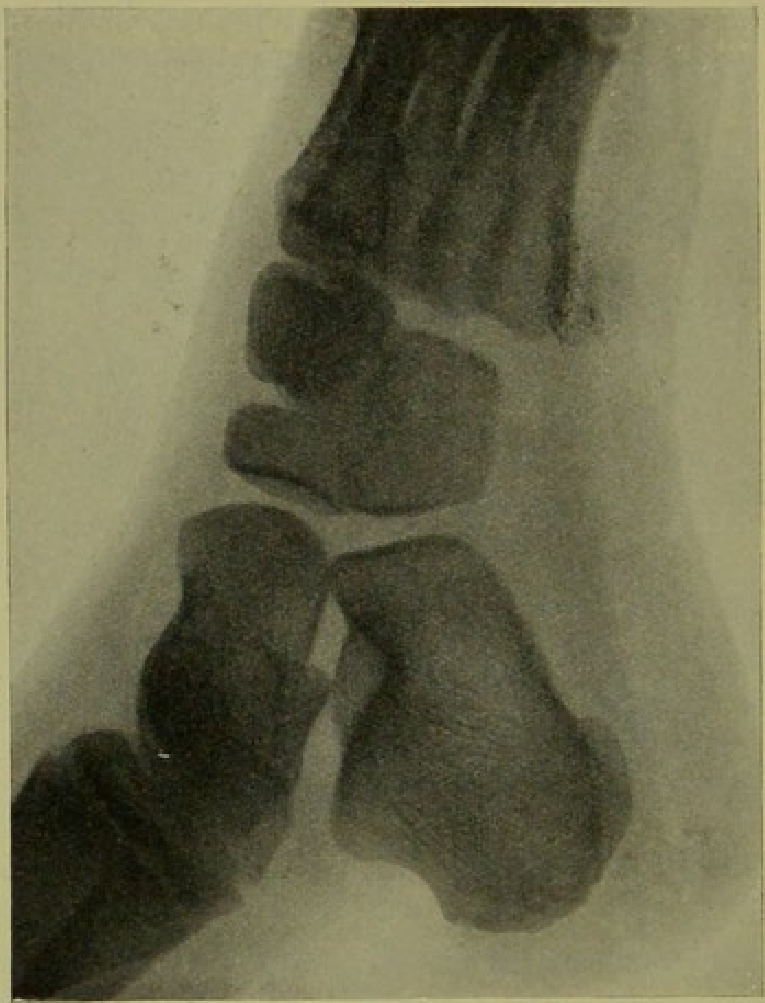


FIG. 107. Skiagram showing ossification of ankle and tarsus at the age of 9.

of tendon sheaths, presence of phthisis, &c., the choice usually lies between Syme's or other amputation at the ankle-joint and amputation through the leg. Formerly, Syme's amputation was performed in all cases, and the result was that not unfrequently sinuses remained, and further portions had to be removed from the bones of the leg. This was no doubt due to the fact that the diseased synovial membrane was usually cut into the portions left behind, and also to the employment of the operation in unsuitable cases. Where Syme's operation is performed, great care must be taken that all the diseased tissues, both synovial membrane and bone, are completely removed. Where the disease of the bones of the leg is extensive, where the tendon sheaths are affected, where there are large abscesses around the joint, where, in fact, Syme's amputation cannot be performed without leaving behind diseased tissues, the best procedure is to amputate through the leg above the diseased parts.

Treatment of Disease of the Tarsus

I need not dilate on the treatment where rest is resolved upon. I believe that either lateral splints or a mass of wool and silicate bandage extending up to the knee are the best, the leg not being allowed to hang down. I must, however, go more fully into the question of operative treatment, and operation comes earlier and more prominently into notice than in the joints previously referred to, and that for several reasons. On the one hand, disease of the tarsus is a more unfavourable form, both locally and generally if left to itself, than that of the joints previously considered, on account of the complexity of the articulations, of the frequent and diffuse bone lesions, and of the tendency to lung mischief. On the other hand, the disease is frequently localized to one part or bone of the tarsus in the first instance, and if this is removed before neighbouring structures have become infected, a complete cure of the disease will often be obtained with an excellent functional result. Hence, it is of great importance to bear in mind what can be done by early operation, to recognize the disease soon, and not to let the favourable moment slip past. I may indicate some of the points in the operative treatment of the following conditions, viz. disease of the os calcis; of the proximal end of the first or other metatarsal bone; of the internal cuneiform; of the cuboid; of the astragalo-scaphoid articulation;

of the scaphoid and the joints in front and behind ; of the whole tarsus ; of the tarsus and ankle.

(*a*) *Disease limited to the os calcis.* In the early stage, where the disease is confined to the interior of the bone, one may delay operation for some time, but when it has reached the surface of the bone and led to the formation of an abscess over it, the proper treatment in the first instance is to remove the abscess, enlarge the opening in the bone freely, scoop out the diseased tissue and stuff the cavity with

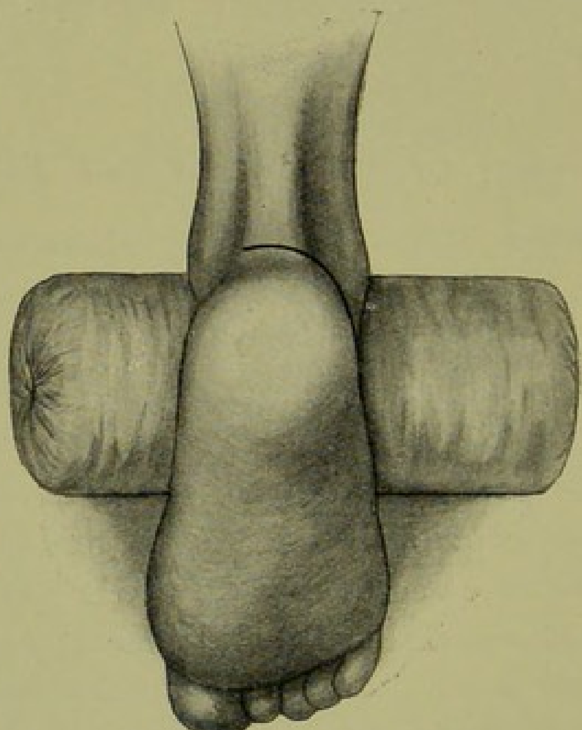


Fig. 108.—Incision for excision of the os calcis.

iodoformed gauze and make it heal from the bottom. The same is the treatment where a sinus is present. Excision of the entire bone (Figs. 108 and 109) becomes necessary where healing will not occur ; where the disease is extensive, several abscesses or sinuses being present ; or where it has spread to the neighbouring joints, either calcaneo-cuboid or -astragaloid. The incision commences on the inner side of the tendo achilles at the lower part and is carried outwards, and then along the outer side of the foot nearly to the base of the fifth metatarsal bone (see Fig. 108). The flap so marked out is turned forwards and inwards and the bone dissected out.

(*b*) *Disease of the proximal end of the metatarsal bones.* Where the disease occurs in the interior of the bone the best treatment is to remove the affected end of the bone before the neighbouring joints have become involved. This is readily done, in the case of the first metatarsal bone, by a longitudinal or curved incision a little to the inner side of the extensor tendon, turning aside the soft tissues, partially dividing the bone in front with a small saw, and

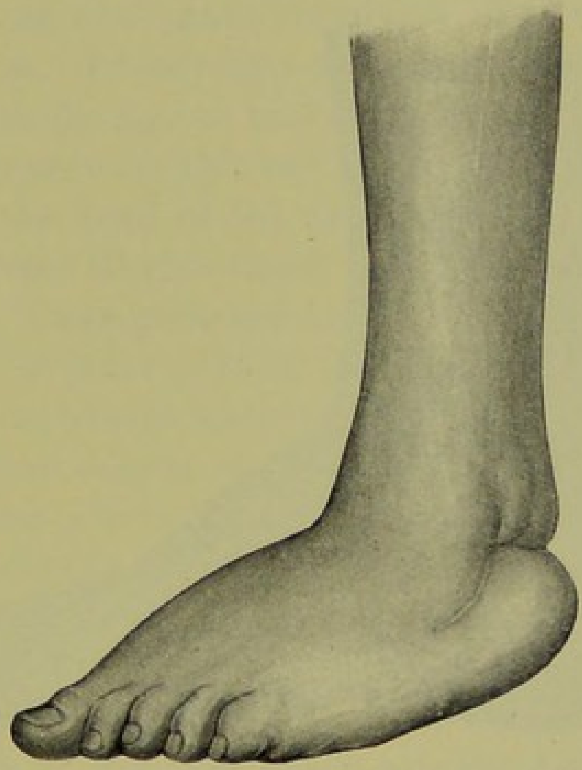


Fig. 109.—Result of excision of the os calcis.

completing the division with bone forceps, seizing the divided end of the bone with necrosis forceps, and cutting through the various ligaments holding it in position; one must make sure that the whole deposit is removed (see Fig. 110). The incision may then be stitched up and the patient is prohibited from walking on the foot for about three months after the operation, so as to give time for thorough consolidation of the parts to occur. This operation does not interfere with the function of the foot.

(*c*) *Disease of the internal or middle cuneiform bones or of neighbouring synovial membrane.* Where the disease is limited to these structures, I would strongly advise early removal of the internal cuneiform alone or of the internal and middle cuneiform, along with all the affected synovial membrane, the wound being stitched up if aseptic, or stuffed and made to heal from the bottom if sinuses are present. The parts are readily reached by a longitudinal incision over the inner side of the dorsum of the foot. The results of this operation are particularly excellent, and I have now several cases where I removed these bones some years ago, with complete

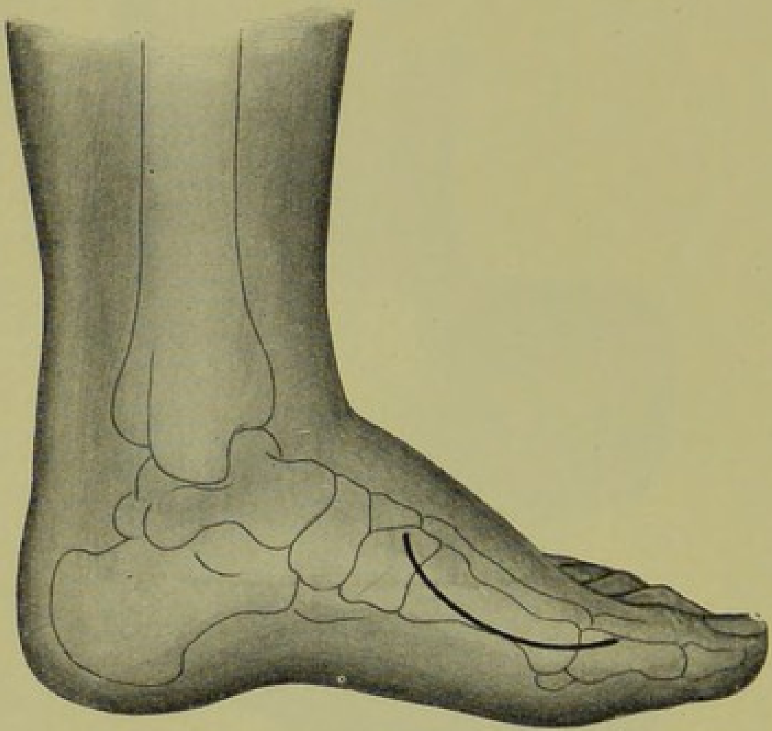


Fig. 110.—Incision for removal of the base or even the greater part of the first metatarsal bone.

success as regards arrest of the disease, and where at the present time one could not tell that anything had been taken away, or, beyond the presence of the cicatrix, that anything had ever been the matter with the foot.

(*d*) *Disease of the cuboid.* The treatment of disease limited to this bone is conducted on similar principles to that of disease of the os calcis, deposits being cleared out if they are limited to the interior of the bone, or the whole bone being removed if necessary.

(*e*) *Disease of the astragalo-scaphoid articulation.* Where disease is limited to this joint it has either begun in the synovial membrane or in the head of the astragalus, and removal of the synovial membrane and head of the astragalus generally suffices with the necessary attention to the articular surface of the scaphoid. The joint can be got at by an oblique incision along the inner border of the tendon of the tibialis anticus, and it is not as a rule necessary to divide that tendon.

(*f*) *Disease of the scaphoid and the joints in front and behind.* Here we come to the more diffuse disease, and much depends on the exact condition of parts how much requires removal. In any case the scaphoid must be taken away, and generally one or two cuneiforms. I have in two or three cases removed the two innermost cuneiforms, the scaphoid, and the head of the astragalus, and the hole has filled up with dense fibrous tissue and an excellent result has been obtained. These parts are easily got at by a longitudinal incision along the inner part of the dorsum of the foot, and the tendon of the tibialis anticus requires division.

(*g*) *More diffuse disease of the tarsus.* So far I have been speaking of cases where typical excisions can be done, and wherever it is possible to remove a definite structure by clean dissection it is infinitely preferable to scraping which is, I believe, the usual practice. Once one begins to scrape diseased bone one loses one's guides, and the result too often is that portions of diseased tissue are left behind, and too much healthy tissue is removed. Besides, as I have already pointed out, diseased synovial membrane cannot be satisfactorily removed by scraping. Hence, wherever it is possible the surgeon should make up his mind what structures are diseased, and then remove them by clean dissection. Where an attempt is to be made to save the foot and the mid-tarsus is involved, probably the best way of proceeding is by a transverse incision across the dorsum of the foot, dividing all the structures down to the bone, a longitudinal incision being made at each end of this along the inner and outer borders of the sole. These flaps are then turned upwards and downwards, the bases of the metatarsal bones below and the ends of the astragalus and os calcis above sawn across, and the block of bone comprising scaphoid, cuneiforms, cuboid, and ends of metatarsals, &c., removed. If no sinuses are present the tendons may be reunited, portions if necessary being cut away so as to shorten them, the wounds stitched up, a drainage tube being inserted, and the foot arranged so that the anterior part is drawn up against the posterior. Where sinuses are present the wound should be left open and stuffed with iodoformed gauze. The result is really very good, the

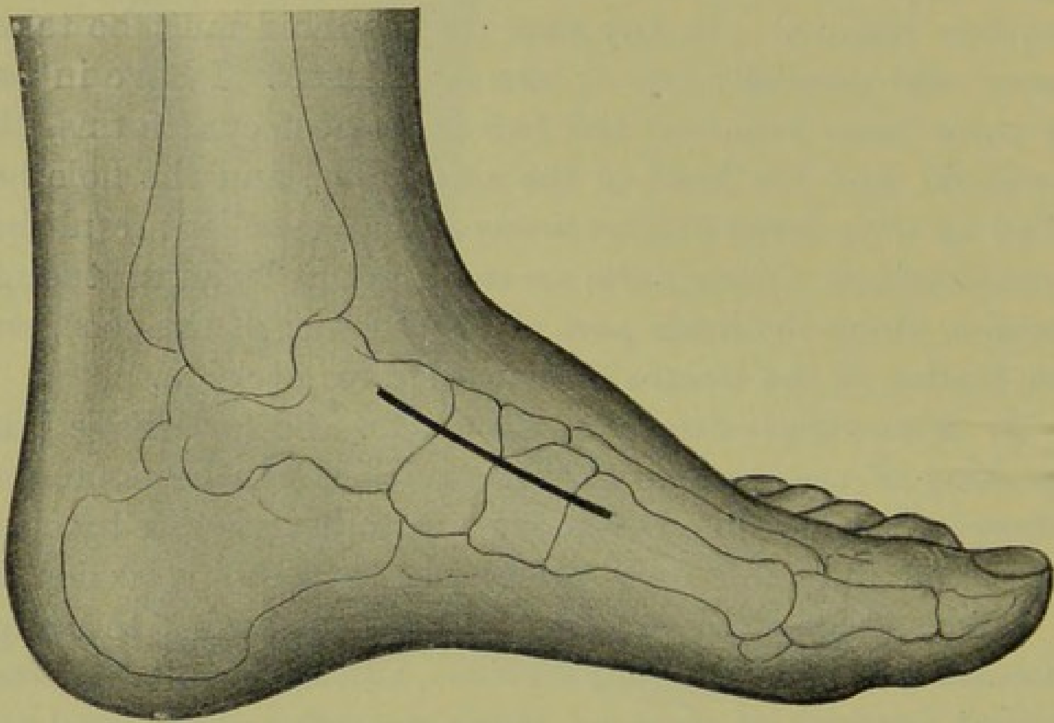


FIG. 111.—Internal incision for removal of the anterior tarsal bones.

anterior part of the foot gets drawn up and firmly united to the posterior, and the patient has a good firm support.

In some instances it may suffice to take out a smaller wedge of bone, but this must be decided in accordance with the local condition. The block of bone may also be removed by long lateral incisions, but the operation is more troublesome and it is very difficult to remove all the disease satisfactorily (see Figs. 111 and 112). On the other hand the foot left after the transverse incision across the dorsum is in reality a very good one, and the tendons can be shortened to the necessary extent before stitching them.

Where amputation is necessary the choice rests between a Syme and a Pirogoff, or some partial amputation of the foot such as sub-astragaloid amputation. I believe that in most cases the Syme's amputation will yield the best result, but the sub-astragaloid amputation is very satisfactory in suitable instances.

(*h*) *Disease of the tarsus and ankle.* Where the disease involves the posterior part of the tarsus and ankle-joint, and operation becomes necessary, our choice practically lies

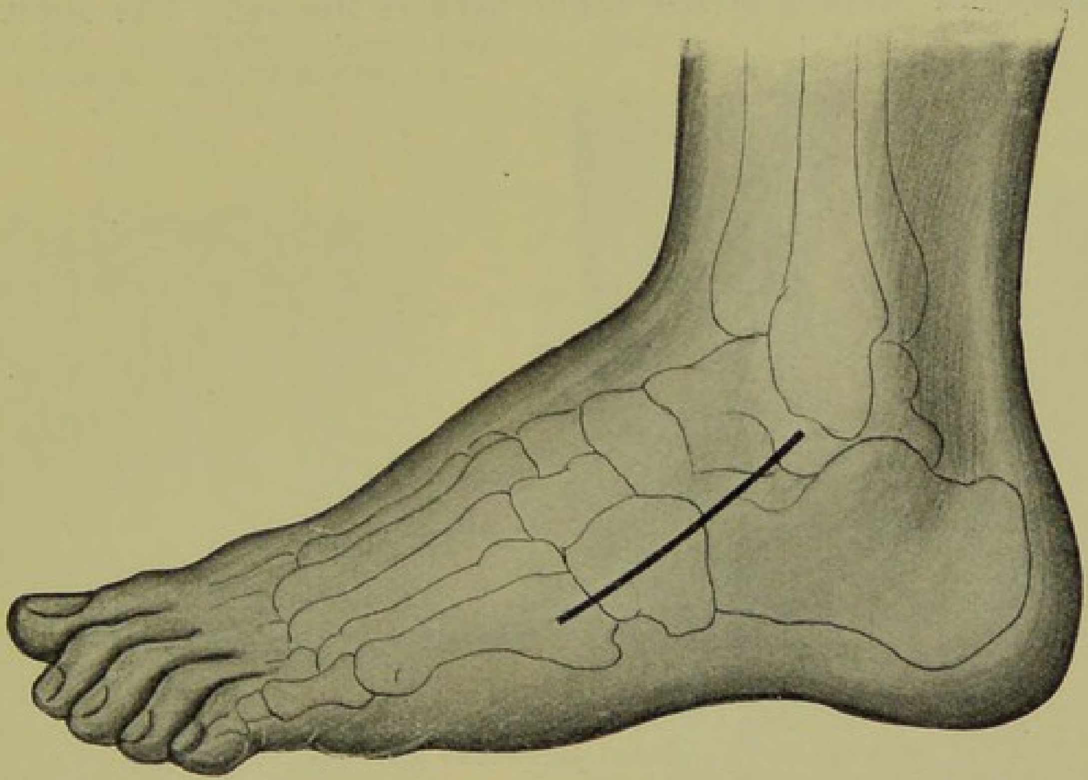


FIG. 112.—External incision for removing the external tarsal bones.

between amputation (Syme, or in the leg) and the operation known as the Mikulicz-Wladimiroff excision. This operation is only applicable to adults, because in it the epiphysial lines of the tibia and fibula are taken away. It consists in removing all the bone between the scaphoid and cuboid, which are sawn through, and the divided lower extremities of the tibia and fibula. The toes are previously bent forward at right angles to the metatarsal bones, the divided tarsal bones are brought into a line with and united to the bones of the leg, and the patient walks on the toes. The following is a more detailed description of the operation :—

Before the operation is commenced the toes are bent violently forward to a right angle with the foot. The patient being then placed on his face, an incision is made, commencing on the inner border of the foot, a little in front of the tubercle of the scaphoid, and is carried transversely across the sole to just behind the tuberosity of the fifth metatarsal bone, dividing all the structures. From the ends of this incision the knife is carried back on each side to the corresponding malleolus, and then transversely across the posterior surface of the lower part of the leg. The ankle-

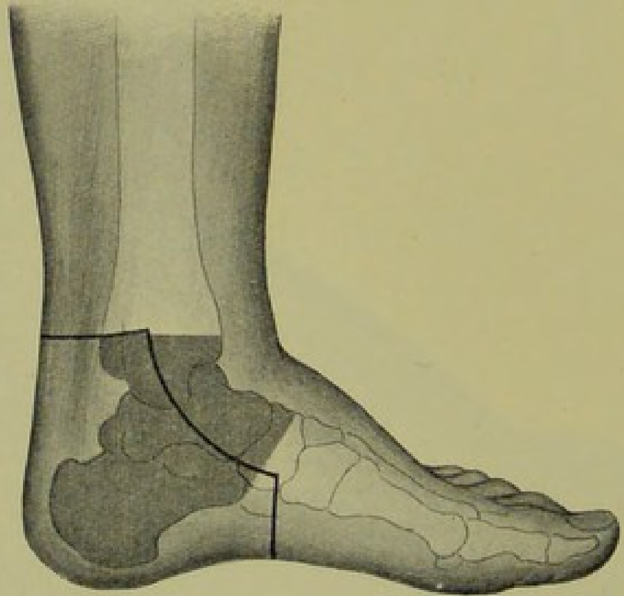


FIG. 113.—Showing the inner incision in the Mikulicz-Wladimiroff operation. The shaded part shows the bones removed.

joint is then opened from behind, and the foot being flexed, the astragalus and os calcis are carefully removed along with the soft parts. The joint surfaces of the tibia and fibula are then sawn off, as well as the joint surfaces of the scaphoid and cuboid. The front half of the foot is thus left connected to the leg by a broad bridge, composed of the skin of the dorsum of the foot, with the extensor tendons, and vessels. After having arrested the bleeding, the remains of the foot are placed in the line of the leg, and the cut surfaces of the tarsal bones are united by silver wire or metal plates to the cut surfaces of the bones of the leg. Care has to be taken by means of a back splint to prevent the foot passing backwards,

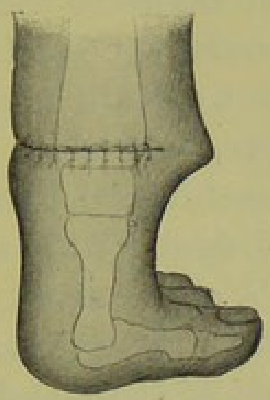


FIG. 114.—The Mikulicz-Wladimiroff operation. Wound stitched up.

FIG. 115.—Final result of this operation.

IG. 116.—Ossification in the tarsus at 5 years of age.

FIG. 117.—Ossification in the tarsus at 9 years of age.

and at a later period the flexor tendons may have to be divided, so that the toes remain at right angles to the metatarsal bones. The patient walks on the ends of the metatarsal bones, and the presence of the toes gives a certain amount of spring in walking. The leg is, however, somewhat longer than the other, and the ends of the metatarsal bones are apt to become painful. On the whole, I doubt if the patient is much better off than after a Syme's amputation. This operation may be extended to cases where the anterior part of the tarsus is also affected, the division of the distal bones being made through the bases of the metatarsals. Roser dissects out the posterior tibial nerve in the first instance, as he fears neuroparalytic phenomena from its division and imperfect union.

CHAPTER XIX

DISEASE OF THE SHOULDER-JOINT

Tuberculous disease of the shoulder-joint is essentially a disease of adult life. It sometimes, but rarely, occurs before ten, but the usual age is between twenty and thirty. It is much more infrequent than disease of the joints already considered. In my list the cases of shoulder-joint disease only form 1·3 per cent of the whole, and this corresponds to other results, for instance, on putting together a large number of cases from different authors, shoulder-joint disease only occupies 1·5 per cent of the whole. Like disease of the tarsus and wrist, disease of the shoulder-joint is very commonly associated with phthisis.

The disease is most often primarily osseous, and caries sicca is not uncommon, in fact, this is the joint in which it usually occurs. The osseous deposits occur most often in the head or great tuberosity of the humerus, but sometimes, though rarely, in the neck of the scapula. The chief destructive changes involve the head of the humerus, which may in some cases be completely separated from the shaft; in other cases the glenoid cavity may disappear, and the neck of the scapula be extensively affected (see Fig. 118). In bad cases the acromion may also be attacked, secondarily to disease in the bursa under the deltoid.

The earliest symptom of disease of the shoulder-joint is usually pain. This pain is often of a neuralgic character, shooting down the arm as far as the elbow, and more especially following the course of the musculo-spiral nerve. There is also aching pain about the shoulder. There may be tenderness in front of or behind the joint, and sometimes at the insertion of the deltoid. These symptoms become worse as the cartilages are destroyed, unless the arm is kept at rest, and even then the patient is not necessarily free from uneasiness. The pain is to a great extent due to pressure on the nerves by the distended or thickened capsule, and hence the musculo-spiral is one of the first to suffer. In addition, a certain amount of neuritis is no doubt set up in

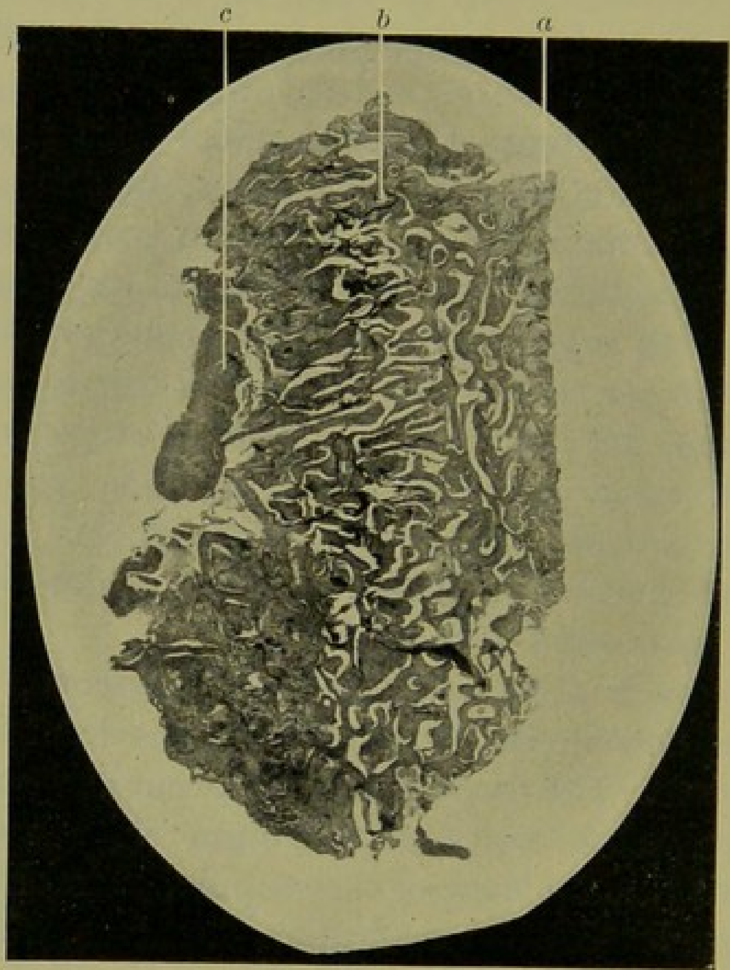


FIG. 118.—Section of the glenoid cavity from a case of tuberculous disease of the shoulder-joint, showing caries of the surface and great sclerosis of the bone beneath. (*a*) cut surface; (*b*) sclerosis of trabeculæ; (*c*) carious joint surface.

a good many cases. The pain is also excited by movements, more especially by rotation of the limb.

The swelling of the capsule is not very marked as a rule, partly because the muscles around the joint conceal it, and partly because the deltoid atrophies from an early period, and thus the swelling is masked. One can generally, however, make out if the capsule is swollen or distended by the greater rotundity of the shoulder, the hollows being filled up, especially the groove between the deltoid and the pectoralis major. In the axilla also one can feel that there is a soft pad between the fingers and the head of the bone corresponding to the thickened capsule (see Fig. 119). Where the bursa under the deltoid is involved in the disease, as sometimes happens, there is, of course, marked fullness around the outer side of the joint (see Fig. 120).

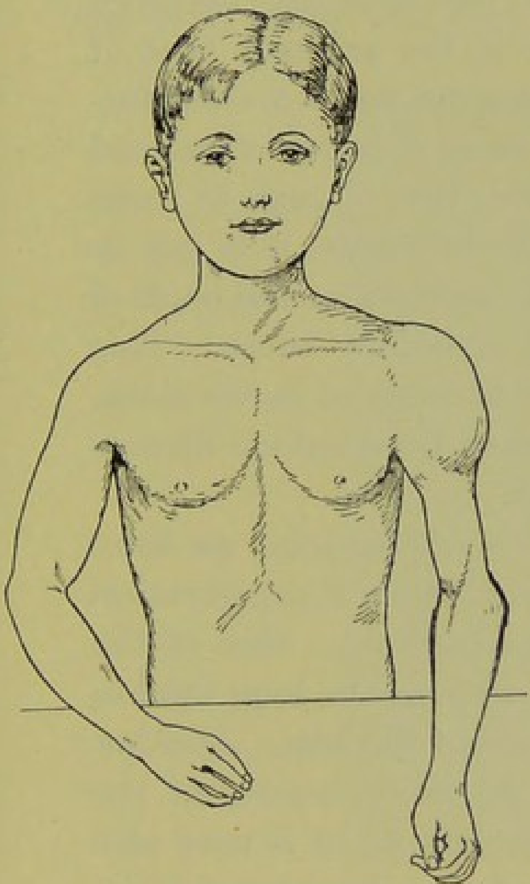


FIG. 119.—Tuberculous disease of the left shoulder-joint with unusually marked enlargement of the capsule.

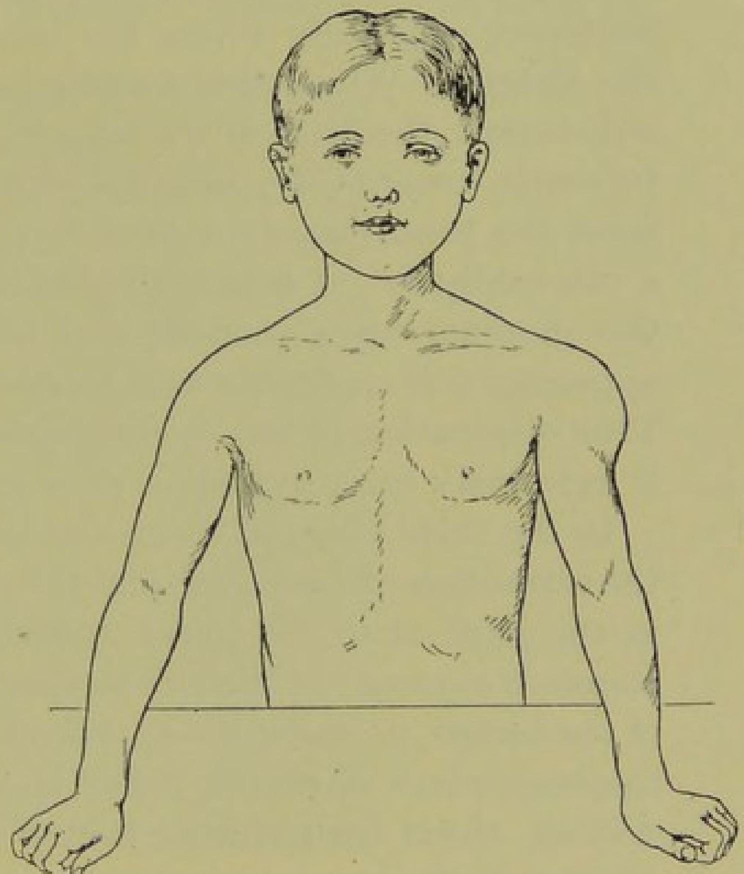


FIG. 120.—Tuberculous disease of the bursa under the acromion.

In the early stage of pure synovial disease movement is only restricted, not completely abolished, and the arm is kept a little out from the side and somewhat flexed, and rotated outwards. The shoulder at the same time droops, and the arm appears longer, or may indeed be actually slightly longer, as measured from the tip of the acromion to the external condyloid process. As time goes on the second stage is reached, the bone becomes inflamed, and the muscles around the joint become contracted ; abduction of the limb gives place to adduction, and we find the arm closely applied to the side, rotated inwards and quite rigid ; the shoulder is also elevated from contraction of the trapezius, and there is apparent and ultimately real shortening. At this stage no movement takes place between the humerus and the scapula, the apparent abduction of the arm, which may be produced, being entirely scapular movement. The atrophy of the deltoid becomes very marked, and the shoulder becomes flattened, especially where the bone is the primary seat of the disease. Where this wasting has gone on to a considerable extent, the head of the bone looks as if it were displaced forwards towards the coracoid process, but, though in some cases the head may be a little too far forwards, it is not as a rule really so ; it is merely that the muscles at the back of the shoulder have wasted, and left a hollow there. This appearance is especially well marked in cases of caries sicca. True dislocation of the shoulder-joint in tuberculous disease is extremely rare, but cases do occur.

In the third stage of disease of the shoulder-joint we have the formation of abscesses, and the occurrence of suppuration in the joint or in the bursa under the deltoid. One of the common courses for the pus to take is along the long tendon of the biceps, pointing about the middle of the arm. Another frequent place is at the lower and posterior border of the deltoid, about the posterior fold of the axilla, or it may also project at the lower and anterior border of the same muscle, or, again, it may point in the axilla.

As I have already said, this is the chief joint in which the form of disease described by Volkmann as *caries sicca* occurs. This has already been described on p. 69, and may be looked on as a tuberculous osteomyelitis of the head of the bone. The characteristic lesion is the atrophy of the bone, often going on to a considerable extent before the cartilage is destroyed, without any marked synovial thickening, or without suppuration except in a few instances towards the termination of the case. Here flattening of the shoulder from wasting of the deltoid is an early feature, and a very marked one, because there is no synovial thickening to make up for it (Fig. 121). Rigidity also occurs very early, and the trouble ultimately ends in bony anchylosis.

The diagnosis of tuberculous disease of the shoulder-joint is not always easy at an early period, and especially where it does not begin in the synovial membrane. The chief difficulty is to distinguish it from rheumatoid arthritis, and in the early stage this may be almost impossible. In cases of

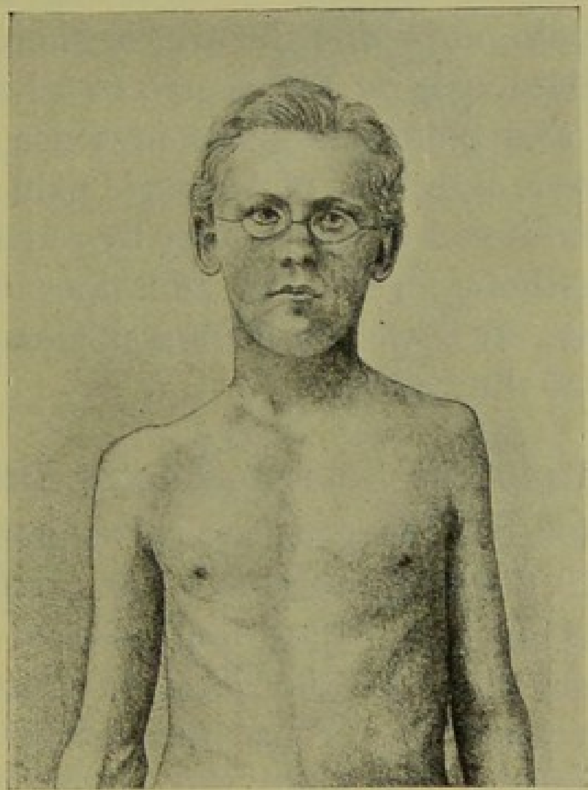


FIG. 121.—Caries sicca of left shoulder-joint, showing the absence of swelling and the marked flattening of the shoulder. (After VOLKMANN.)

tuberculous synovial disease the presence of marked swelling of the soft tissues of the joint and the absence of grating are opposed to rheumatoid disease. On the other hand, in primary bone disease there is much greater rigidity of the joint from the first than in the rheumatoid joint. In rheumatoid arthritis there is a good deal of movement, and grating or crackling in the joint without very much pain. The pain in the latter occurs in exacerbations, and is worse after a period of rest, and often also at night. Of course, the presence of other tuberculous lesions increases the probability of tuberculous joint trouble. Another difficulty is where a patient has had a fall on the shoulder, from which he dates his trouble. Here we may have simply adhesions in the joint, tuberculous disease, rheumatoid arthritis, or a fracture. The diagnosis from adhesions is sometimes very difficult in the early stage, especially where, on the idea that there was some inflammation going on, blisters and other counter irritants have been applied, and led to thickening of the tissues. One must be guided by the amount of thickening, by the presence or absence of pain on jarring the arm or shoulder (absent in the case of adhesions), by the degree to which movements are restricted and painful, by the presence or absence of pain when at rest, especially of neuralgic pain down the arm, &c. The diagnosis can be made surer by putting the patient under an anæsthetic, when the adhesions can be broken down if present. It is well to have a skiagram taken to see the condition of the bones.

Treatment of Shoulder-Joint Disease

The principles of treatment are, of course, the same as elsewhere, and I need only refer to a few points. In the first place, in fixing the arm a position must be chosen which will be a useful one, as the joint is generally more or less stiff after recovery. What one usually finds is, that the arm is fixed to the side, the elbow being at right angles, and the arm rotated inwards so that the hand lies on the chest. The result is that the range of clavicular movement is not sufficient to enable the patient to raise the arm to a useful distance from the side, while the patient is unable to rotate his arm outwards, and the function of the hand is interfered with. It must, therefore, be put up considerably abducted, and this is done by a wedge-shaped pad in the axilla (see Fig. 122).

The arm must also be rotated outwards, so that the forearm projects forward in a line with the antero-posterior axis of the body, in order that the hand may be moved freely clear of the side of the body. The best way is, having arranged the wedge as just mentioned, to bend the elbow to right angles and rotate the arm outwards, and then to put up the whole, including the elbow and part of the forearm, in silicate or plaster of Paris bandages, renewing these as they become loose. If it is desired to make any applications to the shoulder, it can be left uncovered. Later on, the arm can be put in a sling.

In some cases, especially of bone trouble, and in caries sicca, the use of the actual cautery is of great benefit in

FIG. 122.—Arrangement for tuberculous disease of the shoulder-joint. The forearm should be pointing more forwards.

giving immediate relief of pain. The broad cautery should be applied in front of and behind the joint, and the wounds treated as before described.

The employment of extension by weight and pulley is also sometimes useful, the patient lying in bed with the arm about half-way between flexion and extension, and also midway as regards rotation (see Fig. 123). Various arrangements have been made for keeping up extension while the patient is walking about, and they may be of use in suitable cases. I think, however, that the question of operative interference may with advantage be considered comparatively early in disease of the shoulder-joint.

Where abscesses have formed, the treatment depends on the answer given to the question of operation, which we may, therefore, now refer to. With few exceptions, the disease is one of adult life, and, therefore, the question we have to refer to is that of excision. I may at once say that in a good many cases I believe much time will be saved by early

Fig. 123.—Arrangement for extension in disease of the shoulder-joint.

excision, and a more useful arm will result. When the disease has passed beyond the first stage, the joint will, on recovery after expectant treatment, be more or less stiff, and it is a matter of the greatest difficulty to get anchylosis in a really useful position. The patient is going about, dressing and undressing, and constantly tending to shift the arm, or grumbling if it is kept too far out from the side, or if the forearm projects forwards; and this has to go on for many months or years. At the same time, as I mentioned at first, the majority of these cases fall victims to phthisis. On the other hand, by early excision the disease is cut short, the wound has healed in a week or two, and a useful movable joint is obtained. The objections to excision are the danger of the operation, the shortening of the arm, and the risk of a flail joint. The danger of the operation is very slight if the skin was unbroken beforehand, and this need only influence us where the patient has

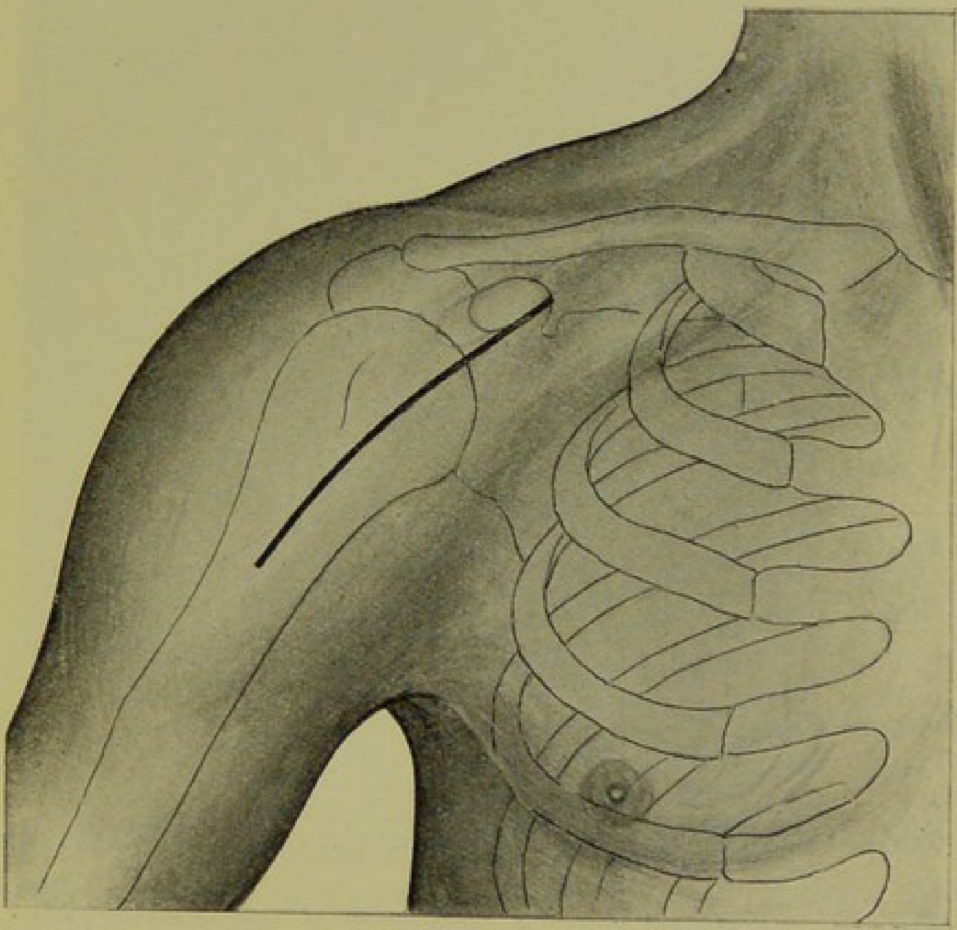


Fig. 124.—Line of incision for excision of the shoulder-joint.

advanced phthisis, or is old and weak. The shortening is slight, unless when done in childhood, where, of course, in accordance with what I have previously said, I should consider it to be contra-indicated. As to the risk of a flail joint, I think that is not great, if one takes care not to injure the muscles unnecessarily, and especially to peel off the periosteum at the muscular attachments, provided it and the subjacent bone are healthy. It seems to me that, in suitable cases, it is surely preferable to excise the joint early, and thus get a rapid cure with a useful joint, rather than persevere for an indefinite time with rest, &c., with the ultimate result, after many months or years, of a stiff joint, and often in spite of the utmost care, with much impaired usefulness, not only of the shoulder, but of the elbow and hand, and a great risk of death from phthisis.

As regards the operation of excision, I do not see any reason for departing from the usual method of a long anterior

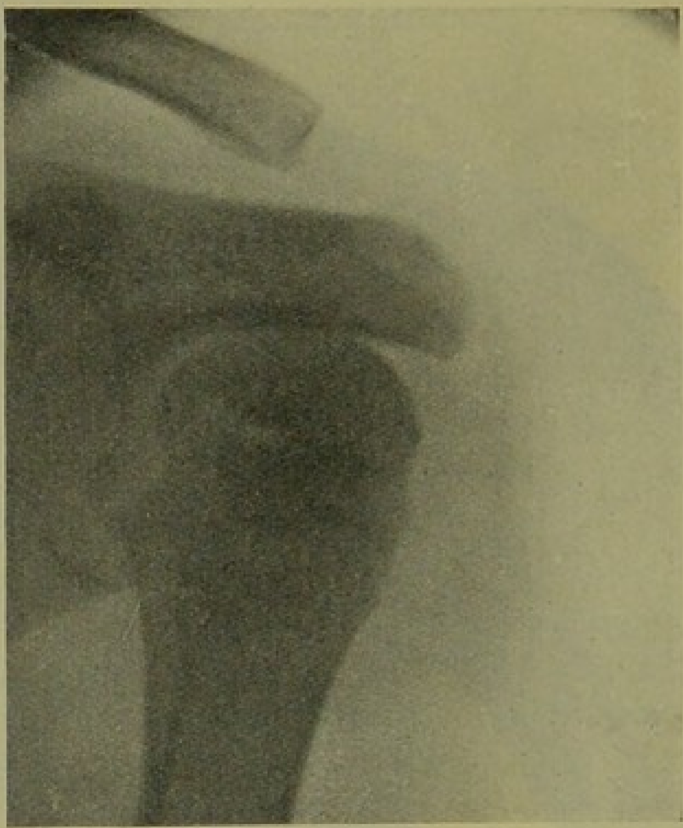


FIG. 125.—Skiagram showing ossification at the shoulder-joint at 5 years of age.

incision, except in so far that after the ends of the bones have been removed, the whole of the synovial membrane should be carefully dissected away. The incision commences just external to the tip of the coracoid process and extends downwards and outwards parallel to the anterior border of the deltoid, dividing skin and fascia only, the arm being slightly abducted and rotated outwards and the shoulder resting on a sand-bag (see Fig. 124). The biceps tendon is freed from its sheath, and the deltoid is raised. If the deltoid bursa is affected it must be dissected out, and the front part of the capsule is also taken away. The arm is now carried backwards and the head of the bone protruded, the muscles attached to the tuberosities being partially or

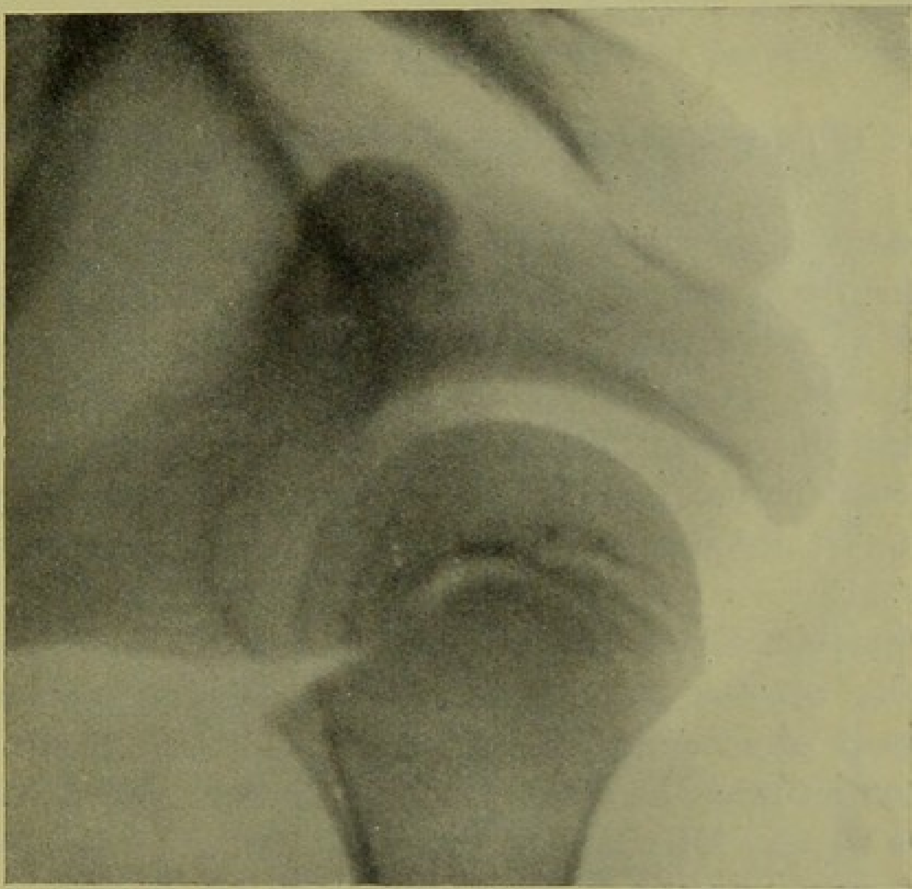


Fig. 126.—Skiagram showing ossification at the shoulder-joint at 9 years of age.

entirely divided. In most cases enough bone can be removed without complete division of the rotators. The glenoid cavity is now removed, and the remains of the capsule clipped away.

CHAPTER XX

DISEASE OF THE ELBOW-JOINT

Disease of the elbow-joint occupies the fifth or sixth place in order of frequency, comprising in my statistics 7·9 per cent of the whole cases, and in the larger collected statistics 6·3 per cent. It occurs mainly in young adults, at an earlier age than disease of the shoulder-joint. Most of the cases commence before twenty (66 per cent), but after ten years of age. In my statistics one-third of the cases commenced before ten.

In this joint the disease seems to be much more frequently primarily osseous than synovial, and the olecranon is the part most often attacked. Thus König found in 62 cases operated on that the disease was purely synovial in 10 and osseous in 42. Of these 42 cases the ulna, more especially the olecranon, was the primary seat in 22, the humerus in 17, humerus and ulna together in 2, and the radius in 1. Middeldorpf found in 137 cases that the disease was primarily synovial in 30 and osseous in 107. Of the bones the ulna was attacked primarily in 49, the humerus in 33, the external condyle in 12, the internal condyle in 4, the humerus and ulna together in 18, the radius in 3, the humerus, radius, and ulna in 2, and the radius and ulna in 2. The synovial form was most frequent below fourteen years of age, the proportion between synovial disease and bone disease at that period of life being 29·5 to 70·5. The disease, whether synovial or osseous, commences most often on the outer side of the joint.

The elbow is one of the joints where we should especially be on the watch for the early beginnings of the disease, which are often localized either in the bone or the synovial membrane. Of the bones the most likely place is the olecranon (see Fig. 127). Disease of the olecranon will be indicated by enlargement of that bone, and if the deposit has reached the surface outside the joint, there is a painful spot, with bogginess and subsequently an abscess, in addition to the thickening. Another place where a localized bone deposit should be

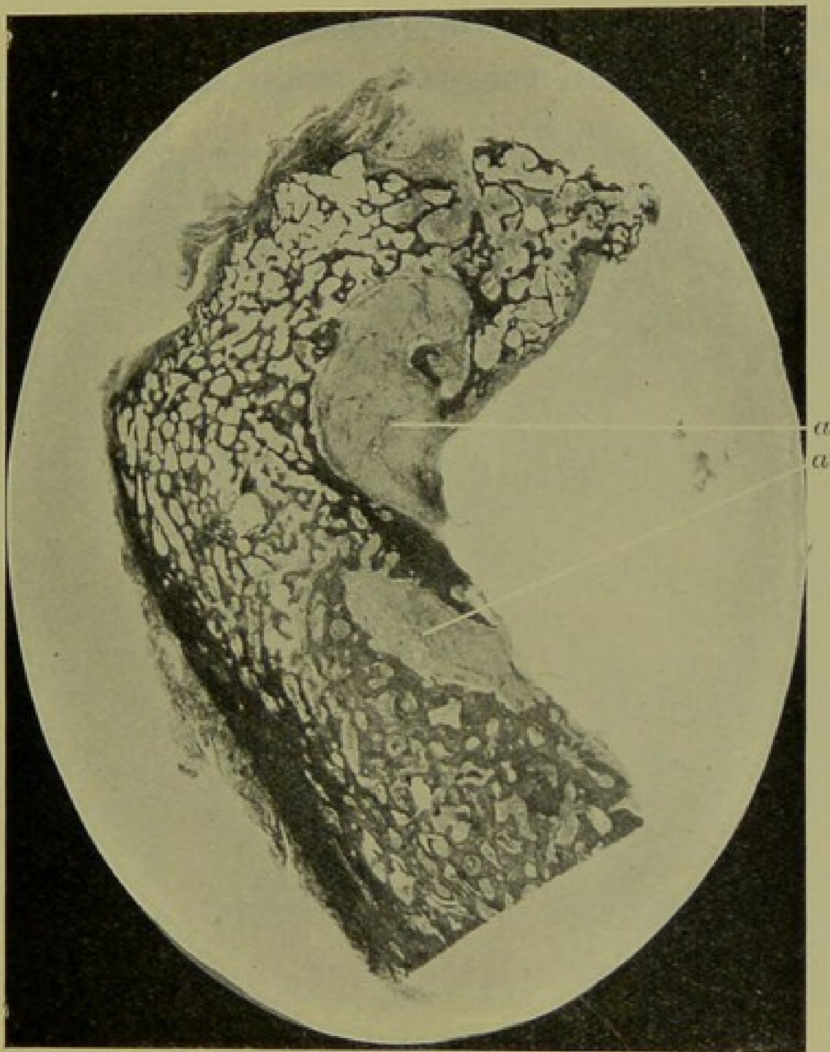


Fig. 127.—Section of the olecranon from a case of tuberculous disease of the elbow-joint, showing two tuberculous deposits (*a*) which have formed in the bone beneath the articular cartilage and have burst into the joint and given rise to the trouble. Articular cartilage completely destroyed.

looked for is in the external condyle of the humerus. Localized synovial deposits are not so common, but I have seen them on the outer side of the joint about the head of the radius.

The course of these localized deposits is the same here as elsewhere. When the deposit in the bone reaches the surface, it leads to the formation of an abscess over it, and not uncommonly, in the case of the olecranon, infects the bursa.

Where it reaches the joint, it causes the typical joint disease, either thickening of the synovial membrane spreading from the point of rupture of the deposit, or sudden infection of the whole surface with great pain and suppuration in the joint.

Leaving these local deposits, we may now consider the symptoms where the synovial membrane is diffusely affected, whether primarily, or by extension from a local bone or synovial deposit. In the early stage of primary synovial disease there is very little pain, and the joint moves with

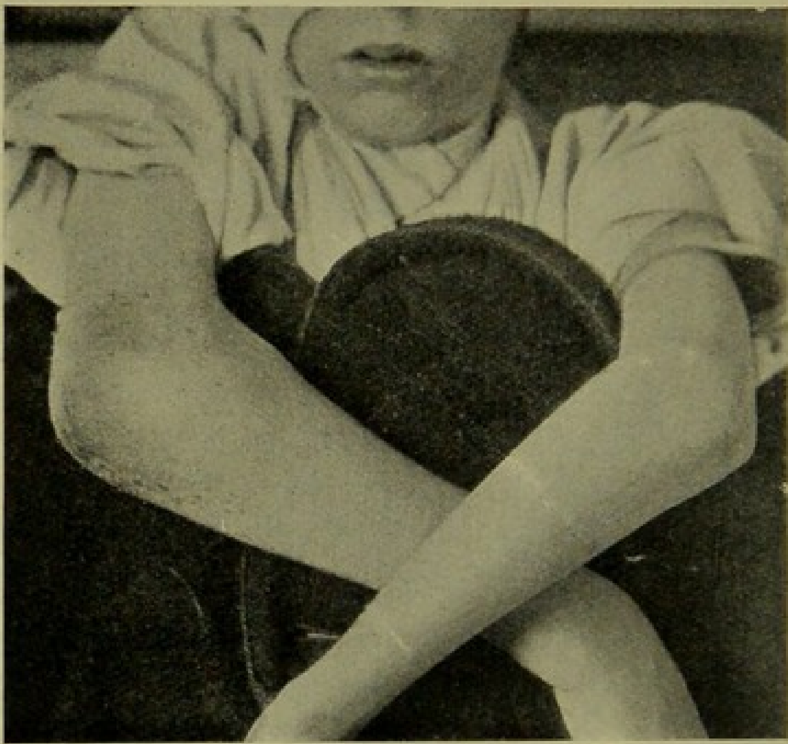


FIG. 128.—Disease of the right elbow-joint.

considerable freedom. The thickening of the synovial membrane is apparent in the hollows on each side of the olecranon, which are filled up, especially on the outer side; the tip of the olecranon is also more indistinct on account of the filling up of the olecranon fossa (see Fig. 128). As time goes on, this swelling on each side of the olecranon, which was at first in the form of ridges, becomes more diffuse, and we have a uniform enlargement in the region of the elbow-joint, which is more marked at this period, seeing that the muscles of the upper and forearm are undergoing atrophy (see Fig. 129). As the cartilage becomes destroyed, pain is complained of, and the joint becomes fixed by muscular action, in the first instance, in the characteristic position, viz. about an angle of 125° to 140°, and more or less completely pronated. In the third stage, we have the formation of abscesses around the joint, which generally point and leave sinuses around the posterior and outer side.

Where the case is one of primary bone deposit, which has communicated with the joint, we have in the early stage the

FIG. 129.—Disease of left elbow-joint showing general enlargement of the joint.

localized thickening of the part with some indefinite aching, followed by symptoms of involvement of the joint, viz. early rigidity, great pain on moving or jarring the part, but no marked swelling in the first instance. The further symptoms of the disease are similar to those just described.

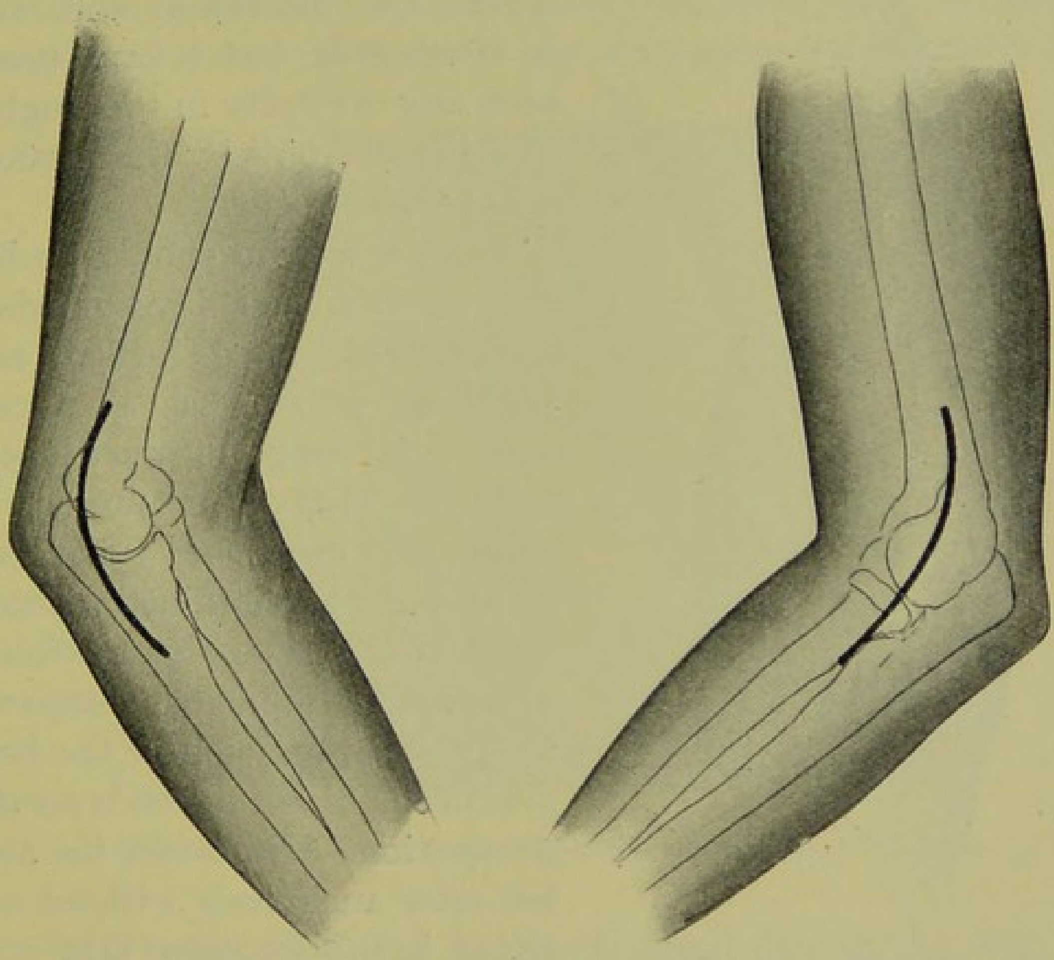
The ultimate result without treatment, if recovery takes place, is anchylosis in the position just described, a position which is most inconvenient, and which interferes greatly with the utility of the limb.

Treatment

The elbow-joint is one where we can occasionally save the joint by early operation in cases where the disease is distinctly localized at first. This is more especially the case where the deposit is present in the olecranon, or, as in one case on which I operated successfully, in one of the condyles of the humerus. I have also operated successfully in a case where there was a localized thickening in the synovial membrane in the neighbourhood of the head of the radius, and where removal of the affected synovial membrane arrested the disease. It is unnecessary to do more than mention the fact.

Where expectant treatment is to be employed the joint should be fixed at a right angle with the forearm midway between pronation and supination. The most satisfactory arrangement is a silicate case ; splints do not keep the forearm in the proper position as regards rotation. The case should extend as high up the upper arm as possible and down to the wrist, in fact, it is best to fix the shoulder and wrist-joints. Of splints the best is a posterior wire splint, coming well round the sides of the arm. I do not think that either extension or counter irritation are of much value in disease of the elbow-joint, the former not being easily managed, and, as regards the latter, the joint being too superficial.

The operative measures, apart from the partial operations just referred to, are arthrectomy in children and excision in adults, and both yield very satisfactory results. As regards arthrectomy, I should advise its performance at a comparatively early period of the disease, when the whole joint has become affected, and when there is no improvement on a fair but not prolonged trial of absolute rest, or when it is evident that if recovery takes place the joint will be stiff. By means of complete arthrectomy the disease is got rid of, and even without much passive motion an excellent result as regards movement is obtained. Arthrectomy is best performed by means of lateral incisions, one on each side of the joint (see Figs 130 and 131). These incisions are carried down to the capsule, care being taken on the inner side to look for, isolate, and pull forward the ulnar nerve, and on the outer side in separating the capsule not to go too low and injure the posterior interosseous nerve. Having exposed the capsule on each side the triceps is lifted up, and the synovial membrane over the olecranon fossa isolated, and the same is done on each side of the olecranon and over the



FIGS. 130 and 131. Lateral incisions for arthrectomy of the elbow-joint. These incisions are also most useful for excision.

head of the radius. The joint is then opened and the posterior synovial membrane cut away. After detaching the muscles from the condyles and dividing the lateral ligaments one can now define the surface of the anterior capsule, and by means of the finger can lift off the various structures in front of it. Having in this way isolated the capsule it is cut off above and below where it joins the bone. It is while clearing the capsule on the outer side that one has to be especially careful of the posterior interosseous nerve. The joint is now quite loose and it is easy to protrude the ends of the various bones through either incision, remove all remains of synovial membrane, and investigate the surface of the cartilage and the ends of the bone. The bones are now replaced, the wound stitched up and the usual dressings applied. Some surgeons saw across the olecranon and wire it afterwards, but I have never seen any difficulty in thoroughly clearing the joint by the method I have described.

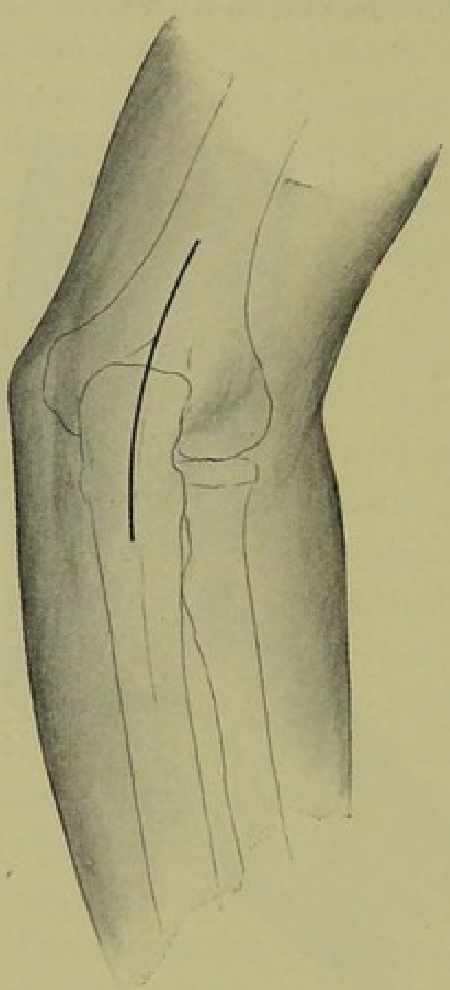


FIG. 132.—The vertical posterior incision for excision of the elbow-joint.

Passive motion should be begun in about ten days or when the wounds have healed, and kept up as long as is necessary. It may be mentioned, however, that in a number of cases an excellent functional result has been obtained without employing any passive motion.

In adults, I believe comparatively early excision is the best practice. Much depends on the occupation. No doubt the arm left after anchylosis without excision is the stronger arm, and for some employments movement is not so important as strength. Further, the length of time for which the patient is incapacitated must be considered, excision when properly performed, that is combined with complete removal of the disease, putting a stop to the trouble at once, and only laying the patient aside for a few weeks. I have more than once performed arthrectomy in adults, but I do not think the results are so good as those of complete excision. Perhaps the most common incision is a long vertical one over the olecranon (see Fig. 132), but in my opinion the best incisions for excision are lateral ones, as already described with regard to arthrectomy, and the capsule must be freed in a similar manner. If the back of the olecranon is healthy, the periosteum with the attachment of the triceps may be peeled off behind and left attached to the periosteum of the healthy bone below. The bones are sawn off in the usual manner. Passive motion should be begun in a few days, and a good plan later on, if the joint tends to become stiff, is to put on extension at night to

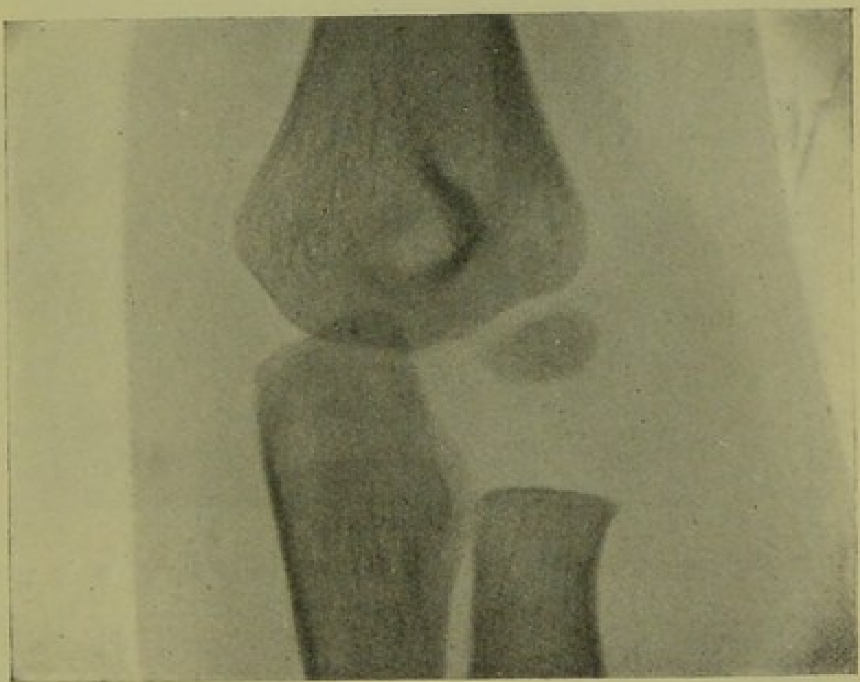


Fig. 133.—Ossification at the elbow-joint at the age of 5 years.

straighten the arm, and an elastic band during the day to bend it.

Where sinuses are present arthrectomy or excision should be performed, as the chances of recovery without operation are small and the treatment is very prolonged. Especial care must be taken in these cases to remove all traces of synovial membrane, and also, of course, to purify the wounds.

Amputation is hardly ever required in elbow-joint disease, unless the case has been neglected or the disease allowed to go on too far.

The functional results of excision depend very much on the method of operating, the amount of bone affected, and the after treatment, and hence opinions vary very much with regard to it. Perhaps a fair estimate is that given

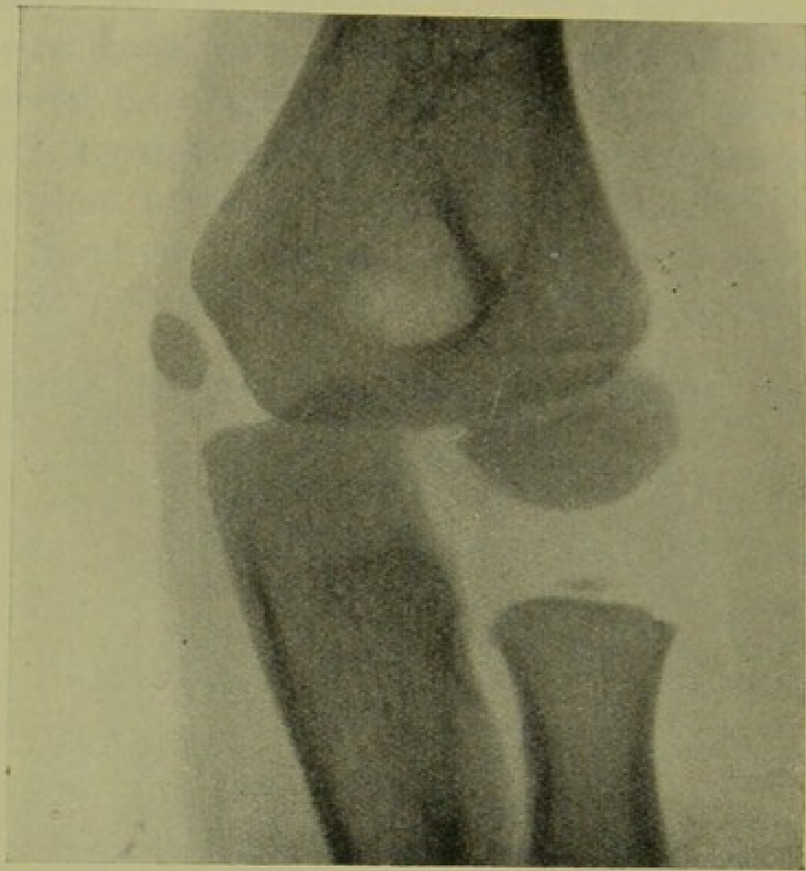


FIG. 134.—Ossification at the elbow-joint at the age of 9 years.

by Middeldorpf, who, taking Maas's and Giebe's cases together, found that good joints, flail joints, and stiff joints resulted after excision in the percentage proportions of 75, $12\frac{1}{2}$, $12\frac{1}{2}$.

CHAPTER XXI

DISEASE OF THE WRIST-JOINT

Disease of the wrist-joint, like that of the shoulder, is a disease of adults, commencing most frequently during the third decade, and it forms about 5 per cent of the total cases of tuberculous bone and joint disease. It is, I think, most often

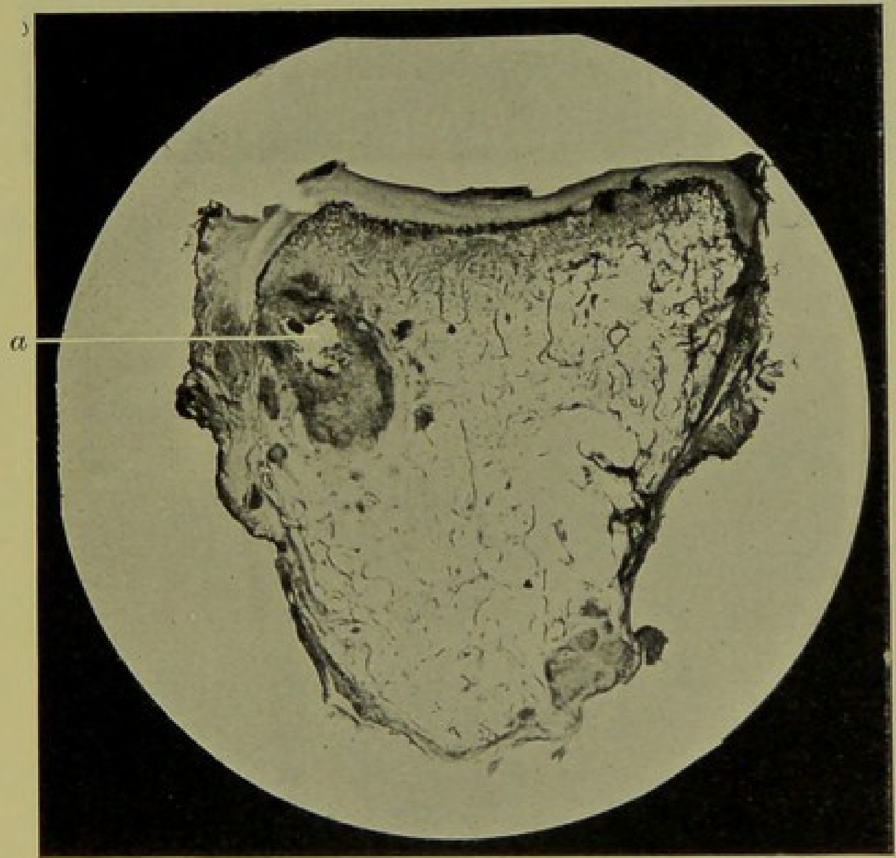


Fig. 135.—Section of the trapezium from a case of wrist-joint disease, showing the presence of a tuberculous deposit (*a*) and destruction of the cartilage.

primarily synovial, but this is a very difficult point to determine on account of the number and small size of the bones. Primary osseous deposits occur in the lower end of the radius, and also in the ends of the metacarpal bones, chiefly the second and third. I have only seen two specimens of primary deposit in a carpal bone, in both cases in the trapezium (see Fig. 135).

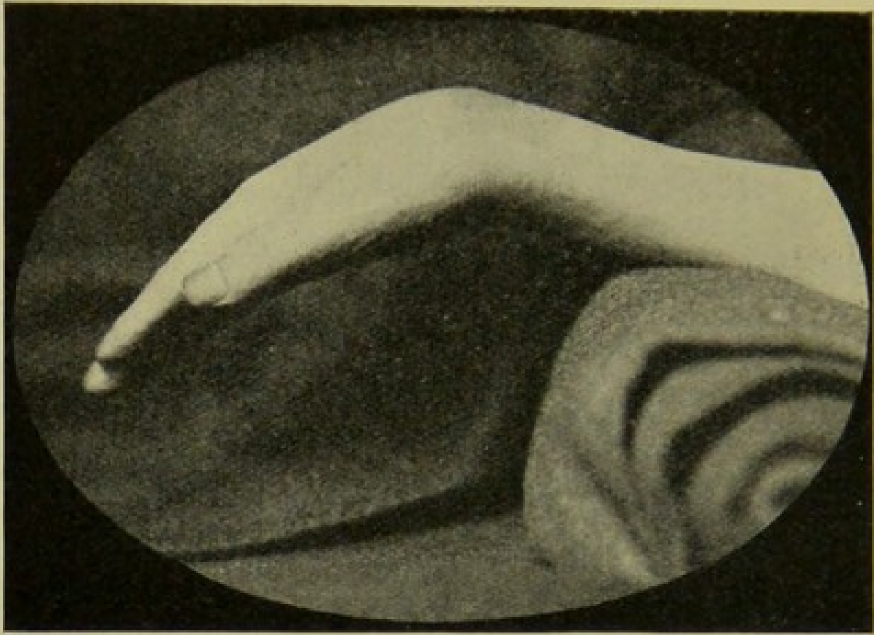


FIG. 136.—Disease of the carpus. The hand is flexed—the very worst position.

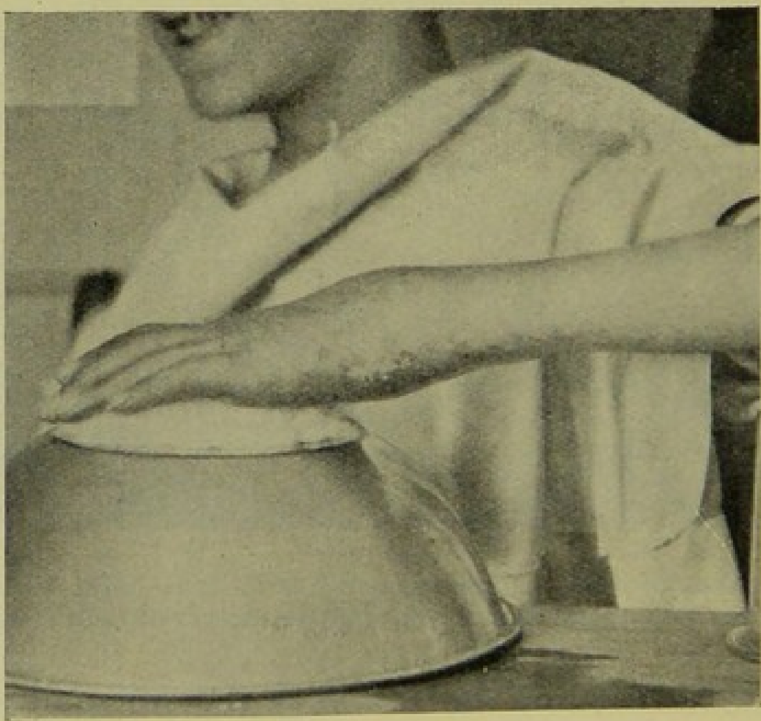


FIG. 137.—Disease of the carpus.

The course of the disease is similar to that in other cases, and need not be specially described. It begins with thickening around the joint, passing on to softening of the ligaments with lateral mobility, destruction of the cartilages with much pain, and ultimate suppuration and anchylosis. It is especially apt to be accompanied by phthisis.

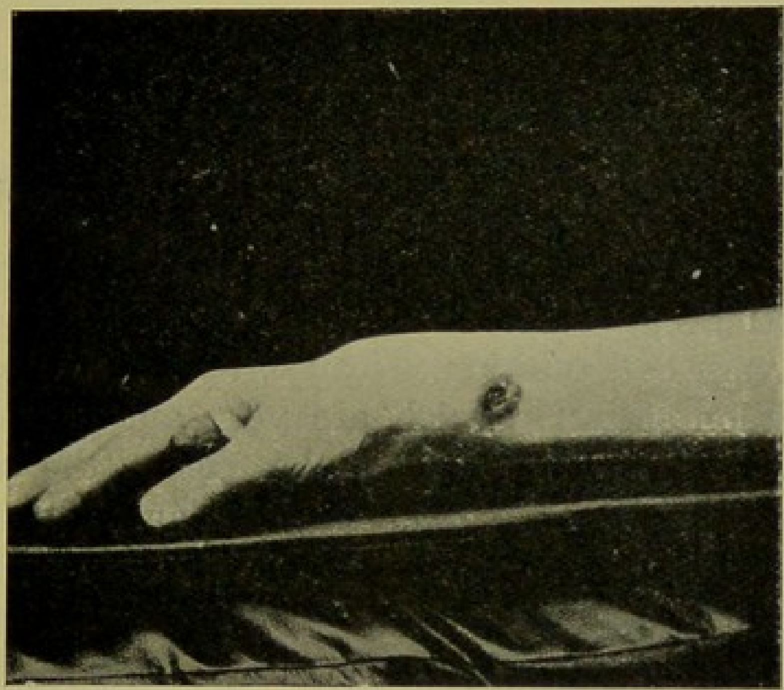


FIG. 138.—Disease of the wrist-joint with sinus. Primary tuberculous deposit in the lower end of the radius.

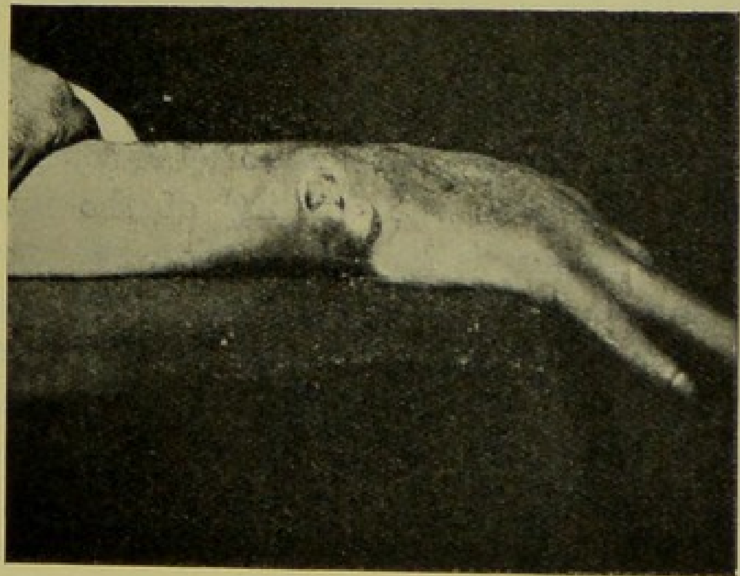


FIG. 139.—Disease of the lower end of the ulna affecting the wrist-joint.

The thickening frequently begins, and is most marked on the outer and posterior aspect of the joint, corresponding with the most frequent commencement of the disease in that region, and it usually causes the appearance of a marked projection on the back of the wrist. The lateral mobility of the wrist, obtained by fixing the forearm and then grasping the wrist and displacing it laterally, is pathognomonic of tuberculous disease.

The characteristic appearance of the hand in cases which have not been treated, is that the hand and fingers are held straight out or slightly flexed at the wrist-joint, the fingers and thumb side by side, there is a marked swelling on the back of the wrist, and all around as well (see Figs. 136 and 137), and sometimes partial dislocation of the carpus backwards. This is a very bad position, because, apart from adhesions in the tendon sheaths, which are very apt to occur, and interfere with the movements of the fingers, the usefulness of the hand is much impaired. Even with a healthy joint, if the wrist and fingers are placed in the same line with the forearm, the grasp is weak, and where disease is present, the muscles wasted, and the action of the tendons interfered with, it is usually impossible to shut the fist at all with the hand in this position. Further, the opposition of the fingers and thumb is also lost where the thumb is kept constantly alongside the fingers.

Where the cartilages are becoming eroded there is great pain, and, the ligaments being also softened, the patient is unable to lift the hand, but supports it with the other. Further, in addition to the wasting of the muscles, the nutrition of the fingers is imperfect, they become tapering, glistening, and somewhat purplish. When suppuration occurs the sinuses are generally formed on the back of the wrist (see Figs. 138 and 139). It is also not very uncommon in cases which have been allowed to go on too long, for the sheaths of the tendons to become affected, an occurrence which gravely complicates the treatment of the case.

Treatment

In applying splints or other apparatus to keep the joint at rest, special attention must be paid to the position of the hand in accordance with what I have just said. The splints should stop at the knuckles so as to allow free movement of the fingers, and the best arrangement is, I think, a silicate bandage, strengthened in front by the incorporation of a light metal band. This should bend back opposite the wrist, so as to throw the carpus and metacarpus backwards; the metacarpus should form an angle of about 150° with the forearm. The forearm should be midway between pronation and supination, and it is, I think, well to carry the bandage above the elbow-joint. These silicate bandages are of course renewed whenever necessary. A more convenient arrangement in some cases is an anterior poroplastic splint bent back at the wrist as above and strengthened by a band of aluminium. It should be cut away opposite the ball of the thumb so as to allow the thumb to drop, and should not extend below the knuckles so that movements of the fingers can be kept up.

As regards operative measures it is rarely that one meets with a case before the joint has become diffusely affected, and where it would be possible to cut short the disease by removing the primary focus. Of course, if such a case came under notice, that ought to be done, but usually we have to deal with diffuse disease, and our choice of operations lies between arthrotomy, excision, and amputation. Arthrectomy in diffuse disease is not possible, apart from removal of the carpus or at any rate, a modified excision, and as the disease is essentially one of adult life, this matter is not so important. In children, however, it might be possible, after removal of the carpal bones, to clean the other parts without further removal of bone. Although complete arthrectomy does not come much into play in acute disease, a good deal can be done in some cases by partial operations, either partial arthrectomy or simple arthrotomy. The first essential for these partial operations is that there is no phthisis, and the second that the disease is not progressing rapidly, but rather that the condition remains *in statu quo* without improvement. In suitable cases I have seen distinct improvement as the result of free incisions into the wrist-joint, with or without removal of portions of the affected tissue, the wounds being left freely open and the joint drained. As I have previously explained in speaking of knee-joint disease, this method is not likely to effect much where the tuberculous tissue is abundant and undergoing caseation, and where one finds yellowish cheesy points in the synovial membrane. As to the best place for the incisions, one usually chooses the lines for Lister's excision of the wrist, in case excision should become necessary subsequently, but of course if there is any special part where the swelling is most marked, the incisions should be made there, care being naturally taken not to injure the tendons or the tendon sheaths, and thus not to incapacitate the fingers, or open a way for infection of the tendon sheaths.

The decision between excision and amputation depends partly on the general condition and partly on the local state of the part. As regards the general condition, the presence of phthisis is of course the gravest complication. Where phthisis is well marked and operative interference is necessary, amputation is much better practice than excision, and it is remarkable what improvement in the condition of the lung often follows the removal of the hand. Where the lung trouble is not advanced, and the general condition otherwise good, one may perform excision in preference to amputation. Formerly, where the whole disease was not removed, and where discharging and often suppurating sinuses remained for months, amputation was almost imperative, but nowadays, where the whole disease is thoroughly removed, and where proper antiseptic precautions are taken, healing occurs by first intention, and as the patient is not confined to bed, there is no particular advantage in amputation unless in bad cases. Another condition where amputation becomes necessary is where, in addition to disease of the joint, the tendon sheaths are affected, a very serious complication. In such cases where suppuration occurs amputation is the best practice.

As regards the methods of performing the operations, amputation is most conveniently performed by the modified circular operation as low down in the forearm as possible. Excision may be done either by Lister's original operation or by Langenbeck's modification, preferably, I think, by Lister's method, which gives freer access (see Fig. 140). It is hardly possible in the case of the wrist-joint to remove the synovial membrane thoroughly, and it is well where any suspicious tissue is left to cauterize it thoroughly with the

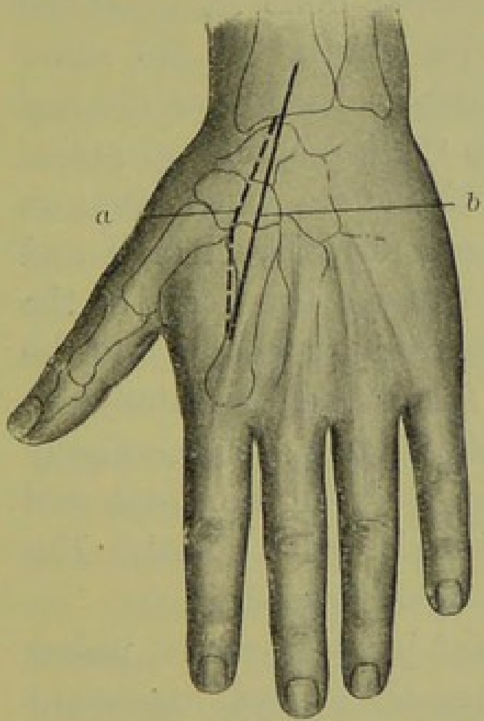


FIG. 140.—(*a*) Lister's incision for excision of the wrist. (*b*) Langenbeck's incision.

FIG. 141.—Ossification in carpus and hands at the age of 5.

thermocautery, and to fill the wound with iodoform and glycerine. Afterwards the hand is put on the splint designed by Lord Lister with the view of throwing back the metacarpus, and passive and active movements of the fingers should be begun almost at once. It has been proposed to shorten the flexor tendons at the time of the operation, but this is hardly necessary if the knuckles project well backwards. A very good functional result is obtained by excision in most cases if proper care is taken in the after-treatment with regard to the position of the metacarpus and the movement of the fingers.

In Lister's operation two incisions are made, a radial one on the dorsum of the hand so planned as to avoid the radial artery and also the extensor tendons of the thumb and index finger and a free ulnar incision towards the front of the wrist. The radial incision commences above at the middle of the dorsal aspect of the radius on a level with the styloid process. It then runs towards the inner side of the metacarpo-phalangeal joint of the thumb, but on reaching the line of the radial border of the second metacarpal bone it is carried longitudinally downwards for half its length. In the ulnar incision the knife is entered about two inches above the end of the ulna, immediately anterior to the bone, and is carried down as far as the middle of the fifth metacarpal bone on its palmar aspect. The tendons are gradually cleared and lifted off the capsule, and the carpus with the bases of the metacarpal bones and the ends of the radius and ulna and the synovial membrane are gradually freed and dissected out. Before commencing the operation the fingers are thoroughly moved so as to break down adhesions, and the hand and arm are subsequently fixed on Lister's wrist splint. For further details see the *Manual of Surgical Treatment.*

In the case of disease of the wrist-joint, however, unless phthisis is present or the local condition bad, expectant treatment should be persevered with for a long time.

CHAPTER XXII

DISEASE OF SMALLER BONES

THE parts already mentioned, with the addition of the spine, form about 83 per cent of all cases of bone and joint tuberculosis, leaving about 17 per cent of cases in which other bones and joints are attacked. I shall refer shortly to some of these.

1. *Fingers and Toes.* Tuberculous disease occurs much more often in the fingers than in the toes, and may either begin in the joints or in the shaft of the bones. The disease in the joints has no special interest, resembling on a small scale in every respect the disease in the larger joints, and the treatment is either expectant treatment or amputation, according to the circumstances. In the case of the thumb, however, the retention of any portion is so important that partial operations, excision, &c., may with advantage be employed.

The shafts of the phalanges or the metacarpal bones are, however, often attacked, and the disease may begin either as an osteomyelitis or as a periostitis, most commonly the former. Tuberculous osteomyelitis of the shaft of these bones in children usually gives rise to the typical appearance of strumous dactylitis or spina ventosa (see Fig. 142), where there is a fusiform swelling of the bone due, as shown in Fig. 34, to expansion of the interior of the bone with soft material, and also to new bony formation on the surface. This swelling is firm, not particularly painful or tender to the touch, single, or may affect more than one bone, and does not in a considerable number of cases end in suppuration. On the contrary, it is remarkable how often, if the affected finger is properly fixed and kept at rest, and the child placed under good hygienic conditions, the swelling subsides and ultimately entirely disappears leaving very little trace behind. Sometimes, however, the epiphysial line becomes destroyed or ossified, and a shortened condition of the bone results. In other cases the new tissue breaks down and pus forms and makes its way outwards, and we have at some part or other an abscess, from which a small hole leads to the interior of the bone. A very similar condition may occur in congenital syphilis, and the diagnosis may have to be made by the presence or absence of other signs of syphilis or tubercle.

The treatment of this condition is in the first instance absolute rest and proper general treatment, and as I have

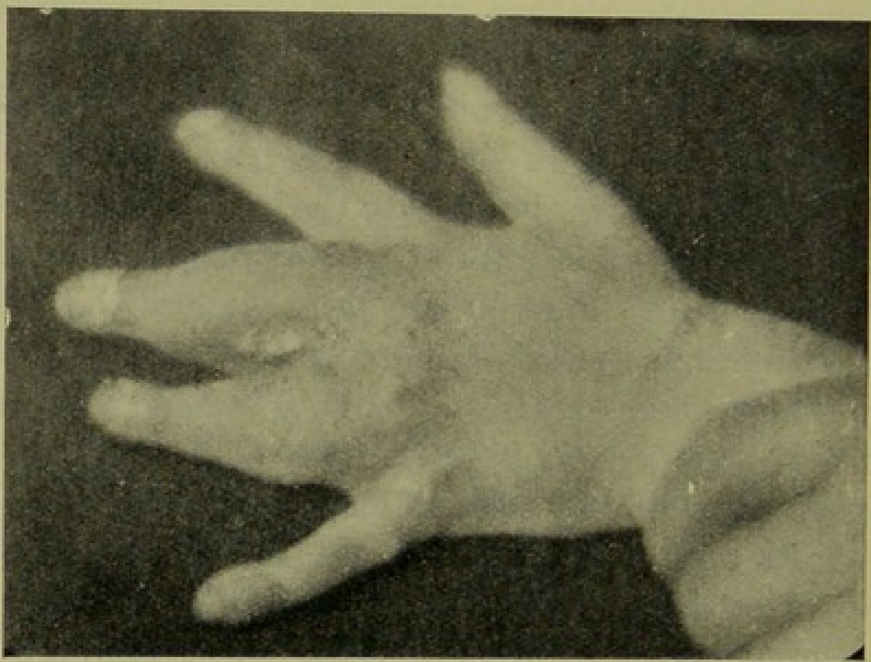


FIG. 142.—Tuberculous dactylitis.

just remarked, in the majority of cases a cure is obtained. Where suppuration has occurred the abscess should be opened, the opening in the bone enlarged, and the interior scraped out. This may have to be repeated more than once, but usually ends in cure. Amputation is, curiously enough, rarely necessary in this condition.

In adults tuberculous periostitis is more common, or if the medulla is primarily affected, it is often associated with the necrotic form (see Fig. 34). In these the prognosis is not so favourable, and although some of the milder cases yield to rest, &c., the disease is very apt to prove obstinate, and, in a good many instances, requires amputation.

2. *Ribs.* The ribs are comparatively frequently affected with tuberculous disease. Thus, in Billroth and Menzel's table of 1,996 post-mortem examinations in cases of carious bone disease, the ribs occupy the sixth place in order of frequency, forming rather more than 6 per cent of the whole. The ribs most usually affected are the fourth to the eighth, generally about their middle. Tuberculous disease of the ribs is essentially an affection of adults, and seldom occurs in children, and it may occur either primarily in the rib

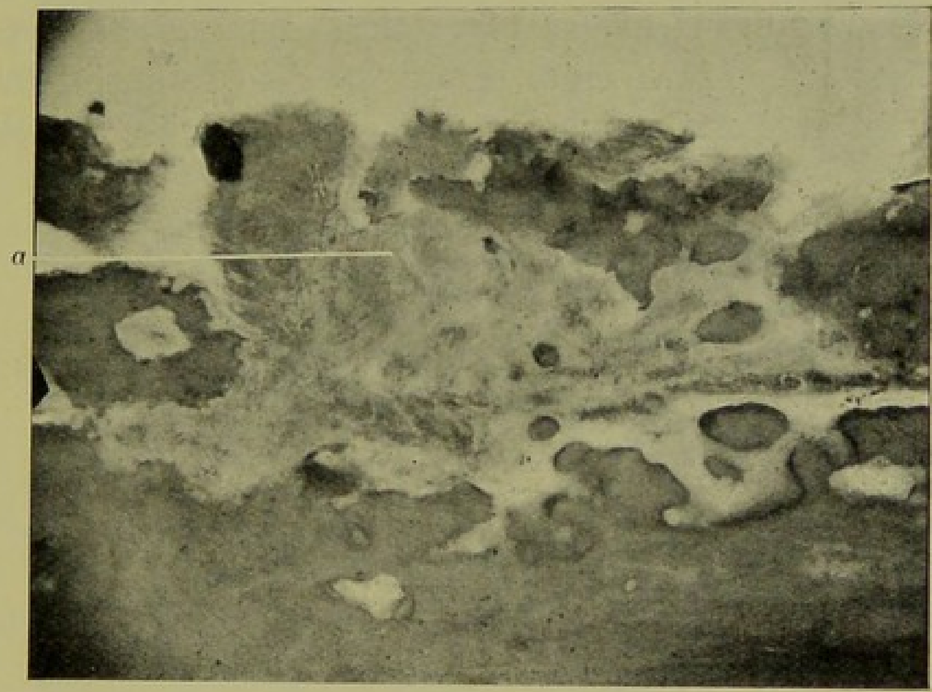


Fig. 143.—Tuberculous periostitis of a rib, showing the way in which the soft tuberculous tissue (a) is eating into the rib.

or secondarily to disease in the neighbourhood. The secondary disease occurs in the form of a periostitis, and may follow a spinal abscess which has passed forward along the intercostal space, and is pointing in the side, or a tuberculous pleurisy especially where an incision has been made, or suppurating tuberculous axillary glands ; it is not uncommonly associated with phthisis. Here, however, we have only to do with the cases where the disease begins in connexion with the bone, and is not merely an extension from the neighbourhood. The disease, in this case, may commence either as a periostitis or as an osteomyelitis, most commonly as a periostitis. Beginning in the periosteum, the tuberculous tissue causes a swelling on the surface of the bone, which presently breaks down in the centre, and forms an abscess. At the same time, the new tissue spreads into the bone along the Haversian canals, and causes erosion of the bone, and sometimes actual necrosis of fragments (see Fig. 143). Hence the bone becomes thinner than usual, and presents a worm-eaten appearance on the surface, while the parts in the neighbourhood are condensed ; this superficial erosion of the bone steadily progresses, till a more or less marked defect is formed, indeed, fracture not uncommonly takes place (see Fig. 144). Much more rarely the disease begins in the interior of the bone, expanding it, and giving rise, in a slight

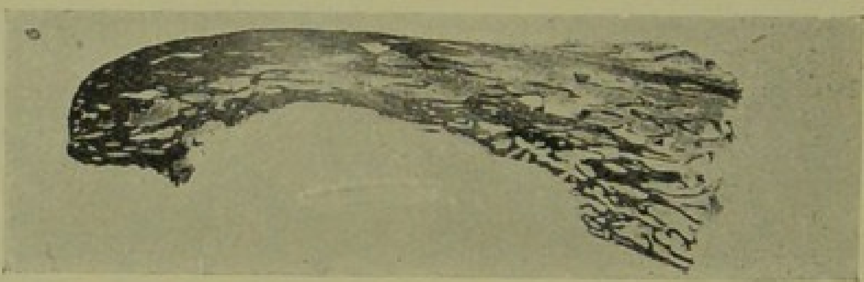


Fig. 144.—Tuberculous disease of ribs, showing defect in bone as the result of the disease.

degree, to the appearance of spina ventosa, referred to in connexion with the fingers.

The early symptoms of tuberculous disease of a rib are very indefinite, consisting, at the most, of some uneasiness, or perhaps a little catching pain on deep breathing or coughing, and sometimes a little tenderness on pressure. If the swelling is chiefly on the inner side of the rib, the pleura may be irritated, and there may be a little cough, pain, and other signs of slight pleurisy. Usually, however, the first thing that is noticed is a little swelling, which leads the patient to seek advice. This swelling is in the first instance, small, rounded, and elastic, and later increases in size, fluctuates, and may alter its shape according to the situation. These abscesses usually spread to the skin, but they may, in the first instance, bulge the pleura inwards considerably, or even open into the cavity, or they may burrow beneath the muscles, and point at some distance from the seat of disease; in the case of disease at the posterior end of the rib, they may even point in the loin or run down in the sheath of the

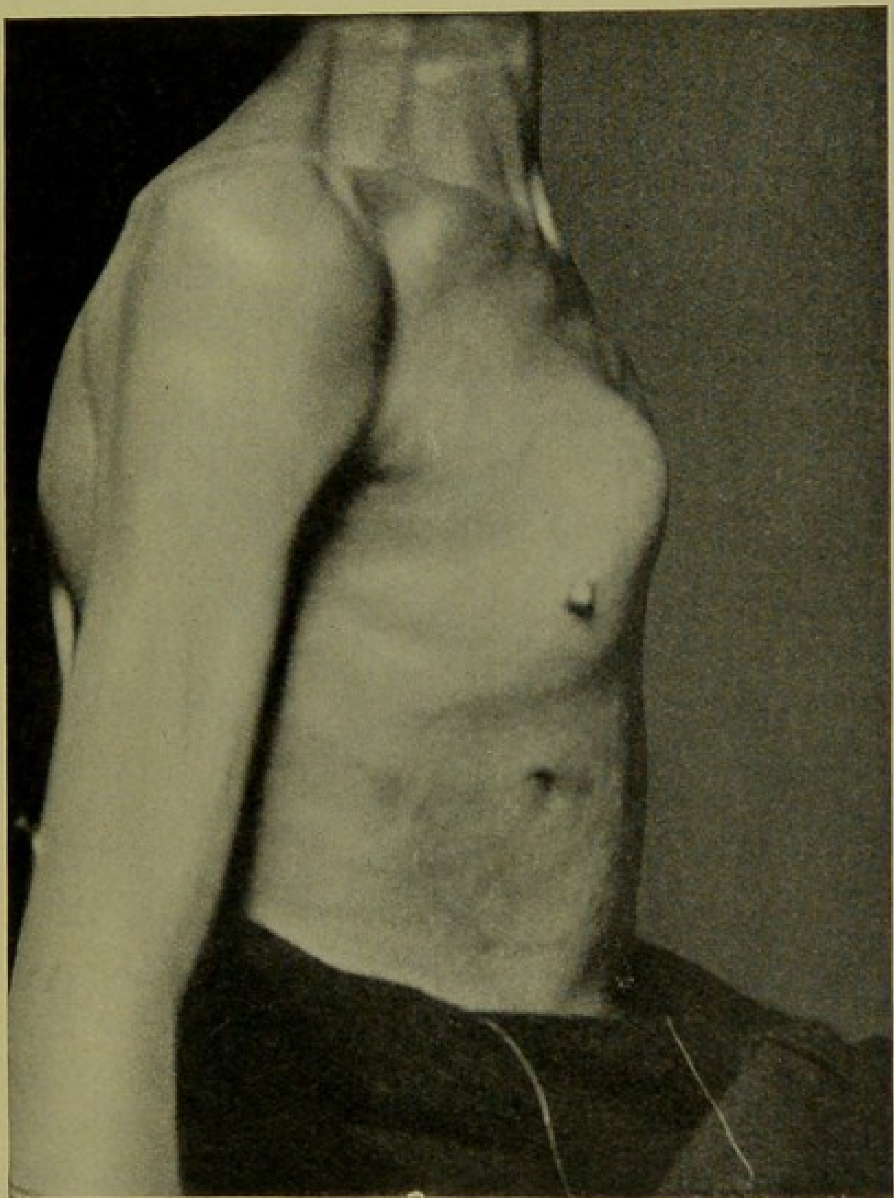


Fig. 145.—Tuberculous disease of rib. There is an abscess above and to the inner side of the breast, and a sinus below the breast.

psoas muscle, and form a typical psoas abscess. The disease not uncommonly affects more than one rib or part of a rib.

The treatment of tuberculous disease of a rib, once an abscess has formed, should be thorough, and if thorough, will lead to a speedy cure. The treatment consists in complete removal of the disease. This is usually readily done. In the first instance, the skin and muscles are reflected from over the abscess wall, and, without opening it (an oval incision (see Fig. 146) being generally necessary), the abscess is thoroughly isolated up to its point of attachment to the rib (Fig. 147). The extent of the affected bone is then defined, the rib divided beyond it on each side, and the whole diseased part

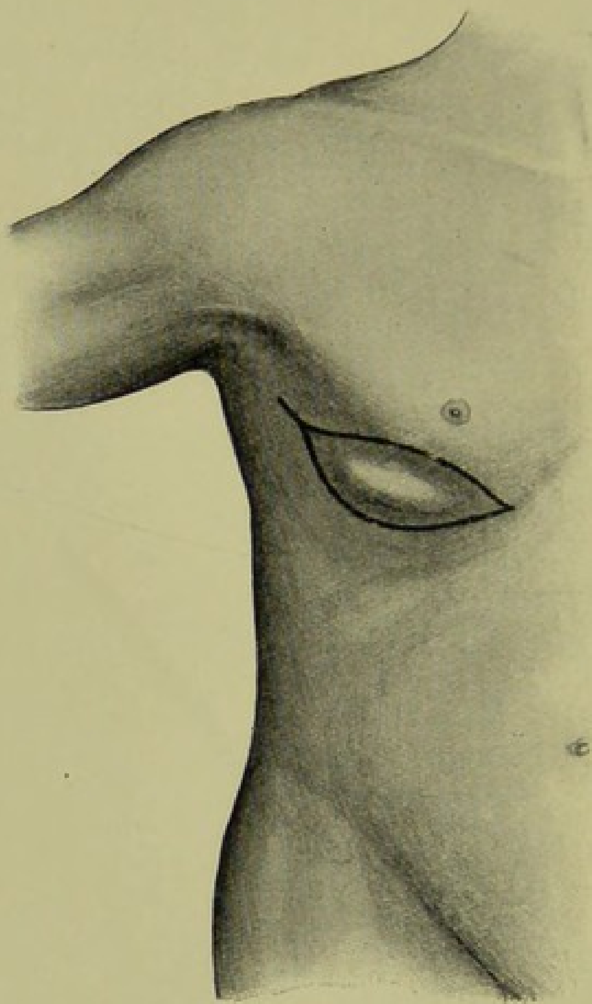


FIG. 146.—Incision for removal of an abscess of the rib.

removed. Very often this can be done without opening the abscess till the rib is lifted out. There then remains a mass of tuberculous tissue, corresponding with the deeper surface of the rib, which must be very thoroughly scraped away; care being taken not to open the pleura. The wound, having been well washed out to get rid of all the pus, is now closed by stitches, no drainage tube being necessary. Healing occurs by first intention, and if a sufficient piece of bone has been removed, there is no recurrence. This is a much better method of treatment than the partial ones of opening and drainage; of opening, scraping, and injecting iodoform and glycerine;

or of opening and applying the actual cautery to the bone, a method at one time a good deal employed abroad.

3. *Sternum.* This bone is not infrequently the seat of tuberculous disease. In post-mortem examinations in cases of advanced phthisis, it is not uncommon to find greyish or yellow deposits in the sternum, but apart from these nodules, which are in reality curiosities, the sternum may present similar changes to other bones, the disease commencing in the periosteum or the interior. Superficial caries of the sternum, secondary to periosteal disease, or to a deposit in the bone, is often very extensive, especially on the pos-

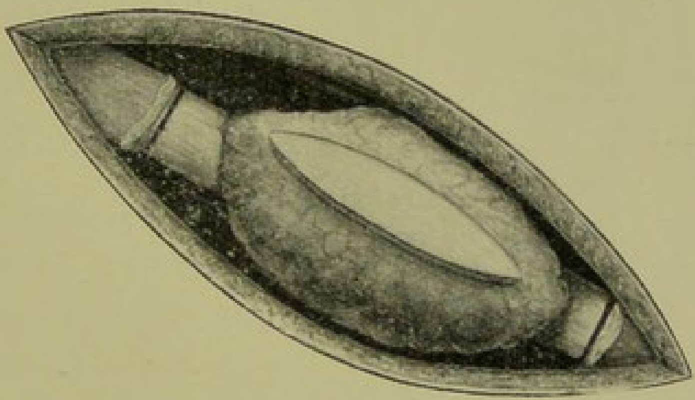


FIG. 147.—Division of periosteum and removal of the rib. The abscess is still intact.

terior surface, where the abscess formed in connexion with it spreads upwards and downwards behind the bone before it makes its way forwards between the ribs or upwards into the neck, and it infects the periosteum and the surface of the bone along its course (see Fig. 148). Deposits in the bone are also not uncommon, leading either to necrosis, or to the formation of a cavity containing soft caseous material.

Tuberculous disease of the sternum begins usually with a little aching in the bone, succeeding which is some swelling when the disease has begun in the interior or on the anterior surface of the bone. This is soon followed by the development of an abscess and all the signs of tuberculous bone disease. Where the posterior surface is affected, in the first instance, the symptoms are most indefinite, and the disease cannot usually be diagnosed till an abscess points between the costal cartilages or above the sternum ; it is rarely that the abscess attains such a size behind the sternum as to cause pressure symptoms. The diagnosis of the first condition must be made in the ordinary manner from acute periostitis ; abscess unconnected with the bone, &c. Where the posterior surface is affected, and an abscess points between the costal cartilages, it may on superficial examination be mistaken for a localized empyema, but careful examination of the chest and the bone will soon reveal the true condition (see Fig. 149).

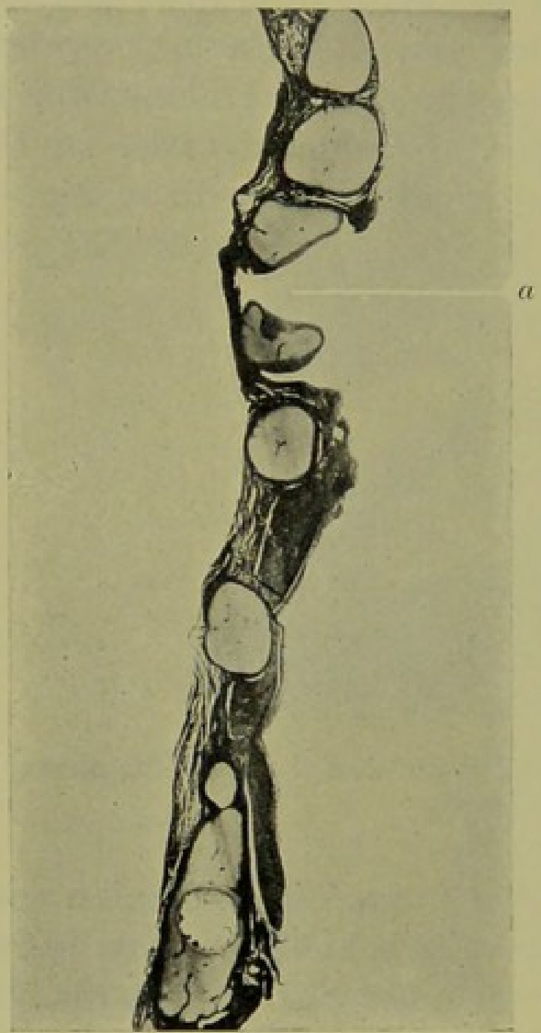


Fig. 148.—Section of sternum from a child, showing at (a) the destruction of the bones as the result of a tuberculous periostitis.

The treatment must be conducted on the ordinary lines, abscesses being opened and washed out, bone being chiselled and gouged away, &c. In some cases, especially of posterior disease, it may be necessary to remove a portion of the sternum, generally the manubrium.

4. *The Clavicle* is rarely affected with tuberculous disease. When it is attacked, it is usually at the acromial end. Not uncommonly the disease is an extension from the acromion process of the scapula. There may also be a periostitis of the shaft of the bone, and in a few instances there has been an osteomyelitis, with distension of the shaft, as in the other short long bones.

There is nothing special as regards symptoms and treatment which calls for remark. The affected piece of bone should be gouged or chipped away.

5. *The Scapula*, apart from the neck and glenoid cavity, is also very rarely affected with tuberculous disease. When it is attacked, the acromion process is the most usual seat, and the disease spreads more readily towards the clavicle than towards the spine of the scapula.

6. *Flat Bones of the Skull.* Tuberculosis of the flat bones of the skull is a rare affection, but one which assumes

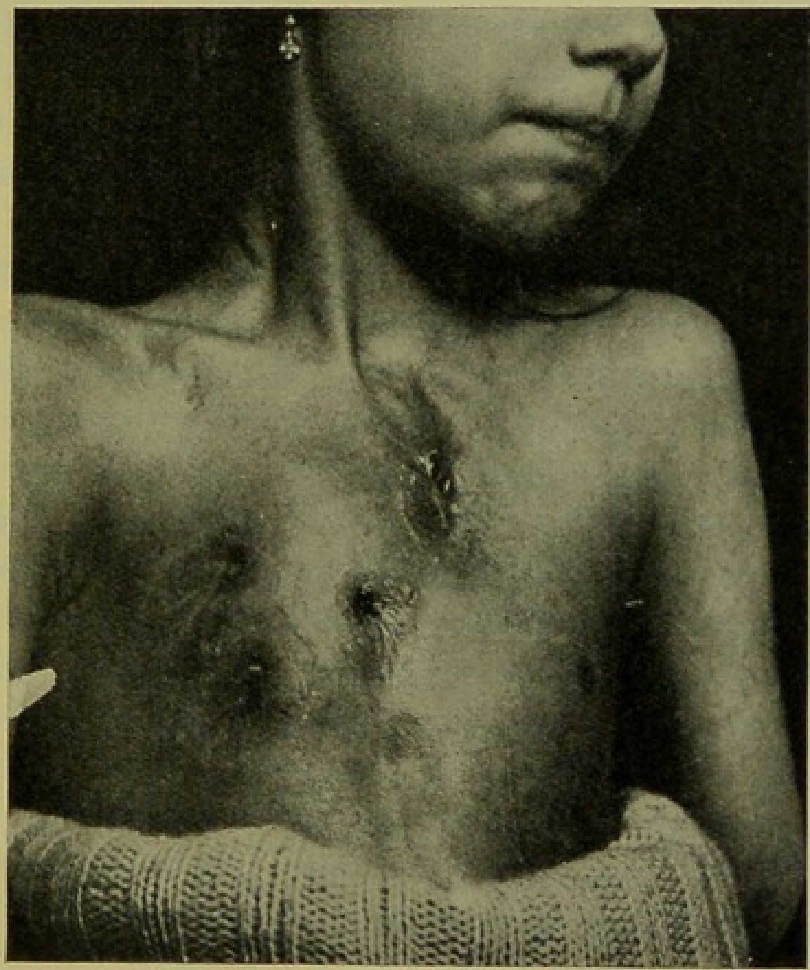


FIG. 149.—Tuberculous disease of the sternum and costal cartilages with sinuses.

importance from its situation. The following is a description of the disease taken from the few cases published, and some which I have myself observed :—

The disease affects young adults, and generally commences with pain in the head of a dull aching character, and tenderness on pressure over the affected part. The pain is presently followed by the formation of a fluctuating or semi-fluctuating tumour, in fact a chronic abscess. In some cases, however, the first symptoms after the pain are those of pressure on the brain from the formation of a collection of pus between the dura mater and the skull, such as dullness, sleepiness, slowing of the pulse, vomiting, &c. After a time the abscess bursts or is opened, and on passing a probe, the bone is felt to be bare, soft, and breaking down under the instrument, and in most cases one or more small necrosed fragments are found.

The bones affected are chiefly the frontal, especially in the neighbourhood of the orbital margin and the external angular process, and the parietal. I have also had one case where the upper part of the occipital was affected. The mastoid process of the temporal is, of course, very commonly diseased, but that I do not refer to here.

As a rule, the affection only begins in one place at a time, but it not uncommonly appears afterwards in other parts of the same bone, or in other bones. The process is, no doubt, similar to that already described, and in most cases it commences in the diploë. Here the disease presents the two usual forms, viz.—the formation of a deposit, either consisting of cheesy material, or more usually containing one or more sequestra. These sequestra are generally small, about the size of a pea or bean, but they may be more extensive, and in one or two cases they have been as large as a five shilling piece. They generally involve the whole thickness of the skull, and the inner table may be more extensively involved than the outer. Apparently there is no rarefying osteitis in the neighbourhood. Where the inner table is affected, the dura mater is separated from the bone over a considerable area, the interval between it and the bone being filled with tuberculous material, often undergoing caseation.

As a rule in these cases, there are symptoms of tuberculous disease in the other bones of the body, and apparently this affection usually occurs in the course of very severe tuberculous bone disease. It may be the first affection, but generally it only commences after other bones have become involved. It may also begin in several parts of the skull at the same time, and in these cases the prognosis is bad, and in them there is generally severe tuberculosis elsewhere. It frequently seems to bear some relation to injury, apart from cases of external wound or compound fracture where infection may have occurred directly from without.

This disease must be carefully diagnosed from syphilis. The later clinical symptoms, more especially the formation of a chronic abscess, are different from those of syphilis, but as a rule the case cannot be diagnosed till the abscess is opened. The character of the lesions in the bone, more especially of the necrosed fragment, is very different; as a rule, in syphilis the surface of the bone is extremely irregular, and shows a large number of small holes surrounded by hard, dense bone. Generally the gumma spreads into the bone from the periosteum, and hollows out a sort of spiral in the bone; in the skull this spiral is arranged like the mainspring of a watch, but in the long bones it is more like a corkscrew. The walls of these spiral channels are composed of dense, ivory-like tissue, and this gives rise to the great weight of the sequestra in syphilitic disease. In syphilis also the sequestra are generally much larger than in tuberculosis. The characters of the tuberculous sequestra have already been fully described. The Wasserman reaction will also help.

As these cases are not recognized till an abscess has formed or has burst, the treatment is essentially operative. Where an abscess is present it must be opened freely after thorough disinfection of the parts, and the condition of the bone examined. Where the disease seems to be entirely periosteal, it may be sufficient to chisel away a thin scale of the bare surface of the bone, remove the wall of the abscess, fill the cavity with iodoform and glycerine, and stitch up the wound. Where, however, the disease is situated in the diploë, and especially if sequestra are present, it is best to remove the affected part completely by means of a trephine, and investigate the condition of the inner table before closing the wound. Where sinuses are already present they must be thoroughly removed and the wound sponged with pure carbolic acid, the bone being dealt with in the manner just described.

7. *Mastoid process.* Tuberculous disease of the mastoid

process is very common in connexion with disease of the ear, and leads to many complications, such as destruction of the middle ear, suppuration in the groove of the lateral sinus, abscess of the brain, meningitis, &c. These troubles are, however, accidents, due to the septic complications, and not to the presence of tubercle *per se*, and their consideration

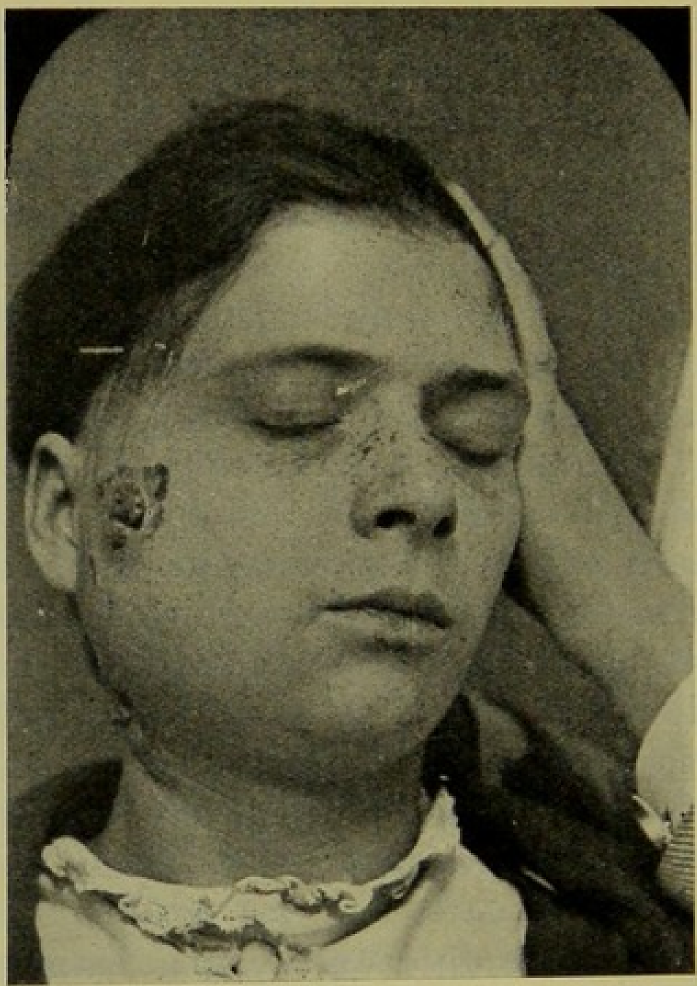


Fig. 150.—Tuberculous disease of the lower jaw affecting the temporo-maxillary joint.

would lead us quite away from the objects of this book. The chief complication related to the tuberculous nature of the disease is the occurrence of tuberculous glands in the neck, which are very common. Where there is evidence of tuberculous disease of the mastoid process, the mastoid antrum and process ought to be opened up without delay and the diseased bone removed and treated on the same lines as elsewhere.

8. *Bones of the face.* Tuberculous disease of the bones of the face is more frequent than that of the flat bones of the skull, and the most common seat of the disease is about the orbital margin of the superior maxilla or the malar bone. There the disease usually commences in the periosteum, and leads both to caries of the bone and to ulceration of the skin, and the latter condition is usually followed by serious ectropion. The lower jaw is also sometimes, but not so frequently, attacked, and in it the disease usually begins about the angle, and leads to swelling and abscess formation, the abscess bursting externally over or beneath the jaw, or sometimes into the mouth (see Fig. 150). I need not enter into any special description of the symptoms or treatment of these affections, as they coincide in all respects with the symptoms and treatment of bone disease elsewhere.

In some cases of scrofulous ozæna the tuberculous disease has attacked the bones of the nose, either primarily or secondarily to disease of the mucous membrane over them. Where sequestra are present, we generally have to do with primary tuberculous disease of the bone. Over the affected parts the mucous membrane becomes ulcerated, or a large granulation mass is formed, which may fill up the nasal cavity. These cases must be treated by free scraping away of the diseased tissue, and subsequent cauterization, the treatment being repeated on any appearance of fresh disease.

CHAPTER XXIII

DISEASE OF THE SPINAL COLUMN

TUBERCULOUS disease of the vertebræ is the most common tuberculous bone affection in children, occupying in my lists from 40 to 46 per cent of the whole, and, taking all ages together, it still remains at the head of the list. Thus in Billroth and Menzel's table, to which I have previously alluded, the vertebræ were the seat of disease in 23 per cent of the cases. As to the age at which it begins it has been found by most authors that at least 50 per cent of the total cases commence before ten years of age ; Drachmann indeed gives the proportion as 77 per cent. Some authors, Müller for example, assert that tuberculous disease of the vertebræ does not occur under three years of age, and that cases so diagnosed earlier are in reality either syphilitic or rickety. This, however, is not the case. Jaffé was able to make a post-mortem examination on a case which commenced when the child was eight weeks old, and which was undoubtedly tuberculous. In my own list of in-patients one commenced at three months, and three others during the first year of life, and these were shown to be tuberculous by the occurrence of psoas abscess and by post-mortem examination in one instance. I also possess the cervical vertebræ from a child aged 1½ years, parts of which have been destroyed by tuberculous disease (see Fig. 153). Among my out-patient cases I had four which were only a few months old when they came under observation, three were a year old, eight were two years old, &c. The explanation of the greater frequency of disease of the vertebræ, as compared with other bones, is no doubt in part at least that there are so many vertebræ, but apparently also they are especially predisposed.

The favourite seat of the disease is the dorsal vertebræ, chiefly the middle and lower ones, then the upper lumbar, and then the cervical, especially the upper cervical. This is, however, variously stated by different authors, some placing the first lumbar as the one most frequently affected, others giving the sixth and seventh cervical, others the sixth and seventh dorsal. I think that my statement meets the facts of the case. The disease may commence in the interior of the bone or on the surface. Commencing in the interior it

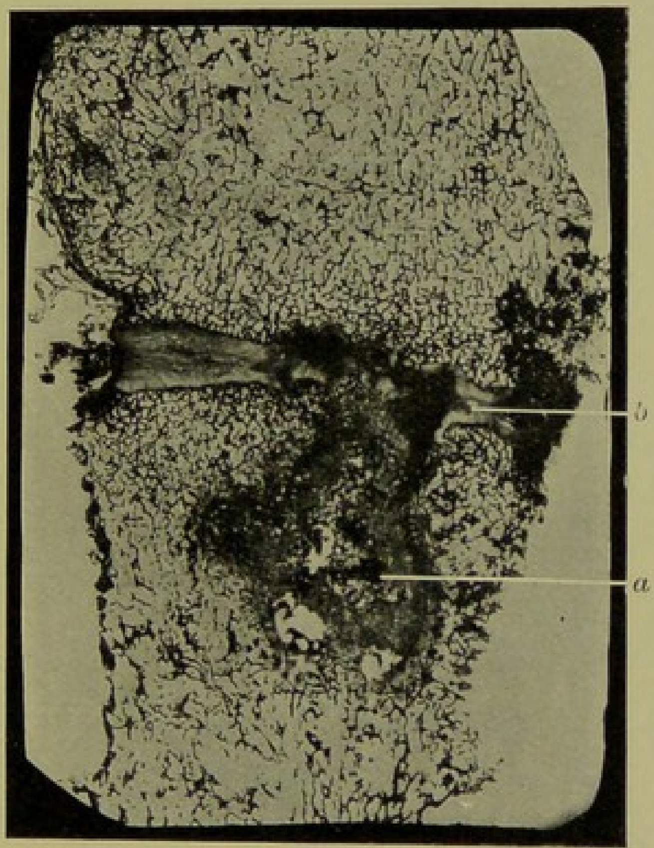


FIG. 151.—Section of vertebræ, showing at (*a*) a tuberculous deposit in the bone spreading up to and destroying the intervertebral cartilage (*b*).

presents the usual two forms, viz.—soft deposits or sequestra ; on the surface it either begins in the periosteum or very soon involves it, and spreads along the surface of the vertebræ causing a more or less extensive superficial caries. The deposits in the interior of the bone usually commence near the intervertebral cartilages, and rarely affect more than two or three vertebræ (see Figs. 151 and 152). They generally make their way to the surface on the front or sides of the vertebræ, and then spread over the surface causing a superficial caries. They also spread towards the intervertebral cartilages and destroy them either in part or completely. In rarer cases they extend backwards and reach the surface at the posterior part of the body of the vertebræ. When these deposits reach the surface they often lead to the formation of an abscess either at the sides of the vertebral column, or, where they extend backwards, in the spinal canal itself. These deposits in the bone destroy the body of the vertebra in which they occur more or less completely,

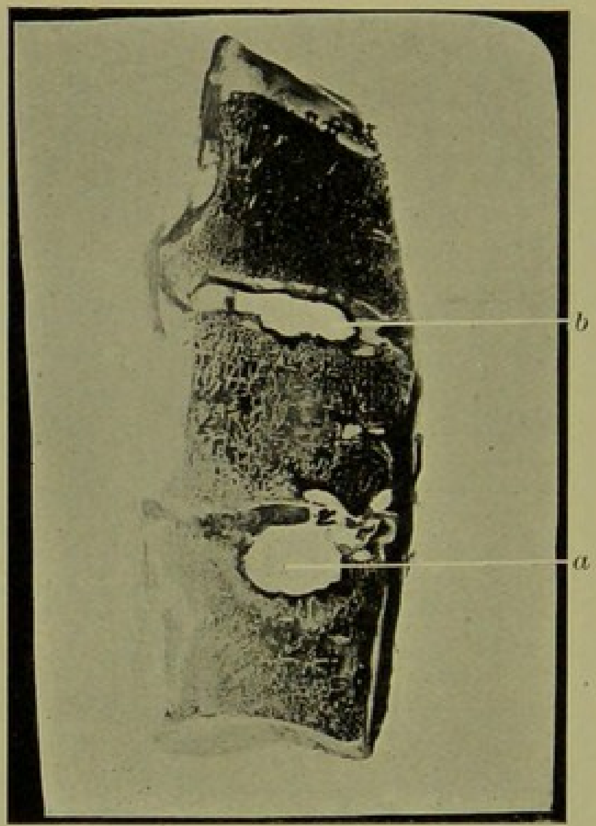


FIG. 152.—Section of vertebræ, showing at (*a*) the seat of a tuberculous deposit in the bone which has destroyed the intervertebral cartilage, and at (*b*) a similar condition where the deposit has been closer to the cartilage. The intermediate vertebra and the one above are sclerosed.

the weight of the body causes the vertebra above to sink down, and more or less acute curvature results. Where a single body only is destroyed the curvature is quite angular. Not uncommonly, however, two or three bodies are simultaneously attacked, the result being that the curvature is not so abrupt and involves three or more vertebræ. The most common arrangement is that one or two bodies are more or less completely destroyed as the result of primary deposits in their substance, and that secondarily to that, and as a consequence of periosteal extension, the intervertebral cartilages of several adjacent vertebræ disappear, and thus there is a gradual curve affecting several vertebræ with, in

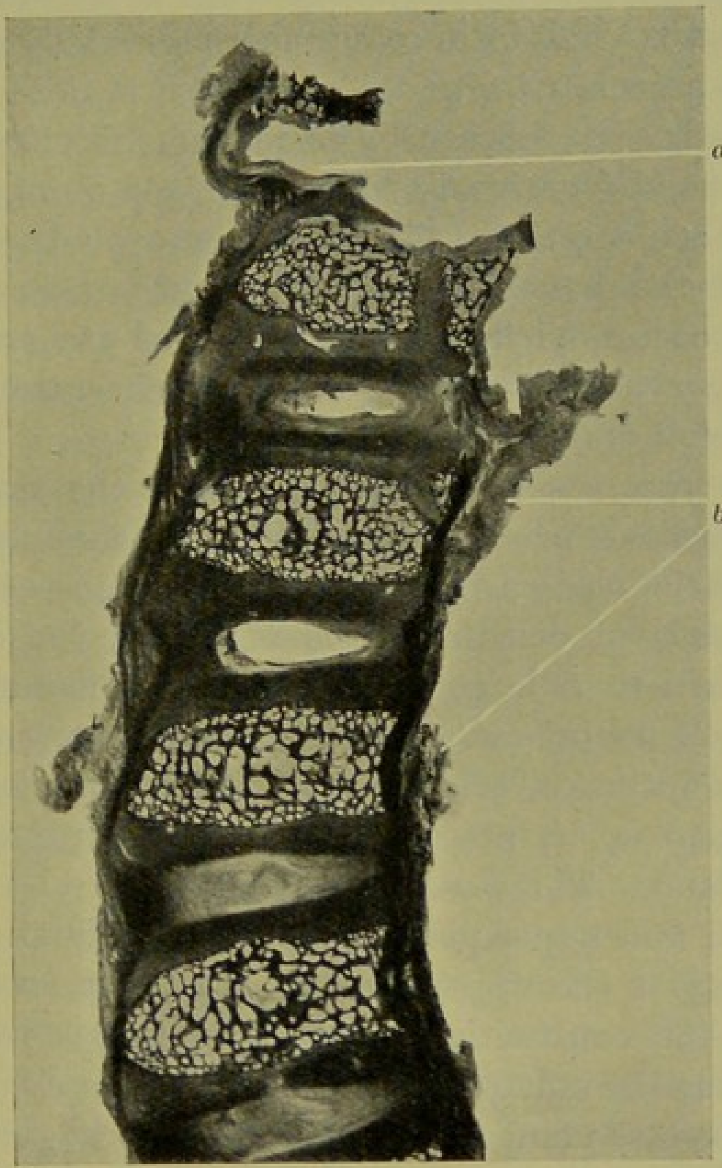


Fig. 153.—Section of the upper cervical vertebræ from a child with retro-pharyngeal abscess. The uppermost vertebræ (a) is almost completely destroyed, the next is undergoing destruction from the front, and the tuberculous periostitis (b) is extending down in front of the vertebræ.

the centre, a more acute curve due to the destruction of one or more bodies.

Where superficial caries of the vertebræ occurs it is either the primary disease, or is secondary to a deposit in the vertebræ which has reached the surface. In whichever way it arises the disease spreads along the surface and generally extends over a considerable number of vertebræ (see Fig. 153).

When it reaches the intervertebral cartilages it spreads inwards along them and destroys them; this is increased by absorption of the upper and lower surfaces of the bodies to some extent, and consequently there is an extensive and gradual curve. This form occurs more especially in adults, is most often associated with abscess, and, if it alone is present, there may be no curvature, or in the first instance only a gradual bend due simply to the loss of a number of intervertebral cartilages. On the other hand, the deposits in the interior of the bones are less frequently associated with abscesses, occur chiefly in children, and are accompanied by acute curvature, and the other displacements (such as lateral) which are sometimes present.

In some rare cases the disease affects the transverse or spinous processes primarily, and then it usually commences as a superficial caries, quickly followed by abscess.

In the case of disease of the vertebræ, the destructive processes are to a large extent due to inflammation and absorption of the inflamed bone. The inflammation is set up, in the first instance, of course, by the tuberculous disease, and it is kept up by pressure, and the absorption is mainly due to pressure. This pressure is partly caused by the weight of the head and upper part of the spinal column, especially the bending of the upper part of the body forwards, and partly by the contraction of the muscles surrounding the spine keeping the inflamed parts in constant and firm contact. I regard the last point as one of very great importance, and it is one which is not generally understood or regarded. I have already pointed out the importance of muscular contraction in hip-joint disease, and my remarks apply with still greater force to the spine.

Symptoms

In discussing the symptoms and signs of spinal disease we have to note differences, according to the situation of the affection, but I may in the first instance sketch a case, say, in the dorsal region, and then subsequently refer to the chief points in detail. In the early stage the patient has a sense of uneasiness and aching in his back, especially after he has been up for some time, which is relieved by lying down. Sometimes at this stage there may be neuralgic pains shooting along the ribs or even down the limbs, but this is not so common in dorsal disease as in cervical or lumbar disease, and in any case it is not very common as an early symptom. By and by the aching pain in the back becomes more marked, especially on running, jumping, going downstairs, &c., and the child ceases playing and is always wanting to sit or lie down. Examination of the back at this time does not usually show curvature, but distinct rigidity can be made out, neither bending forwards nor backwards being properly carried out; pain will also be induced by pressure on the head or shoulders, and by pressure over the transverse processes on each side of the spine. As time goes on the back becomes more prominent at the seat of disease, and by and by a distinct curvature develops. At this stage the pain becomes more marked, and when the child is asked to pick up anything from the floor he does not stoop but bends his knees, and often in rising again he supports his trunk by placing his hands on his thighs. If the case is neglected the curvature increases, and very often symptoms of paralysis supervene, commencing with pains around the waist, abnormal sensations in the limbs, ending ultimately in complete paraplegia. At the same time abscess, usually psoas or lumbar, appears, and by and by bursts and leaves a discharging sinus. Ultimately the patient dies of exhaustion from the prolonged discharge, of phthisis, of tuberculous meningitis, &c. Such is the very common history of a case where no treatment has been adopted, but the symptoms do not always follow this course; sometimes the presence of an abscess is the first indication of anything wrong, at other times a curvature may already be found when the patient first complains, &c.

I may now refer more in detail to some of the chief symptoms.

1. *Pain.* This is a constant symptom of active disease of the bodies of the vertebræ. The pain is of a dull, aching or

gnawing character, and is increased by movement, running, jolting, jumping, going downstairs, &c., and is always worse towards evening if the patient has been going about during the day. The aching goes on for a considerable time, even after the patient lies down, but generally towards morning he feels pretty comfortable, unless the disease is progressing very actively. The pain is greater where the substance of the bodies of the vertebræ is affected than where there is only caries of the surface. In addition to pain at the seat of disease, there may be even at an early period pain of a neuralgic character radiating from it. These early pains are frequently looked on as rheumatic, and may be quite of a fugitive character ; in other cases they are more definite, consisting, in dorsal disease, of a feeling of weight and constriction around the chest, in lumbar disease, of pain along the sciatic nerve, &c. When these symptoms are bilateral, there is generally actual pressure on the cord, but the earlier fugitive pains have been referred to neuritis from pressure on the nerves outside the canal by the tuberculous material. These early neuralgic pains are apparently most frequent in cervical disease.

In investigating the existence of pain, all actions which produce pressure on or movement of the affected vertebra should be tried. Pressure on the head or on the shoulders, if the disease is situated in the dorsal or lumbar regions, will at once produce pain at the seat of disease. Similarly, stooping, lateral, and rotatory movements also cause pain. The favourite method of examination is to tap the spines of the vertebræ, when pain will be experienced over the seat of disease. This is not, however, a very satisfactory method, because if the tapping is roughly done, or the skin thin and sensitive, the pressure of the skin against the spines causes pain at that part, while on the other hand, where there is only superficial caries, pain may not be elicited. A much more delicate test is obtained by pressure on the transverse processes. By pressure on the transverse processes rotation of the bodies is caused, and pain is at once produced, even when the disease is not extensive, and as these processes lie deeply, the fallacy of pain from pressure of the skin against the bony points is got rid of. This method of examination is specially valuable in cases of hysteria where, while pressure on the spines generally elicits the complaint of pain, the patients do not exhibit a similar result from pressure further to the side, and besides, the skin, which is frequently hyper-sensitive, is not pressed against sharp bone.

2. *Rigidity.* One of the earliest symptoms of tuberculous disease of the spine is rigidity of the affected part. The muscles surrounding the affected vertebra pass into a state of tonic contraction, and fix that part of the spine more or less completely. Hence, on causing the patient to move his spine in various directions, the affected part is kept rigid, and the movements are imperfectly performed. Thus, if the part affected is the dorso-lumbar region, and the patient is told to pick up something from the ground he does not stoop to do so but bends his knees till his hands can reach the ground. Similarly, where the upper cervical vertebræ are affected (especially in atlo-axoid disease), the rotation of the head on the spine does not occur, but if the patient is told to look to one side he rotates his trunk, or if to nod the flexion occurs in the dorsal region. This early rigidity is a most important diagnostic point, especially in distinguishing the disease from hysterical affections. In the latter case, although the pain complained of may be excessive, this rigidity of the spine is usually absent.

3. *Deformity.* The amount of deformity in spinal disease depends on the parts of the bodies which are affected. Where there is superficial caries of the vertebræ there is, in the first instance, no deformity, but by and by, as the intervertebral cartilages are destroyed, the back becomes, in the first instance, flattened (where there is naturally a curve forwards) (see Fig. 154), and ultimately a certain amount of antero-posterior curvature is produced. As a rule, in this form of disease a number of vertebræ and intervertebral cartilages are involved, and hence the curve is not acute, but is rather a gradual bend backwards, and it is not usually very marked. Where the disease has commenced in the form of a deposit

in one or more vertebræ the curvature is much more marked and acute, from the more or less complete destruction of one or several bodies (see Fig. 155). Here, as a rule, the curvature is not nearly so extensive as in the former case, but it is

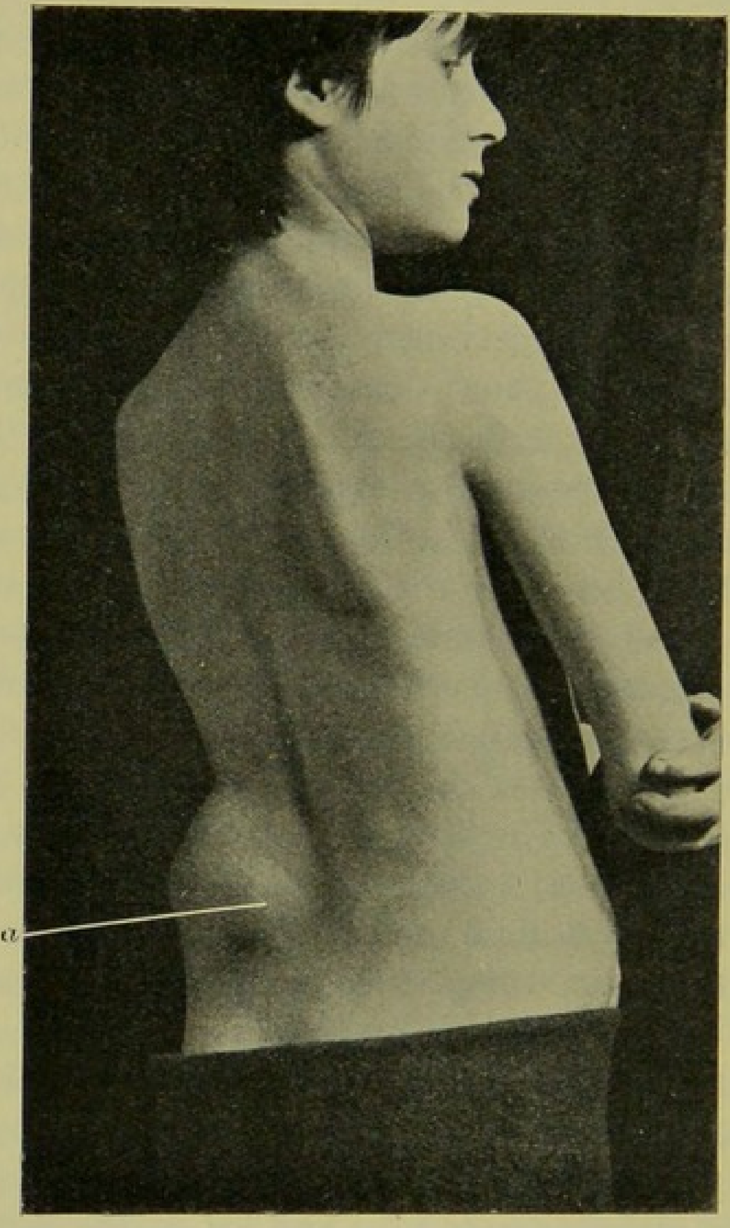


FIG. 154.—Case of disease in the lumbar region with lumbar abscess (*a*). No posterior curvature is present, but the lumbar region instead of being hollow is flattened.

much more abrupt. It may occur suddenly or gradually, is always antero-posterior, but may also, in some cases, be somewhat lateral. This last condition is produced where one side of the body has been more destroyed than the other, or where the body has been completely cut across, and where, generally as the result of some sudden movement, the upper portion has slipped to one side. This is really a partial lateral dislocation, but true lateral curvature may also, though rarely, be associated with the antero-posterior. The chief cause of the rapid development of the antero-posterior curvature is the erect posture, the weight of the upper part

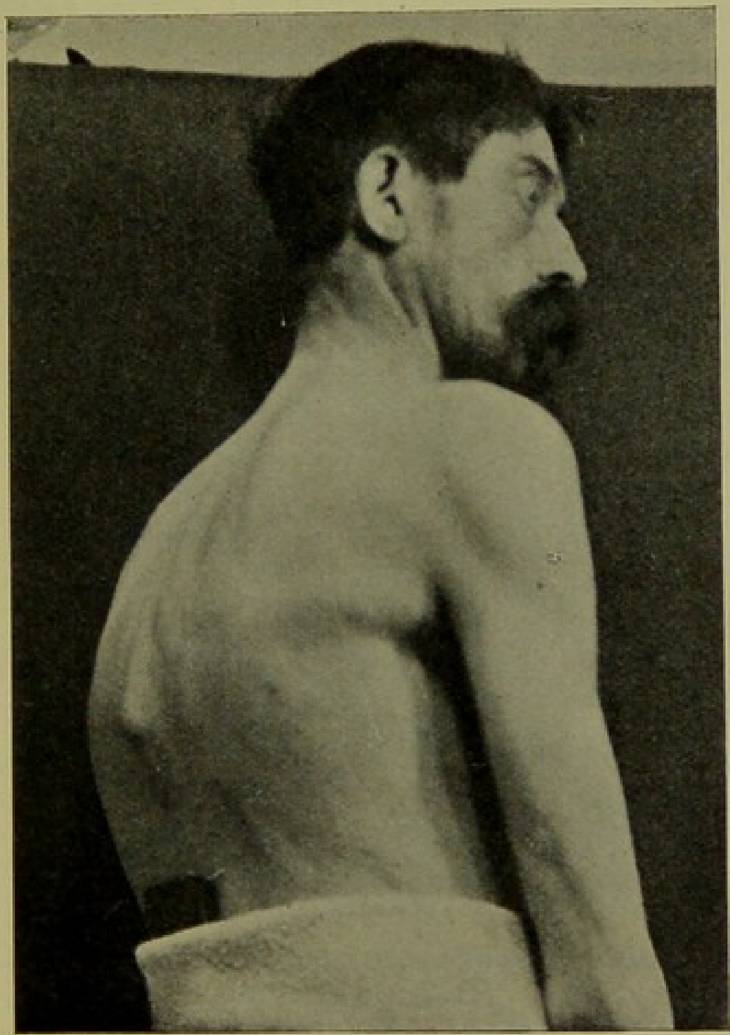


Fig. 155.—Acute Pott's curvature in the lower dorsal region.

of the spine crushing together the soft bone, but it may also occur more gradually where the patient is kept in bed in the recumbent posture, but without any extension apparatus. In the latter case it results from the tonic contraction of the muscles surrounding the spine gradually pulling the vertebræ together as the diseased parts become absorbed.

4. *Abscess*. As in tuberculous disease elsewhere, the formation of a chronic abscess is a frequent accompaniment of

tuberculous disease of the spine. It is most frequent in cases of superficial caries, the disease naturally extending readily to the soft parts as well as to the bone, and it also occurs earlier in these cases. Hence in adults, where this form of disease is most common, abscess is more frequent than in children, where we most commonly meet with deposits in the substance of the bodies and acute curvature. These abscesses

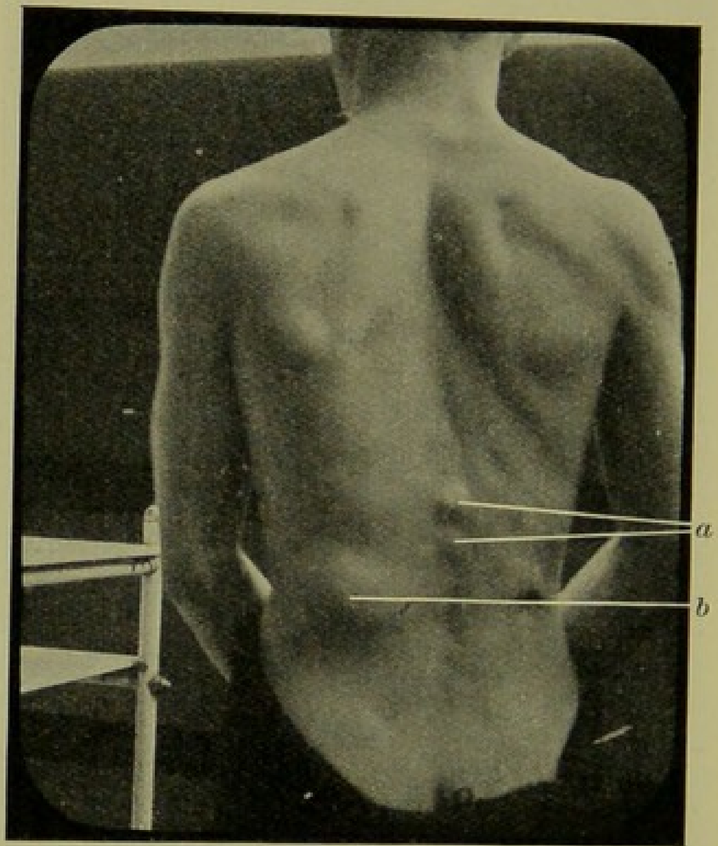


FIG. 156.—Disease of the lower dorsal vertebræ with curvature (*a*) and lumbar abscess (*b*).

form in front, or at the sides, of the bodies, and point in various places according to the region affected. In the upper cervical region they most usually form in front of the vertebræ, giving rise to retro-pharyngeal abscess, which points in the pharynx or passes outwards on each side at the upper part of the anterior triangle ; in other cases they may extend backwards and point in the suboccipital region. At the lower part of the neck they usually appear in the lower part of the posterior triangle, or they may project the œsophagus and trachea forwards ; they may also pass down into the posterior mediastinum, or into the axilla. In the dorsal region the abscesses form inside the thoracic cavity in front or at the sides of the vertebræ, and they sometimes make their way backwards between the transverse processes, and project in the back, forming dorsal abscesses. In other cases they extend forwards beneath the pleura, and pass outwards about the middle of the side of the thorax, giving rise at first sight to the idea that the case is one of abscess in connexion with a diseased rib ; this idea is often strengthened when, on opening the abscess, the rib is found to be bare, for the periosteum is very apt to become infected at the point where the abscesses have passed outwards ; the diagnosis can, however, be made by the presence of other symptoms of spinal disease, and by finding that a sinus leads backwards towards the vertebræ. Abscesses in connexion with the dorsal vertebræ may also, though very rarely, extend into the posterior mediastinum, burst into the pleura, lung, &c. At the upper part of the dorsal region the abscesses not uncommonly pass upwards, and point in the lower part of the posterior triangle, and at the lower part of this region they most usually pass downwards through the pillars of the diaphragm, and along the sheath of the psoas muscle, forming typical psoas abscesses (Fig. 157), or point in the lumbar region behind (see Fig. 156). In the lumbar region they generally pass down in the sheath or substance of the psoas muscle as psoas abscesses, or they pass backwards and form lumbar abscesses. Where the lowest lumbar vertebræ are affected, they may form in the iliac fossa, and point above Poupart's ligament, at the outer part, as iliac abscesses; or sometimes, though rarely, they extend backwards through the sacro-sciatic notch, or through the obturator foramen, and point in the buttock or back of the thigh, or even in the perineum.

5. *Effect on the spinal cord.* The disease of the bodies of the vertebræ may not only extend forwards, but also backwards, and, under certain circumstances, lead to prejudicial effects by pressure on the cord. This pressure originates in two ways. In the first and most common mode, the dura

mater becomes infected and thickened, the condition of pachymeningitis being produced, and the thickened membranes fill up the spinal canal and press on the cord. In other rarer cases, an abscess forms beneath the dura mater, and causes it to bulge backwards and compress the cord against

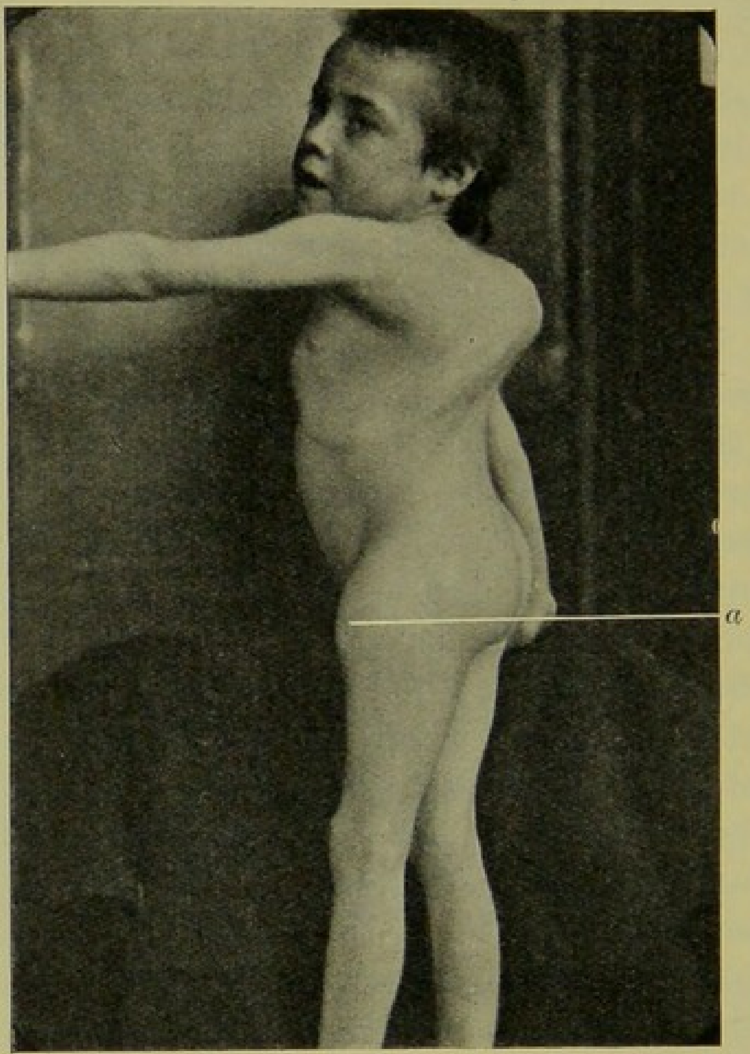


Fig. 157.—Tuberculous disease of the dorsal region affecting a number of vertebræ and producing a general posterior curvature. The general deformity of the thoracic cavity is well seen. At (*a*) a psoas abscess is pointing just below Poupart's ligament.

the laminæ of the vertebræ ; in this case the symptoms of pressure may suddenly subside when an abscess forms in front or is opened, the internal abscess communicating with and emptying itself into the external. It is possible, also, that similar symptoms may arise in cases of very acute curvature from kinking of the cord and interference with the circulation. Or, that in an acute curvature the cord may be stretched over the bodies of the vertebræ, and pressed upon in that way, but pressure over the curved vertebræ does not as a rule occur. As a matter of fact, however acute the curvature, the calibre of the spinal canal remains the same, so long as there is no pachymeningitis or abscess in it, and as it is actually shortened, the cord lies quite loosely in it, and is not stretched over the anterior wall of bone, but, if pressed on, it is by the mass of granulation tissue which is present behind the bone. This is a very important fact to remember from the point of view of treatment. The pachymeningitis is greatest at the anterior surface, and seldom surrounds and constricts the cord, and, in the first instance, it is generally non-tuberculous. As a result of the pressure from whatever cause, myelitis occurs at the seat of compression, and there the cord may be flattened, softened, and, in some cases, almost diffluent; secondary degenerations spread from this point. The spinal nerves may also be pressed on and undergo alterations, as the result of the new growth of granulation tissue in the neighbourhood.

The symptoms which arise from this condition differ, of course, according to the part of the cord pressed upon, but they all consist of the effects of pressure, leading to paralysis of the parts beneath. Prior to paralysis, various trophic changes may occur from this inflammation of the cord and nerves, such as wasting of the muscles, dry scaly skin, local sweating, vaso-motor disturbances, such as œdema, coldness, &c. As a rule, paralysis of motion is the first to occur, and may be complete as regards the lower extremities, and in certain cases as regards the rectum and bladder. Sensation is very seldom lost, and if impaired, is the first to recover. The paresis is, in the first instance, slight, and may remain so, but usually after some time spasm, and subsequently contracture, occur, accompanied by atrophy of the muscles. The reflexes are exaggerated, and ankle clonus is present at this stage. If sensation is affected, tactile anæsthesia generally appears first, and analgesia last. Other modifications of sensation, especially retarded perception, may also occur. Want of co-ordination of movements may be observed. The nutrition of the affected limbs is also profoundly affected.

The symptoms and signs of spinal disease vary according to the region affected, and I may, in a few words, refer to the chief points, with especial reference to the pressure effects on the cord.

(*a*) *Disease at the upper part of the cervical region.* Here the disease generally begins, and is most advanced in the atlo-axoid articulation, and the odontoid process of the axis is very frequently affected. The main seat of the disease is in the articular surfaces, the cartilages of which become extensively destroyed, sometimes more on one side than on the other; portions of the bones may also become necrosed, especially the anterior arch of the atlas. There is a great tendency for the atlas to be displaced forwards on the axis. When recovery takes place, anchylosis is the result.

In the early stage, the symptoms are, difficulty in moving the head, local pain, and pain radiating about the back of the head and following the course of the various upper cervical nerves. Pressure on the head or neck causes pain, nodding and rotation are diminished or abolished, there may be a certain degree of wry-neck, and deformity in the sub-occipital region, that fossa being filled up. The degree of pain varies, and, in many cases, becomes aggravated as the disease goes on, so that, after some months, the weight of the head becomes unbearable, and the patient supports the head with the hands, or remains lying: this condition may be somewhat relieved if an abscess forms, the head being then supported, so to speak, on a water pillow. At this period, also, displacements of the bones are apt to occur.

At the same time, grave symptoms may appear as the result of compression of the cord, either by the soft tissues or the displacement of the bones, especially by pressure of the odontoid process. Where displacement occurs suddenly, immediate death may result from crushing of the medulla, but this is very rare, and usually the pressure takes place more gradually, and death is preceded by paralytic symptoms. These begin as feebleness of the extremities, and often limited paralyses ; the arms are usually affected first. The lower extremities may be affected, and sometimes also the bladder and rectum, in the form of retention and constipation, though in some instances of incontinence.

(*b*) *Cervical and cervico-dorsal disease.* In this region the stiffness of the neck is very apparent, and there may also be wry-neck, there is marked angular curvature, the neck is shortened, and the anterior part rounded (Fig. 158). Where the upper dorsal region is also affected in children, there is deformity of the thorax, the ribs approaching each other, and running almost vertically downwards, and the antero-posterior diameter of the thorax is much reduced. Pain is also present in the region of the cervical or brachial plexus, according to the situation of the disease. As regards the effects on the cord, pressure effects are not so common here as in the lower dorsal region, and when they occur, the upper extremities are usually first attacked, but the lower limbs may subsequently become affected. The paralysis may be unilateral, or even confined to groups of muscles, and in this case it is due to alterations in the roots of the nerve trunks. Very often, also, there are pupillary changes, either myosis or mydriasis, and there may also, in rare instances, be other troubles, such as pulmonary, cardiac, or gastric disorders, in the form of cough, slow pulse, vomiting, &c. Where there is complete paraplegia, there is often retention of urine and constipation.

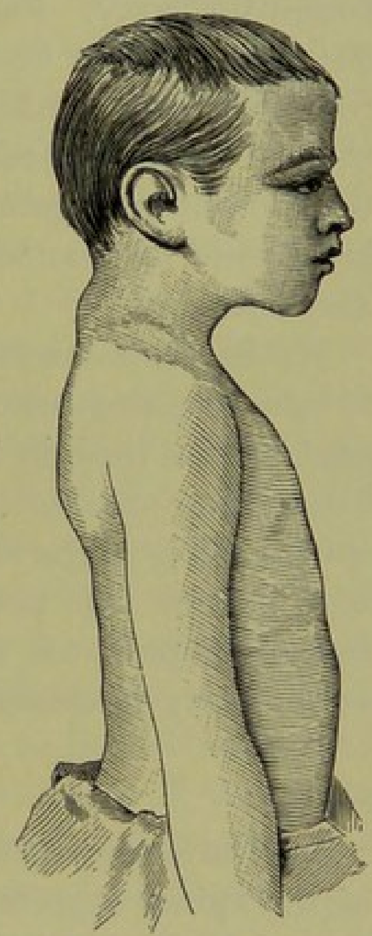


Fig. 158.—Position of the head in disease of the cervical spine. (After Bradford and Lovett.)

(*c*) *Dorsal and Dorso-Lumbar Disease.* After what has been already said it is unnecessary to go again into the symptoms of the disease in this situation, and I need only remark that where the curvature is in the mid-dorsal region the thorax assumes a globular shape, the sternum being projected forwards, and the antero-posterior diameter increased (see Fig. 157). Paralysis is most common in disease in the mid-dorsal region, and not nearly so frequent in lumbar disease. At an early stage there may be pains radiating down the limbs, and especially round the waist, as if a cord were tied round the body. Paraplegia may be complete or incomplete, the limbs are at first flaccid, but later there is contracture, reflexes are generally increased, and sensation diminished or it may be abolished. When the pressure is at the level of the lumbar enlargement, the limbs remain flaccid, the reflexes are feeble or abolished, and there is incontinence of urine and fæces.

(*d*) In lumbosacral disease the nervous troubles are due to neuritis, and hence the paralytic symptoms are limited to parts of the limb in the first instance, and are not necessarily bilateral or symmetrical, reflexes soon disappear, and faradic contractility of the muscles is lost. In disease in this situation in children the pelvis is apt to be deformed, becoming funnel-shaped. A somewhat similar deformity may result secondarily in dorso-lumbar disease.

Diagnosis

In adults rheumatoid arthritis may attack the articulations of the spine, especially in the cervical region, and it may at first sight be somewhat difficult to distinguish it from tuberculous disease, but in the former case the deviation of the neck is slight, or not at all present; in the early stage the movements, although limited, can be carried out to a certain extent without violent pain, and are accompanied by creaking; the swelling of the neck is hard, not soft, as in the tuberculous condition; the disease may last a long time without giving rise to marked deformity, and the general condition remains good.—The more acute joint affections, such as rheumatism, come on quickly instead of insidiously, attain their height in a few days, and then gradually subside. —A secondary malignant deposit in the body of a vertebra may give rise to a curvature, and has been mistaken for tuberculous disease, but the history of the primary disease, the violent pain which precedes the deformity, the existence of other secondary deposits, &c., will prevent the possibility of error.—Hysterical spine is sometimes difficult to distinguish, but in that case rigidity is usually absent, and the tenderness is superficial and not increased by pressure on the transverse processes.—In the case of cervical disease the wry neck associated with it may be distinguished from the other forms by the tenderness of the sterno-mastoid or other muscles in the rheumatic form, and by the fact that in ordinary old-standing wry-neck, the limitation of movement is only in that one direction, other movements being free.—In some cases of sprain it may be difficult, in the first instance, to be sure that the bone is not affected, but here there is a distinct history of injury, the tender parts are usually to one side of the spine, and there is no deformity. Sprain rarely occurs in children, but if it does the case should be watched carefully.—In rickets, curvature of the spine is not uncommon, but usually it is very extensive and forms one uniform curve, there is not so much rigidity, and other signs of rickets are present.—Hip-joint disease is generally mentioned among the diseases to be excluded, and where psoas abscess is present, or contraction of the psoas muscle from irritation, the thigh is flexed, abducted, and rotated outwards; the possibility of complete flexion and free movement in that position, show, however, that the case is not one of hip-joint disease.

Treatment

As in the case of other bones and joints, the essential part of the treatment is to place the affected part absolutely at rest, and as far as possible to remove all sources of irritation. In order to place the spine completely at rest, it is necessary to prevent antero-posterior and rotatory movements, to remove the weight of the upper part of the body, and to put a stop to the spasmodic contraction of the muscles. This can be brought about by placing the patient flat in the recumbent (supine) position on a pretty firm bed, without any pillow, laying heavy sandbags on each side from the axillæ to the feet to prevent lateral movement, with sheets over the legs, pelvis, and thorax, passed under the bags to prevent antero-posterior motion, and extension applied to the head and feet to bring about muscular relaxation.

Formerly it was the fashion to place the patient in the prone position, and even now this is advocated by some. The advantages claimed are that the patient is able to read, play, eat, &c., much more comfortably than when lying on the back, and that there is no direct pressure on the prominent spine, and it is said to restrain the action of the abdominal muscles in bending the spine. The prone position is, however, in my opinion essentially bad, because it does not give the spine absolute rest; because it cannot be satisfactorily combined with extension; because the thorax and abdomen are pressed upon, and there is consequent interference with the functions of the contained organs; because there is pressure on the front or diseased part of the spine; and because the bowels and bladder cannot be relieved satisfactorily without movement.

In fixing the patient in the supine position the bed should be a hair mattress placed on the strongest canvas stretched over the best spring mattress; if the mattress is too soft, or the springs too weak, the body sinks in the middle, and the upper and lower part of the spine are pressed together. For the same reason there ought to be no pillow or bolster, but the head should lie flat in a line with the body, and should not be raised for any purpose, unless, indeed, the disease is in the lower lumbar region, when, so long as the shoulders are not moved, the head may be left free. A point which is not sufficiently attended to is the use of the bed-pan. In introducing it, the patient is rolled round or raised, and this, of course, entails movement of the spine. The best arrangement is to have the mattress made in three transverse pieces of different sizes, the narrowest being opposite the pelvis, and slightly broader than the bed-pan. This narrow piece is again divided into two in the middle, and when the pan is to be used, one half is pulled out, the bed-pan slipped in, and the other side drawn slightly out, so as to let the bed-pan get into position ; in this way the back is not moved, and during defæcation the pelvis rests partly on one half of the mattress and partly on the bed-pan.

The thighs must be kept down as well as the body, because drawing up of the thighs means the action of the psoas muscle, and consequently disturbance of the seat of disease. In cervical disease the head and neck must be placed between fat short sandbags. In very restless patients, especially in cervical disease, it may be necessary to mould a light plaster of Paris casing over the front and sides of the patient, so as to control movement efficiently, but usually the sandbags are enough.

The application of extension to the head and lower extremities is one of the most valuable points in the treatment of spinal disease at all stages. It is applied as follows :— The ordinary extension arrangement is attached to each thigh, and a weight of about 3 lb. to begin with in children is affixed to each, the thighs being somewhat abducted. A similar weight is attached to the head by means of a chin and occipital band meeting above the ears, and continued up to a pulley at the head of the bed. As a rule, 3 lb. is as much as can be comfortably borne at the head, but in adults a little may be put on the extremities. It is not, however, necessary or desirable to have very great extension, because, when long continued, even a slight weight is sufficient to tire out the muscles. The movements of the patient must, of course, be also controlled in the manner already described.

The combination of double extension, with absolute fixation of the spine, is in my opinion the ideal treatment of spinal disease during the progressive stage and in any situation, and a few months' treatment in this way will do as much and more for a case than very prolonged treatment with the various forms of spinal supports. At first sight one might think that the general health would suffer from confinement in bed, but the contrary is the case. The immediate cessation of the inflammatory process, pain, &c., leads to improvement in health, appetite, and general condition, and if the patient is kept under good sanitary conditions, the general health will not suffer for a long time; the cases where improvement in these respects does not follow confinement to bed are in most cases those in which no efficient rest is given to the affected part. I have known cases of psoas

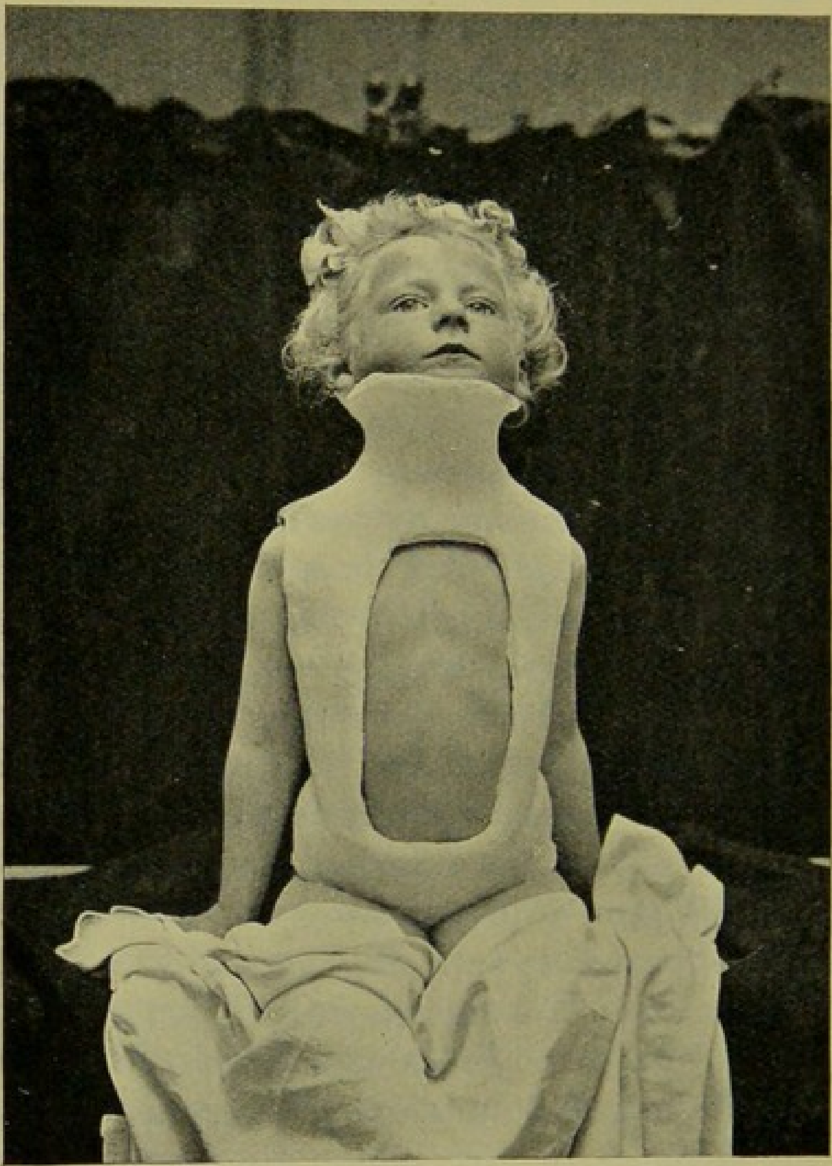


Fig. 159.—Plaster of Paris apparatus applied in cervical disease. (From Mr. Gauvain.)

abscess kept in bed and at rest for a long time, even for years, without the general health suffering in any way.

Where the children are very restless it may be well to put them in plaster of Paris, and this is extensively done at some institutions, such as the Treloar Home at Alton. Figs. 159 and 160 have been given to me by Mr. Gauvain, and illustrate the way in which the plaster is used. Fig. 159

is a case of cervical disease, and Fig. 160 is a case of dorsal disease, where a window is formed behind so that the back can be got at and inspected. This window is closed by a padded door so as to fix the patient rigidly. These arrangements are only employed in conjunction with complete recumbency, and there is no doubt that the fixation of the spine is very complete, more so than with sandbags.

This treatment by complete fixation, with extension if necessary, should be continued for at least six months. By that time, if things have gone on well, it will become a question of allowing the patient greater freedom. This question arises especially in adults, and depends very much on the seat of the disease.

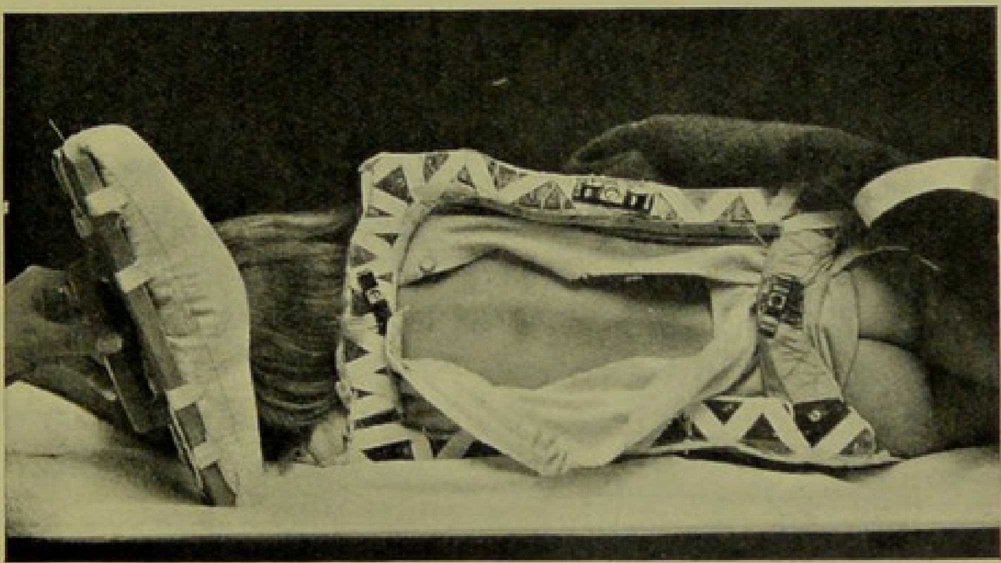


Fig. 160.—Plaster of Paris apparatus for dorsal disease. The window is seen open, the door being held aside by the nurse. (From Mr. Gauvain.)

As regards the various forms of spinal apparatus used with the view of allowing patients to walk about, I may say at once that as a curative means they are of use chiefly in adults, and in lumbar or dorso-lumbar and cervical disease. In children, and in mid or upper dorsal disease, they are for the most part inefficient, because in children the pelvis is not developed sufficiently to form a proper basis of support, and in upper dorsal disease, unless combined with a cervical collar holding up the head, but little support is given, and even then there is no proper fixation of the spine. All arrangements for holding up the head by means of a jury mast are very imperfect.

In children, either from the first, or, better, after a preliminary period of absolute recumbency in bed with double extension, Phelps's box is the best apparatus to employ (Fig. 161). Phelps's box is a trough of wood, in which the body of the patient lies, having two narrower troughs diverging from each other for the lower extremities. The box is made somewhat broader than the patient, so as to allow for lateral pads, which fix him while he rests on a mattress, or on pads so arranged as to prevent undue pressure on the curve. Opposite the buttocks the wood is hollowed out so as to permit of defæcation. The sides of the trough are about 6 inches high for the trunk and lower for the legs; they are hollowed out opposite the shoulders so as to allow free play for the arms. At the feet there are vertical pieces of wood, to which the feet are bandaged, a pad, of course, intervening. It is well to continue the splints about 18 inches above the head, so as to allow room for elastic extension attached to bands under the chin and occiput, and to buckles at the top of the splint. The patient is carefully wedged in with pads and bandaged to the splint (Fig. 162). In this apparatus the

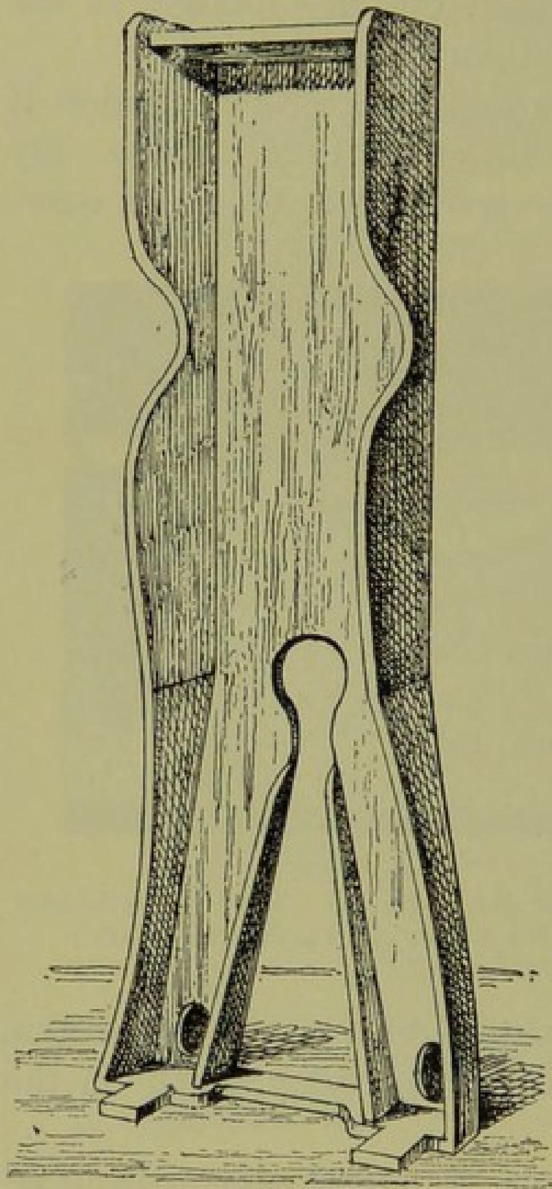


Fig. 161.—Phelps's box for spinal disease.

child lies at absolute rest, and is easily carried about. Further, if the head extension is applied and the lateral pads carefully wedged in, the box may be tilted up so that the patient may look out of the window, &c. Defæcation and

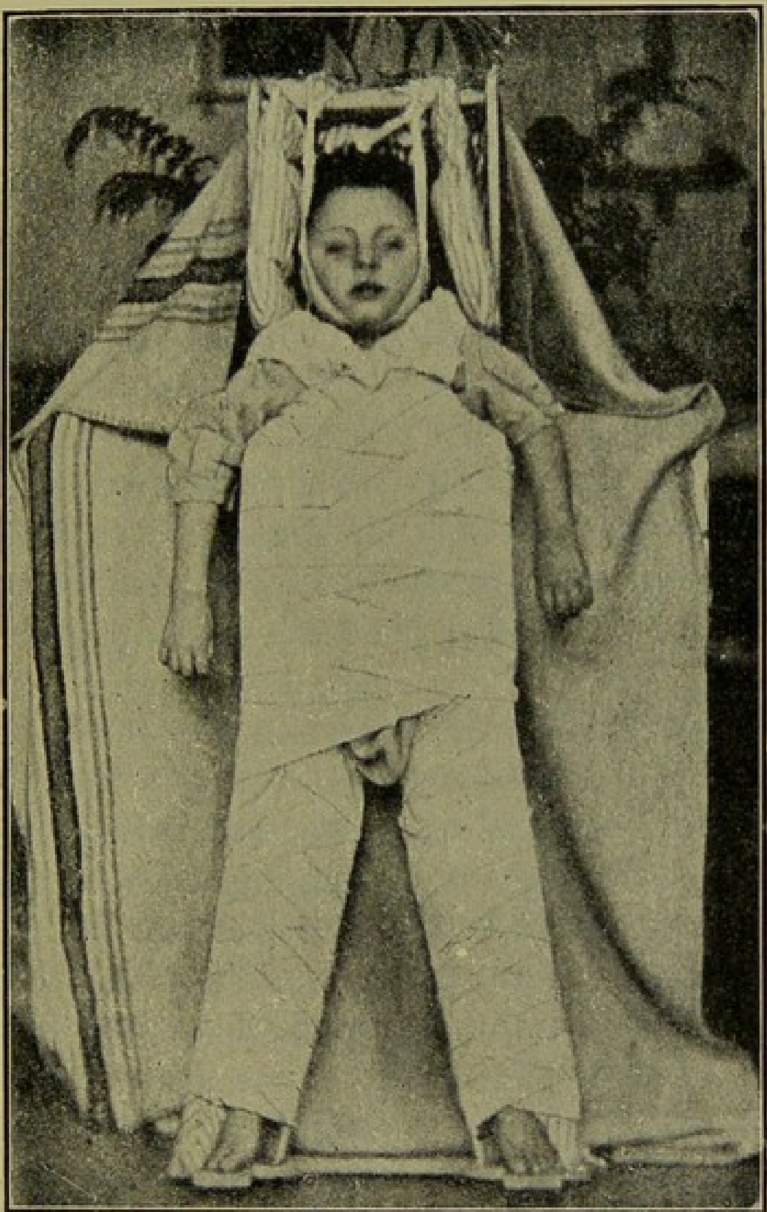


FIG. 162.—Child fixed in Phelps's box.

micturition are performed without disturbing the patient. By undoing the bandages the front and sides and limbs of the child are easily washed without any disturbance, and when it is necessary to wash the back the apparatus is turned upside down on a bed, and then lifted off the child; the patient is replaced in the reverse manner and not by lifting him into the box. Children should be kept in this apparatus as a rule for two or three years. The whole apparatus with mattresses costs from 15*s*. to 20*s*. (Fig. 162).

In private practice these boxes can be made more elegant by having the sides of strong wicker work, the bottom remaining wood.

An apparatus in some ways more convenient but by no means so efficient is a double Thomas's splint, provided with a head rest, the interval between the two upright bars from the buttocks upwards being filled up by a piece of strong canvas.

When the child is ultimately better a light poroplastic jacket worn for a few weeks gives him a feeling of security, and prevents too sudden use of the spine, and is, therefore, of some advantage at this period, but at an earlier stage, as a support for the spine in children, it is not only useless, but in many cases positively harmful. The reason for this is that the pelvis is imperfectly developed, and therefore there is no part for the pelvic band to get a proper purchase against.

In adults, when the disease is in the lumbar or dorso-lumbar, or in the cervical regions, it may be treated from the first with suitable spinal supports, but it is much better if the patient can manage it to employ absolute recumbency with double extension, in the first instance for three to six months. It is not, however, necessary with the disease in this situation to confine the patient to bed for a longer period. In a few months, under the action of perfect recumbency with extension, the new inflammatory material will have become organized and to some extent ossified, and in the adult the pelvis is broad and forms a fairly efficient basis of support.

The idea that the function of a spinal apparatus such as the various jackets is to lift up the thorax and so prevent the pressure of the bodies of the vertebræ on each other is an entirely erroneous one. The only way of preventing the pressure of the bodies on each other is to straighten the spine so as to prevent the upper part falling forwards, this movement taking place at the articular processes. This is most efficiently carried out by the forms of apparatus spoken of by the Americans as Braces, of which Taylor's brace is one of the best. It must be remembered that the articular processes, laminæ, spines and their ligaments, all remain intact although the bodies of the vertebræ are destroyed, that the upper part of the spine merely falls forward and does not bodily descend, and that the object is not to push up the upper part of the trunk as a whole, but to keep back the upper part of the spine and prevent it rotating forwards on the pivot formed by the articular processes, &c., and thus crushing the softened bodies together. The principle of the brace is to place a bar on each side of the spine, having their fixed points at the pelvis and their fulcrum at the seat of disease, and then by an apron over the front of the thorax pull back the upper part of the spine, or at any rate prevent it from falling forwards (Fig. 163).

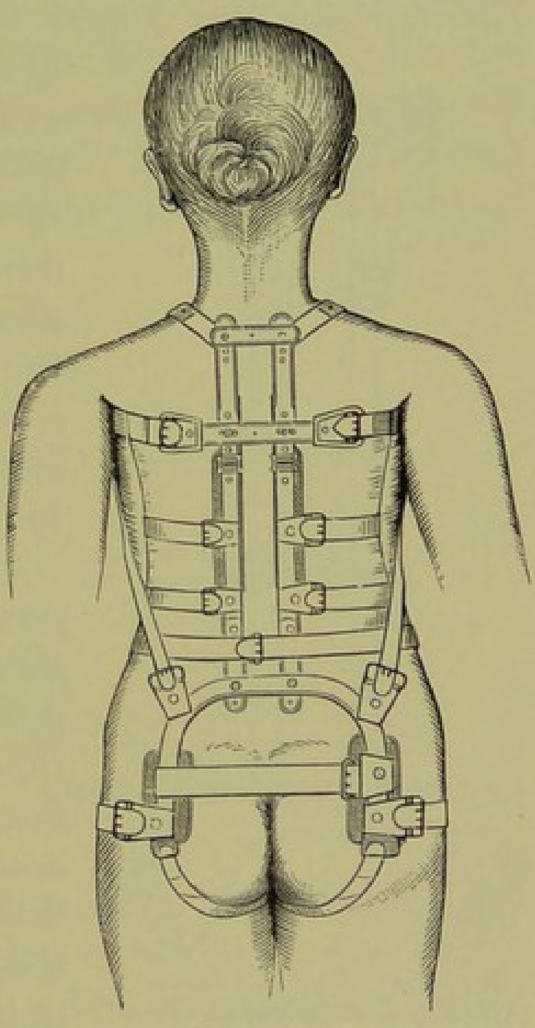


Fig. 163.—Taylor's brace applied. (After Bradford and Lovett.)

I may quote the description of Taylor's brace from Bradford and Lovett's *Orthopædic Surgery*. 'In the first place, a tracing of the back is made. This is done as follows :—The patient lies upon a hard surface, and a strip of flexible metal (lead, or a mixture of lead and zinc) strong enough to retain its position and pliable enough to be readily bent is laid upon the back, from the neck to the sacrum, so as to accurately fit the lines of curve presented by the spinal column. The lead is removed, laid on its side upon a piece of stiff cardboard, and the inner outline traced. . . . The simplest antero-posterior apparatus consists of two uprights of annealed steel, three-eighths or one half of an inch in width, and thick enough to be rigid. The gauge numbers of the steel as to thickness should be eight to twelve. These uprights should reach from just above the posterior superior iliac spines to about the level of the second dorsal vertebra. The uprights are joined together below by an inverted U-shaped piece of steel, which runs as far down on the buttock as possible without reaching the chair or bench when the patient sits down. . . . The uprights are joined above by another U-shaped piece, the upper ends of which should pass over to the anterior aspect of the elevation of the shoulders, or rather to the root of the neck.

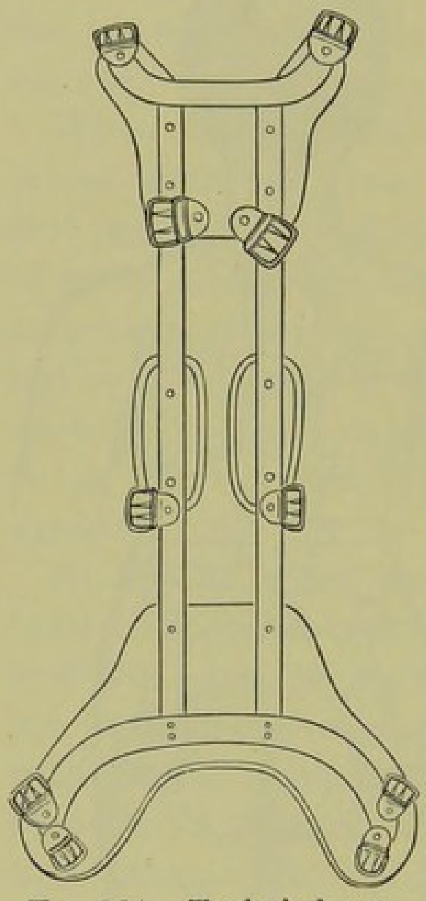


Fig. 164.—Taylor's brace. After Bradford and Lovett.)

'The uprights should be far enough apart to support the transverse processes of the vertebræ and not the spinous processes. They should be bent according to a cardboard tracing of the back, taken as described, and then adjusted to the back. The neck and bottom pieces should be cut out in cardboard in pattern. The whole should then be riveted together and tried on the patient, who should be lying on his face in the recumbent position. Any alteration necessary in the curves of the steel in order to have the appliance fit closely to the back along its whole length can be made with wrenches. The brace can then be wound with strips of Canton flannel, faced with hard rubber and covered with chamois, or be covered smoothly with leather. An accurate fit is essential, the covering is merely a matter of detail.

'Pad-plates covered with felt or hard rubber are needed. In some instances, at the points of greatest pressure (the fulcrum of the lever, &c.), the bars of the brace, if well padded, answer every purpose. Buckles are needed at the ends of the neck piece, at a level with the axilla, opposite the middle of the abdomen, and at the lower end of the brace . . (Fig. 164).

'It is, of course, essential that the trunk be properly secured to the brace. This can be done by means of an apron which covers the front of the trunk, the abdomen, and the chest, reaching from the clavicles nearly to the symphysis pubis. The apron is provided with webbing (non-elastic) straps, which are fastened into buckles attached to the brace.

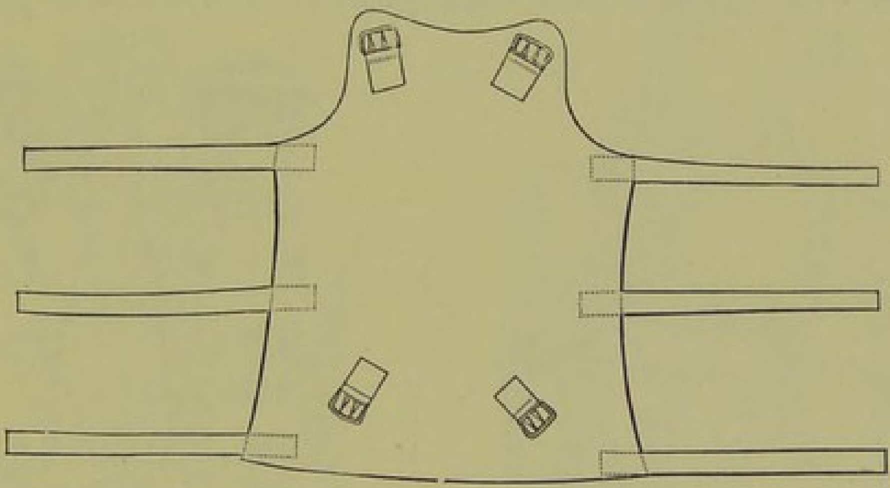


FIG. 165.—Apron for Taylor's brace. (After BRADFORD and LOVETT.)

Padded straps passing from the top of the brace, around the arms, under the axillæ, and attached to buckles in the middle of the brace, help to secure it; but the scapulæ, being movable, cannot be relied upon alone to fix the trunk, and the apron must be furnished with straps at the top which pass over the shoulders to buckles in the top of the brace (Fig. 165).

'In adults, it is often convenient to have the apron split down the front and provided with webbing straps and buckles. It can then be adjusted by the patient himself without touching the straps at the back, which secure the apron to the brace.

'A useful addition in certain cases of dorsal caries is found in the use of Dr. Taylor's chest piece. By means of hard rubber pads a definite counter point of pressure is furnished at the upper part of the chest which keeps the brace closely against the back. The pads of the chest piece may be made of hard rubber and fit in below the clavicles where they cause no discomfort, and restrict the chest movements less than the apron, besides affording more definite support (Fig. 166).

'The brace should be worn day and night, and removed daily that the back may be bathed. While the brace is off the patient should lie on the face or the back. On no account should he sit erect. The back after being washed should be rubbed with alcohol and then powdered with face powder,

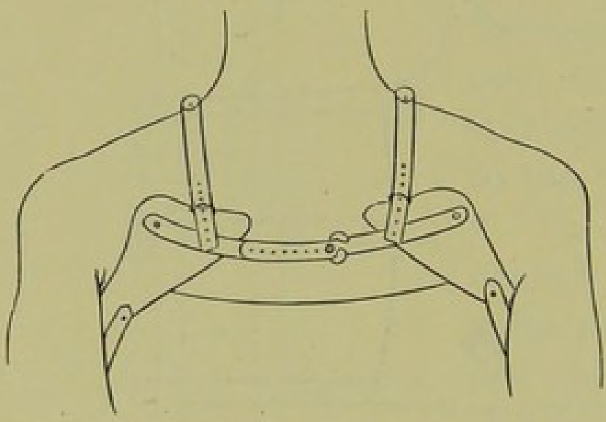


FIG. 166.—Taylor's chest piece. (After BRADFORD and LOVETT.)

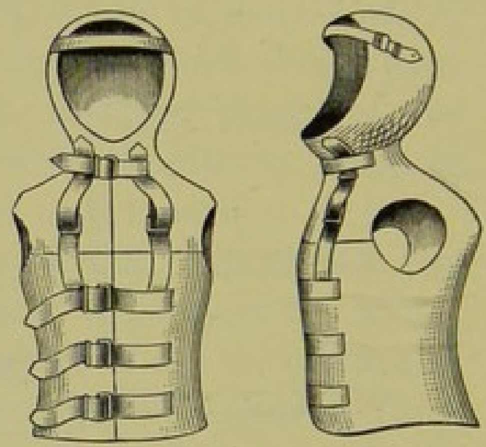


FIG. 167.—Cuirass for cervical or upper dorsal disease. (After BRADFORD and LOVETT.)

corn starch, or Pears' fuller's earth. The brace should then be applied and buckled tightly into place.

'Chafing of the back is sometimes unavoidable in summer. When a severe chafed spot forms, the brace must be removed for the time, and the child lie flat in bed until the ulcer heals.'

Where the disease affects the cervical region the best kinds of apparatus are those in the form of a collar which have a support on the shoulders, and grasp the head so as to fix and support it. There is a number of these collarettes which act very well, but a very simple one is made of poroplastic. I believe that here also the essential basis of support should be the pelvis, and that from a pelvic band a poroplastic jacket should extend upwards grasping the thorax, covering the shoulders, and expanding at the upper part to receive the head (Fig. 167). By having hold of the pelvis flexion of the cervical spine is prevented, which is not the case where the apparatus rests on the shoulders or even extends lower down and is fixed round the thorax.

To Taylor's brace a steel ring can be attached by an upright rod, the ring being made to open in front, and so

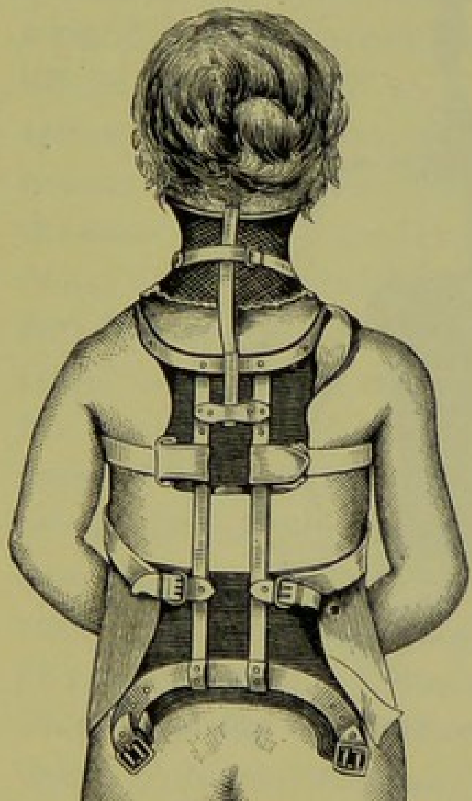


FIG. 168.—Another form of neck support. (BRADFORD and LOVETT.)

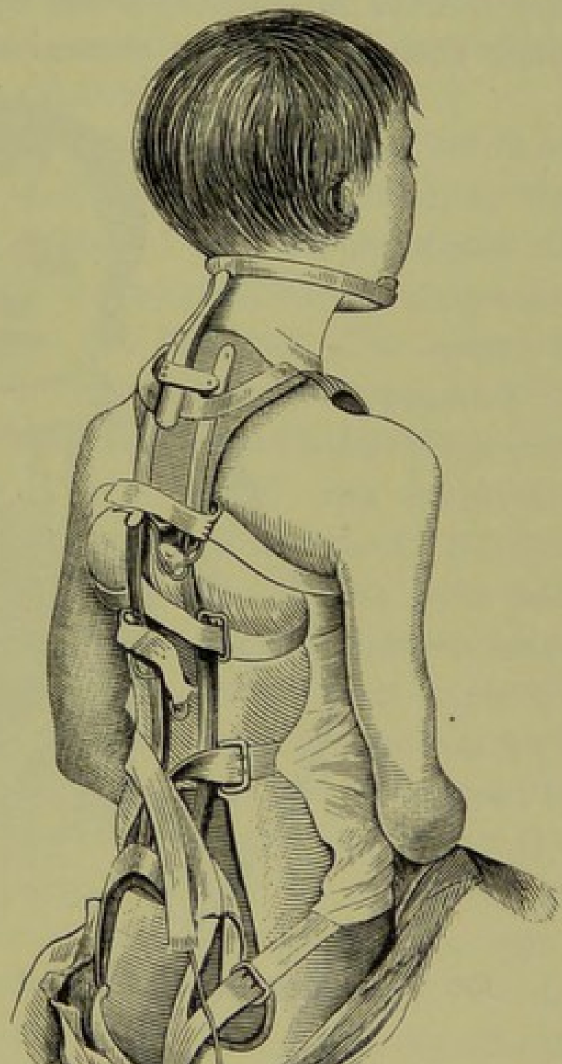


FIG. 169.—Taylor's brace with head support. (After BRADFORD and LOVETT.)

arranged as to act as a rest for the chin and occiput, counter pressure being arranged at the upper part of the dorsal region (see Figs. 168 and 169). There is a great number of supports of this kind for cervical disease, which need not, however, be detailed here (Fig. 170).

Where paralysis is present double extension acts in many cases like a charm. I have in quite a number of cases now employed this method, in more than one of which I felt almost certain that laminectomy would be necessary, but in all recovery has begun immediately on employing double extension, and really more quickly than in the recorded cases of laminectomy. I have already recorded several cases in the *British Medical Journal* for 1892 (see also p. 139), and since then I have had several similar cases. On an average,

FIG. 170.—Ring support for head. (After BRADFORD and LOVETT.)

improvement is noticed within three days, and goes on steadily till such recovery as is possible has taken place, in some cases complete. During the progress of the case the limbs should be assiduously massaged and the faradic current applied.

The action of the double extension is not to open out the curved spine, but to bring about the cessation of the pachymeningitis evidently kept up by the muscular contraction. There is no more striking proof of the great value of double extension in progressing spinal disease than this rapid disappearance of paralysis under its employment. I think this method should always be used for two or three weeks before proceeding to the operation of laminectomy, and, judging from my own experience, the latter operation will be very rarely required. Certain cases, however, remain, in which laminectomy is the only treatment which promises relief, such cases as abscess in the spinal canal, the presence of a mass of caseous material, or constriction of the cord from thickening of the dura mater all round it.

The following is the best method of performing laminectomy :—An incision is made in the middle line down to the spines of the vertebræ to be operated on, and by means of a periosteum detacher the muscles and periosteum are peeled off on each side so as to expose the laminæ. The spine or spines are then clipped off with curved bone forceps, and by means of a saw the laminæ are nearly sawn through, the division being completed by bone forceps ; the ligaments being then divided at the lower part, the plate of laminæ and ligaments can be turned up like the lid of a box, and either removed at once, or left attached and replaced after the completion of the operation. The cord is then exposed, covered by the dura mater, and the soft tissue in front clipped or curetted away ; if the whole dura mater is thickened it can be split open, and room be obtained in this way for the cord. Of course, spicules of bone can also be removed, or pus evacuated if necessary. As I have already said, this operation is really much more rarely required than one would think from the frequency with which it is done by those who advocate it.

Lastly, we have to consider the treatment where abscesses have formed in connexion with spinal disease. I have already (p. 156 et seq.) described the treatment of chronic abscess generally, and in the case of spinal disease we are usually limited to the plan of scraping and washing out the abscess, injecting iodoform and glycerine, and stitching it up, or else to repeated aseptic aspirations. It is only in abscess connected with posterior disease, especially of the spines, or in some rare cases of cervical abscess, that we can dissect out the wall, and deal with the diseased bone. As to the place to open the abscess, the rule should be first, a point which gives one the freest access to the whole cavity, and second, one as far removed as possible from sources of contamination, so that should union by first intention fail, one has plenty of room for the overlapping of the dressings.

In the case of retro-pharyngeal abscess, the best situation for the incision is behind the sterno-mastoid at the upper part; the abscess should never be opened from the throat. An incision is made parallel to the posterior border of the sterno-mastoid muscle at the upper part, above the point of exit of the spinal accessory nerve; after dividing the deep fascia the muscle is lifted up, and the finger or blunt instruments are gradually insinuated in front of and close to the spine, and behind the large vessels, till the abscess cavity is reached. A sharp spoon is then introduced and the sac thoroughly cleared out, care being taken not to perforate the anterior wall with the instrument. Iodoform and glycerine emulsion is then injected, and the wound stitched up. If the cavity fills up again to a marked degree, or if healing does not occur, it is easy to open up the canal and if necessary put in a tube, and, if the hair is shaved away for some distance around, good overlapping of the antiseptic dressings is provided for. Where the disease is lower down in the cervical region and the abscess is in the posterior triangle, the greater part of the wall can usually be more thoroughly removed, and the affected bone can be scraped or gouged away. In clearing out dorsal or lumbar abscesses, the narrow channel through which the pus has passed backwards should be thoroughly opened up, and the whole cavity cleared out. In the case of psoas abscess, the best incision in the first instance is just internal to the anterior superior spine, and if necessary a second incision can be made further back above the crest of the ilium, in order to get better access to the bone in cases of disease of the lumbar vertebræ, but one cannot in reality deal satisfactorily with the bone disease in this region. It is in the first place too far away, and in the second place too extensive, and not sufficiently limited to one side to allow one to get at it properly. Sequestra may, however, be got away by the upper incision.

Disease of the Sacro-iliac Synchondrosis

This disease may be primary or secondary to disease of the lower lumbar vertebræ; in either case it is very often combined with lumbo-sacral disease. Where it is secondary to lumbar disease it most usually begins from the surface in the form of a periostitis. When it begins primarily in connexion with this joint, it generally commences as a deposit in the sacrum or ilium, most usually the sacrum, and as these deposits enlarge they gradually invade the articulation. The interosseous ligament is usually only partially destroyed or may remain intact.

The first symptom of the disease is pain, especially in the lumbar region, which is of course worse after exertion; there is often also pain in the buttock, or along the course of the sciatic nerve. There is generally a little puffiness to be noticed behind, and the muscles of the buttock waste. The patient limps, the limb appearing longer because the pelvis is tilted downwards on the affected side. Pain may be elicited by pressure over the joint behind, or by grasping the anterior superior iliac spines, and pressing them together. As time goes on the pain and difficulty of movement increase, the leg often becomes swollen from pressure on the vein, and abscesses form in various situations either in front of or behind the joint. If behind the joint they point there, but most usually they form in front, and may then burrow in various directions according to circumstances, as upwards pointing above the crest of the ilium, backwards through the sacro-sciatic notch either into the buttock or under the gluteus maximus into the thigh, downwards through the obturator foramen or into the perineum, outwards into the iliac fossa, or along the sheath of the psoas into the thigh.

The prognosis is grave, because phthisis is often present, and because of the great difficulty in getting complete fixation of the parts. In young subjects, also, where recovery takes place, anchylosis results, and oblique deformity of the pelvis is apt to result.

With care the disease can always be diagnosed by the symptoms and signs I have mentioned, and the absence of signs of disease elsewhere. I need only enumerate the diseases which have to be borne in mind—hip-joint disease, spinal disease, various neuralgias, disease of the ilium or sacrum at some distance from the joint (here movements do not cause pain), malignant disease, sciatica (here there is no pain at the articulation, and no apparent lengthening of the limb), and arthritis of the synchondrosis after gonorrhœa or puerperal fever (in the latter acute suppuration occurs, in the former the disease is acute and suppuration is improbable).

As to treatment, the first essential is rest in the recumbent posture between sandbags, or better, in some arrangement like Phelps's box, even in adults. No forms of apparatus to allow the patient to get about are satisfactory. The actual cautery applied behind the articulation before suppuration has taken place, is sometimes of use. Where operative interference is desirable the joint may be got at from behind, and portions of bone chiselled away till the disease is reached, or where the disease is anterior the sciatic notch may be enlarged by the chisel so as to give free access. Naturally, all the other hygienic conditions should be employed in this disease as in that elsewhere.

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