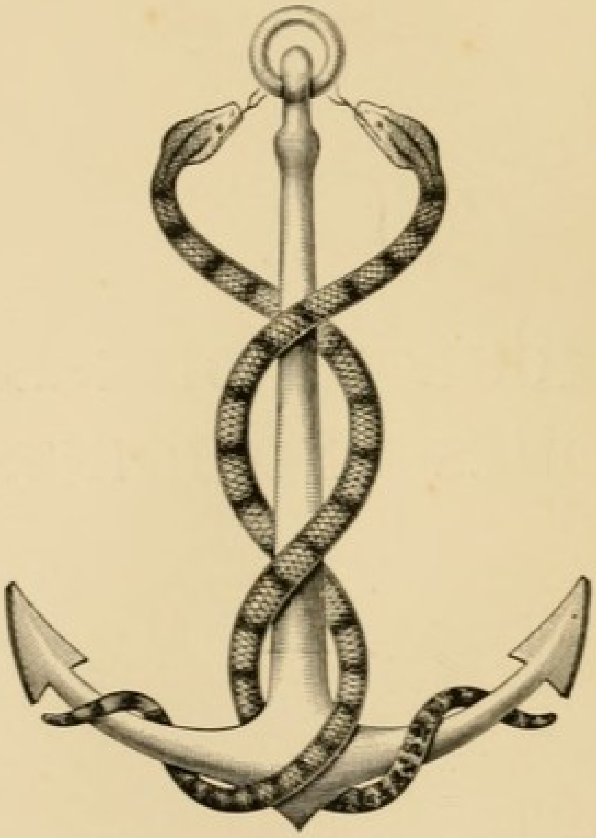
TUBERCULOUS DISEASE OF BONES AND JOINTS.



NUNQUAM ALIUD NATURA, ALIUD SAPIENTIA DICIT.

TUBERCULOUS DISEASE

OF

BONES AND JOINTS

ITS PATHOLOGY, SYMPTOMS, AND TREATMENT.

BY

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PREFACE.

I HAVE divided the matter of the following work into two parts—the first of which deals with the pathology and treatment of tuberculous disease of bones and joints in general, and the second with the symptoms and treatment, founded on the foregoing pathology, of the individual bones and joints in particular. The first part is based on my Astley Cooper Prize Essay, written in 1888, although some modifications have been made in it, and much has been omitted as being unsuitable for the present purpose. In preparing that Essay I went over the whole pathology of these diseases for myself, especially by the aid of complete thin sections of the affected parts, and was, in this way, able to get a very complete view of the sequence of events. I had originally hoped to be able to reproduce the beautiful photographs of these sections which were made for me at the time by Mr. Andrew Pringle, but I found that the expense of their proper reproduction was so great as to render such an attempt altogether out of the question. A good deal of this part has also been published in the form of lectures at the Royal College of Surgeons. The second part of the book will, I hope, be of use to those who are called on to treat these obstinate and very serious cases, and the treatment described is that which I have myself found best, and which is now generally employed by those who have paid special attention to these diseases. The delay in the appearance of this work, which is in part my Astley Cooper Prize Essay of 1889, and is published with the permission of the Governors of Guy's Hospital, has been due to my desire to assure myself, from sufficient experience, that the treatment I was recommending was founded on a sound pathological and practical basis.

W. WATSON CHEYNE.

75 HARLEY ST., W.,
May 1895.

CONTENTS.

CHAPTER I.

DEFINITION OF THE TERM "TUBERCLE" AND "TUBERCULAR TISSUE."

CHAPTER II.

CHANGES IN THE SYNOVIAL MEMBRANE.

CHAPTER III.

TUBERCULAR DEPOSITS IN BONE.

CHAPTER IV.

TUBERCULAR CHANGES IN ARTICULAR CARTILAGE AND THE SURFACE OF BONE.

CHAPTER V.

TUBERCULAR PERIOSTITIS AND TUBERCULAR OSTEOMYELITIS.

CHAPTER VI.

RARER FORMS OF TUBERCULAR BONE DISEASE.

CHAPTER VII.

PATHOLOGY OF CHRONIC ABSCESS.

CHAPTER VIII.

THE TUBERCULAR NATURE OF "STRUMOUS" JOINT DISEASES.

CHAPTER IX.

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

CHAPTER X.

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

CHAPTER XI.

TREATMENT OF TUBERCULAR DISEASE OF BONES AND JOINTS.

CHAPTER XII.

TREATMENT OF TUBERCULAR DISEASE OF BONES AND JOINTS—*continued.*

CHAPTER XIII.

TREATMENT OF TUBERCULAR DISEASE OF BONES AND JOINTS—*continued.*

CHAPTER XIV.

GENERAL PRINCIPLES OF TREATMENT.

CHAPTER XV.

ARTHRECTOMY, EXCISION, AND AMPUTATION IN JOINT DISEASE.

CHAPTER XVI.

DISEASE OF THE HIP JOINT.

CHAPTER XVII.

DISEASE OF THE KNEE JOINT.

CHAPTER XVIII.

DISEASE OF THE ANKLE, TARSUS, AND METATARSUS.

CHAPTER XIX.

DISEASE OF THE SHOULDER JOINT.

CHAPTER XX.

DISEASE OF THE ELBOW JOINT.

CHAPTER XXI.

DISEASE OF THE WRIST JOINT.

CHAPTER XXII.

DISEASE OF SMALLER BONES.

CHAPTER XXIII.

DISEASE OF THE SPINAL COLUMN.

LIST OF ILLUSTRATIONS.

TUBERCULOUS DISEASE OF BONES AND JOINTS.

SECTION I.

PATHOLOGY, ETIOLOGY, AND TREATMENT OF TUBERCULAR DISEASE OF BONES AND JOINTS.

1

DISEASES OF BONES AND JOINTS.

CHAPTER I.

DEFINITION OF THE TERMS "TUBERCLE" AND "TUBERCULAR 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, tubercular, 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 tubercular 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 tubercular development. Up till quite recently the diagnosis was made only by the naked eye, and thus it was only cases where distinct miliary tubercles or larger caseous masses were present that 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 tubercular 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 tubercular 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 tubercular. 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 tubercular nature, and that their pathology was closely allied to that of tubercular 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 thoroughly study these diseases of joints histologically, and to recognise fully their tubercular 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 tubercular 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 tubercular nature of these affections and of their intimate connection with tuberculosis elsewhere is now very generally accepted.

A thorough knowledge of the morbid anatomy of tubercular diseases of bones and joints and of the mode of spread of the disease in the affected parts is very necessary at the present time, seeing that the methods of operative treatment, which have now come into vogue, aim mainly 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 tubercular diseases of bones and joints, I must say a few words as to the meaning of the terms "tubercle" and "tubercular 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 tubercular 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 tubercular 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 tubercular nature of these diseases of bones and joints. Tubercular 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 tubercular elements, a condition which we may term shortly "tubercular infiltration." Both of these forms of tubercular tissue, viz., tubercles and tubercular infiltration, are found in tubercular 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 tubercular 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 leucocytes, 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 leucocytes, recognised by their small, round, densely stained nuclei, but these cells are few in number

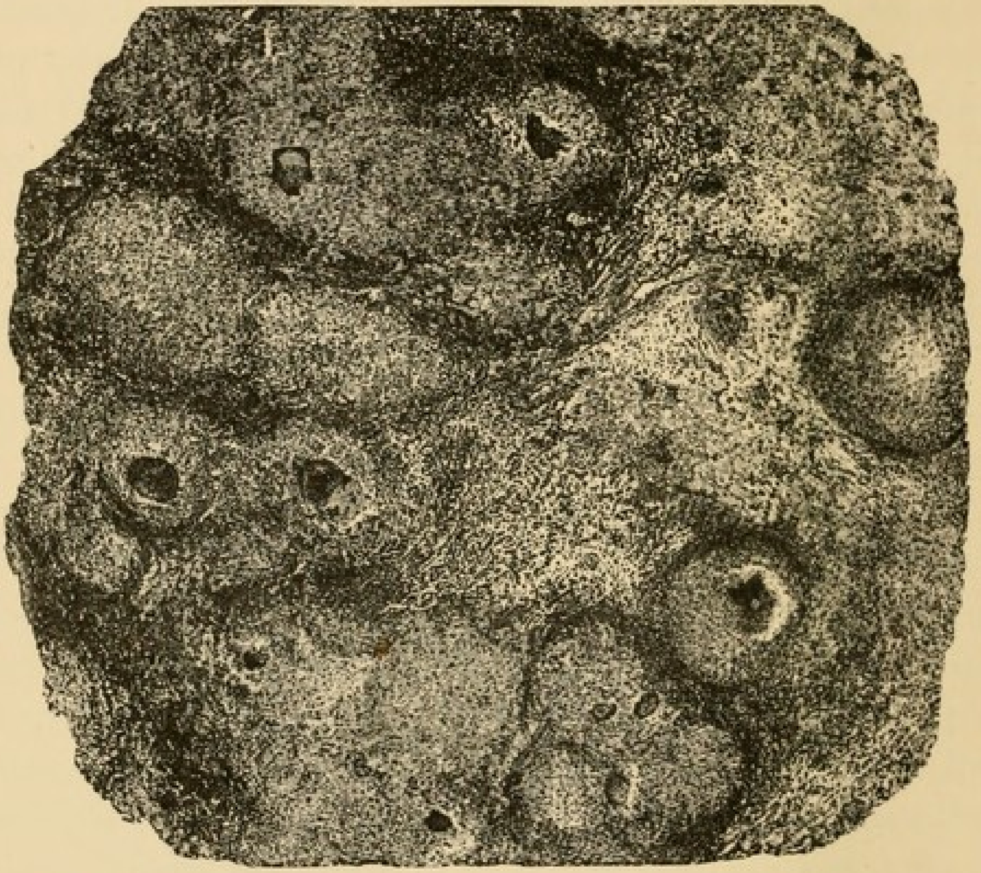

FIG. 1.—Section of tubercular synovial membrane, showing a mass of tubercles under a low power. The majority of them contain a giant cell. The epithelioid cells which make up the main mass of the tubercle are indicated by the paler centre, as contrasted with the dark rim around, which is made up of a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

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 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 connection 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, tubercular 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 "tubercular infiltration." In this condition, which it is most important to recognise, the epithelioid cells are not collected in small masses, but either run through the tissue in broad tracts or are 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. 6 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 tubercular 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 tubercular tissue. In the first place, the epithelioid cells are constantly present in tubercles and tubercular tissue. However uncertain the presence of giant cells, their processes, &c., the epithelioid cells, characterised 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 tubercular 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 tubercular 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 tubercular growth. In the epithelioid cells they are frequently closely applied to the nucleus. In cases where there is tubercular infiltration rather than definite tubercles we see the same thing; the bacilli are chiefly found in connection 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 by the study of the elements in tubercle in which karyokinetic processes occur. Baumgarten has found that in tubercular 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 minimise the importance

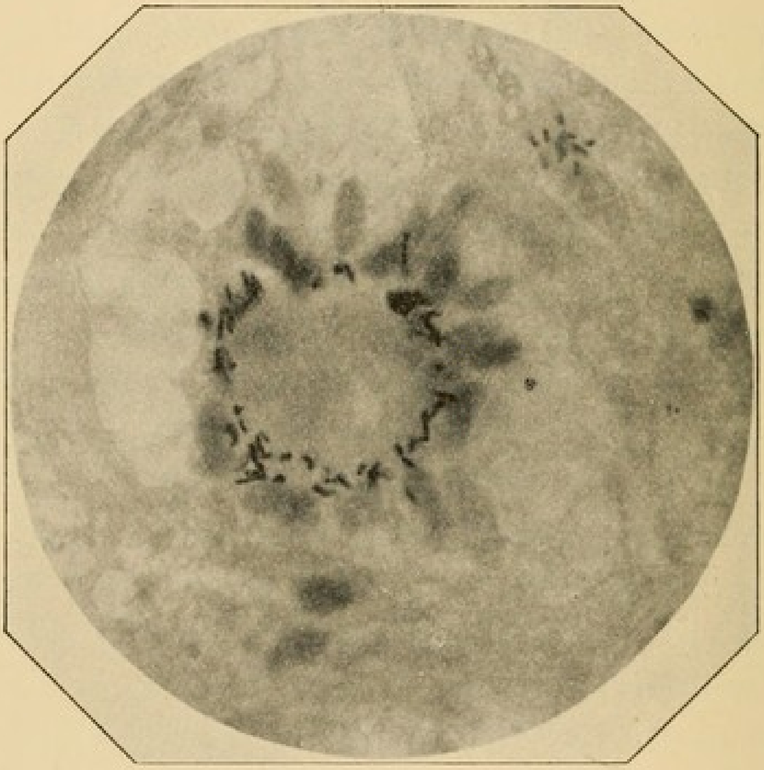

Fig. 2.—Large giant cell from tubercle, with a ring of bacilli lying among the nuclei.

of epithelioid and giant cells in the diagnosis of tubercle by asserting that these cells are found in other and non-tubercular 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 great difficulty in diagnosis is between tubercular 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 the large numbers of epithelioid cells in the tubercular form, and the diagnosis is made in the latter by the tendency to caseation—a point which I shall immediately allude to. It is often asserted that giant cells, like those of tubercle, are present in ordinary granulations. For my own part I do not believe 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 in sinuses after chronic abscesses, where tubercular giant cells are actually present. The ordinary myeloid cells of bone are much smaller than tubercular giant cells, and only have three or four nuclei, generally in the centre of the cell, and the only large cells in bone resembling tubercular 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 from the plasma cells on which so much stress has recently been laid by Ballance and Sherrington. 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. 3 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 tubercular 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 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 tubercular disease many tubercles disappear completely or undergo fibrous transformation, and that they do not all become

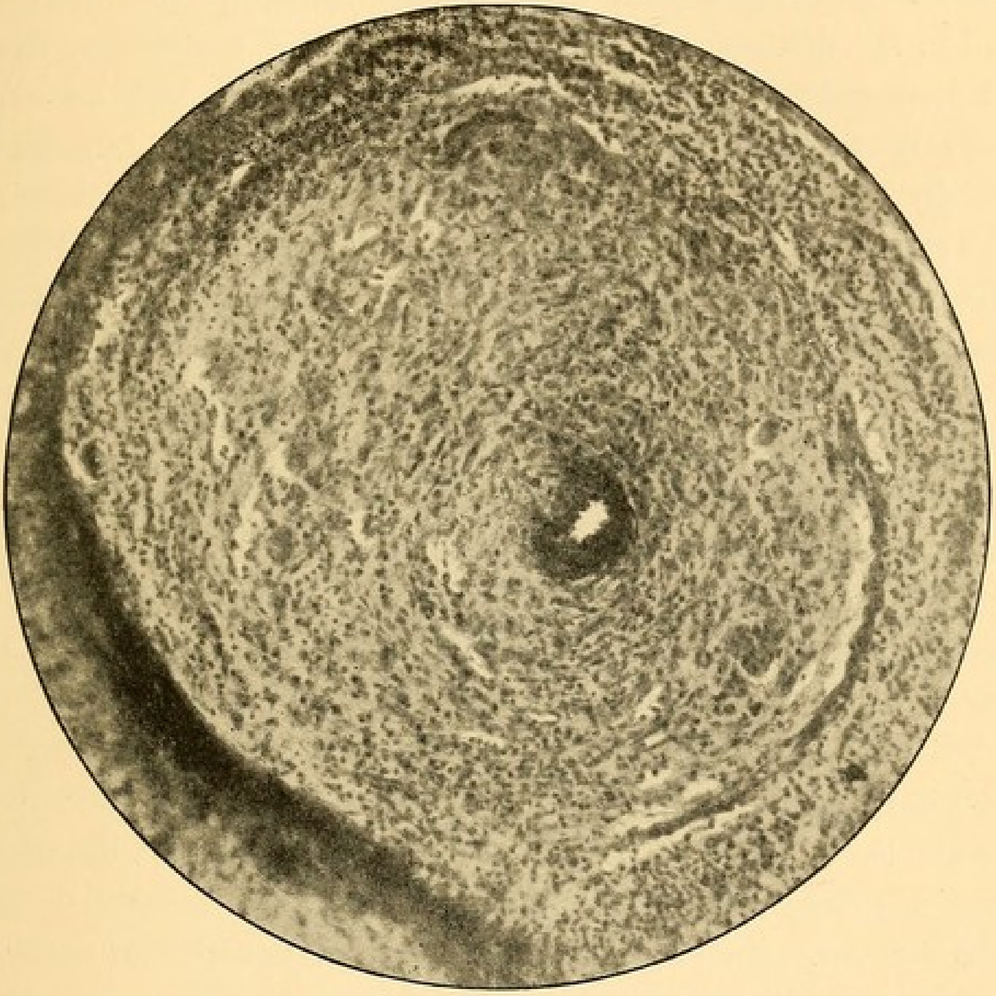

FIG. 3.—Section of a tubercle from tubercular synovial membrane, showing its development in the substance of the internal coat of a blood vessel; the lumen of the vessel being still patent. In the particular tissue from which this was taken (a case of synovial disease of the ankle joint), almost all the tubercles were apparently developed in this way.

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 tubercular 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 tubercular 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 recognised 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 tubercular 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 tubercular deposit in one part of the body being very apt to lead to tubercular growth elsewhere. The tubercular 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 tubercular 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 tubercular 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 tubercular 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 characterised 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 certain conclusion as to the tubercular 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 tubercular infiltration, and where caseation is occurring, I know of nothing else which this can indicate but tubercular 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 tubercular process.

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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 tubercular disease. Now we find that the diseases in which this tissue is present are those which, up till recently, have been clinically known as strumous diseases, and therefore in speaking at the present time of surgical tuberculoses we mean those diseases which clinically would be diagnosed as strumous.

There are many reasons why we must regard strumous diseases of bones and joints as tubercular, and being tubercular as due essentially to the development of the tubercle bacillus, and to these I shall refer again. I may here shortly summarise the facts as follows:—In the first place, I have just referred to cases in which wounds in man have become infected with the tubercular virus, with the result that the various affections, formerly called "strumous," and among them strumous diseases of bones and joints have developed. Further, in these strumous diseases the affected tissues show the presence of tubercles and tubercular tissue; tubercle bacilli are constantly present, though often very difficult to find; these affections are intimately related to phthisis and other tubercular affections occurring elsewhere; the material derived from the diseased joints sets up tuberculosis in the lower animals in the same way as material from an undoubted tubercular source; and similar diseases can be induced in the lower animals by the introduction into bones and joints of tubercular material, and notably, as I have made out, of pure cultivations of tubercle bacilli. In describing the morbid anatomy of tubercular diseases of bones and joints, I therefore describe the morbid anatomy of those affections known up till recently as "strumous diseases."

CHAPTER II.

CHANGES IN THE SYNOVIAL MEMBRANE.

In discussing the morbid anatomy of tubercular 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 covered with caseating material, 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 sub-division 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 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 five, 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 previously, but the parents thought that she had been losing flesh, and she had

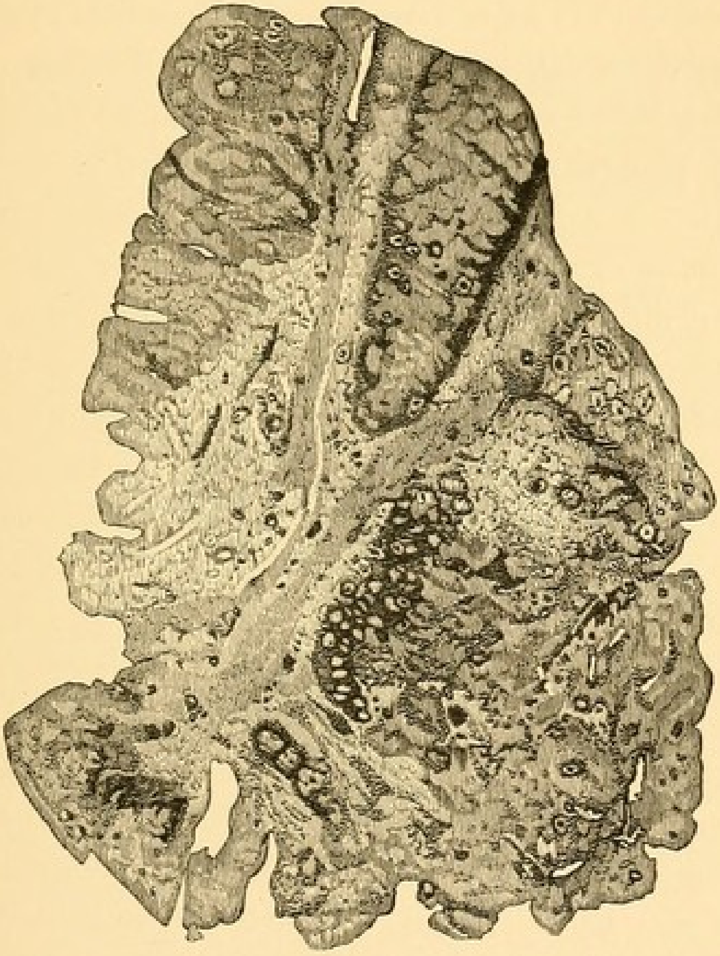

FIG. 4.—Transverse section of the ligamentum teres from a case of tubercular disease of the hip, hardly magnified. The invasion of the ligament by tubercular tissue is well seen all round, and the tubercles can actually be made out at the deeper part. The ragged edge is where caseation is actively taking place.

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 tubercular 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. 4 represents 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.

Fig. 5 shows the appearance under a higher power of the deeper part of this layer, and we see that the tissue at this part consists of densely packed tubercles, frequently with large giant cells, and surrounded by a ring of leucocytes. At the upper part of the photograph fresh tubercles are seen forming in the more centrally placed tissue. Passing now to the free edge (shown in Fig. 6) we no longer see the individual tubercles, they have run together, and we have the condition which I have termed tubercular infiltration, and quite at the free edge this tissue is undergoing caseation. If, lastly, we study the central tissue (Fig. 7), 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 leucocytes. Except in the immediate neighbourhood of the tubercular masses there are no tubercles among this fibrous tissue. We may call this condition shortly “ gelatinous infiltration.”

The sections of the synovial membrane showed exactly the same appearance, except that the tubercular layer was only at one side, the whole of the inner part of the synovial membrane being occupied by tubercular tissue, which was 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 tubercular virus has attacked the surface of the synovial membrane, and

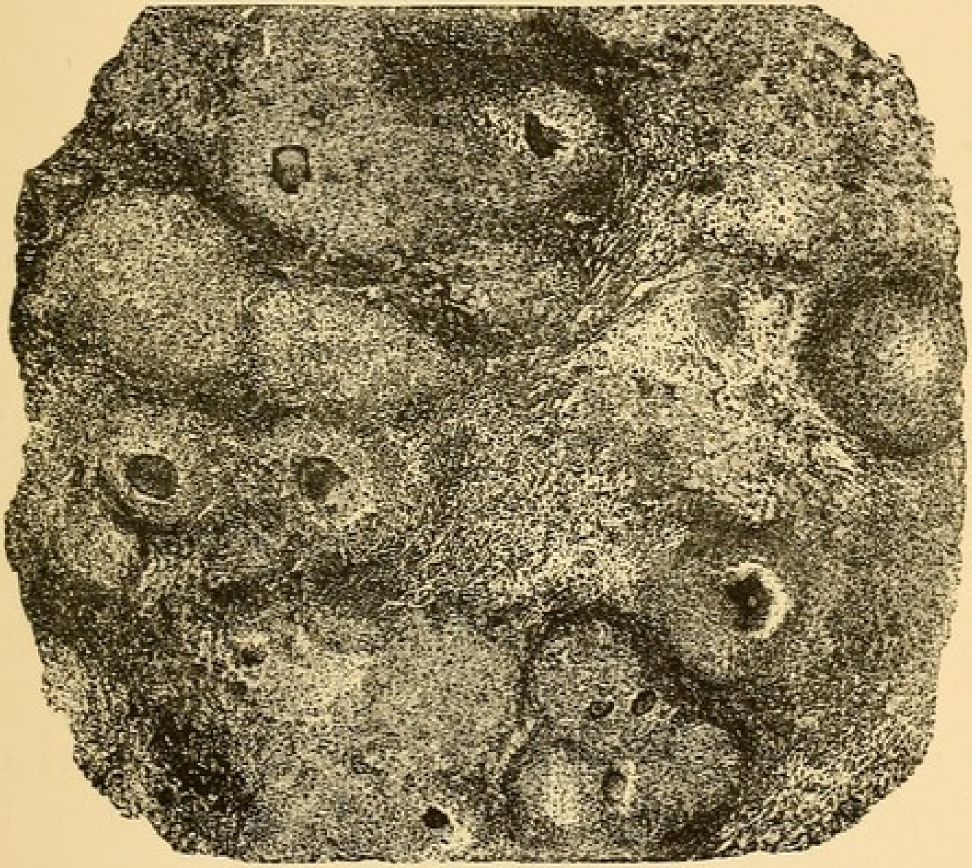

Fig. 5.—Section showing under a higher power the character of the deeper or spreading edge of the tubercular area. The numerous discrete tubercles are well seen.

spread into its substance. In the ligamentum teres the tubercular growth is spreading in on all sides, where the tissue is not too dense. The oldest parts of the tubercular 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, where two layers can be made out, an inner, soft and often caseating, and consisting of tubercular 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 tubercular growth. As time goes on the tubercular 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 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 tubercular growth does not, in the first 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, not at the surface of the synovial membrane, seeing that the oldest tubercles are beneath the surface. Hence the characteristic appearances 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 tubercular 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

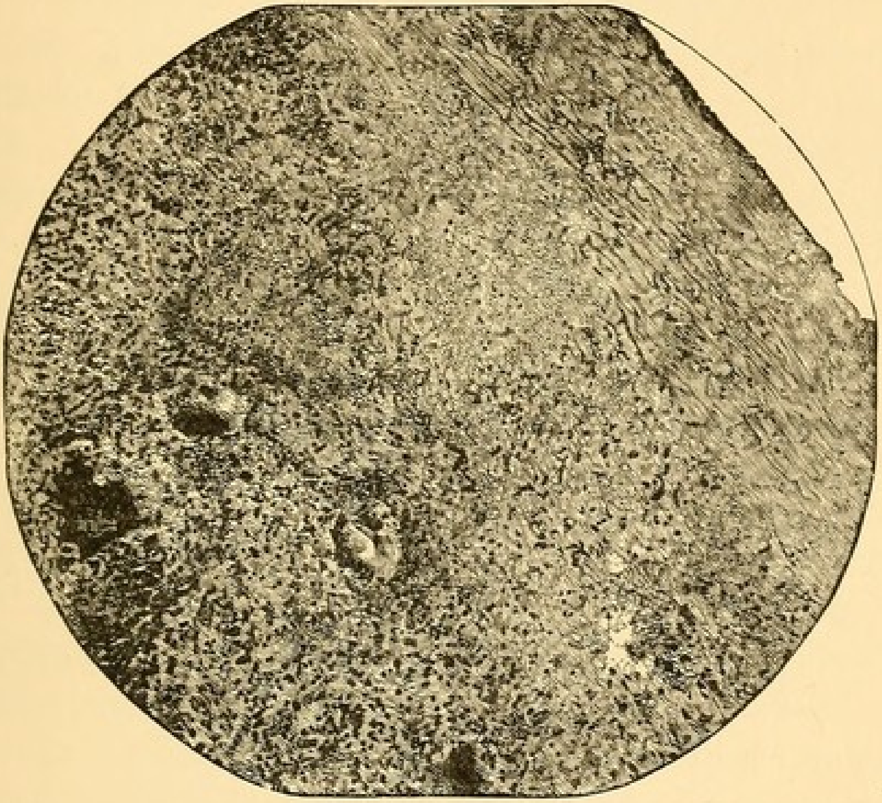

FIG. 6.—Shows the free edge of the same section. Here the tubercles have run together, and the condition of "tubercular infiltration" has been produced. Caseation is going on at the edge, and some giant cells can still be seen.

tubercles in it. This condition is either associated with primary disease of the synovial membrane, where the tubercular deposit is limited to some part of the thickened tissue, or perhaps it most often occurs in connection 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 tubercular area which, however, is present. Usually it will be found at some part where there is a greater 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 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 tubercular 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 tubercular 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. 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 tubercular growth. 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 tubercular 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 tubercular disease and find that a

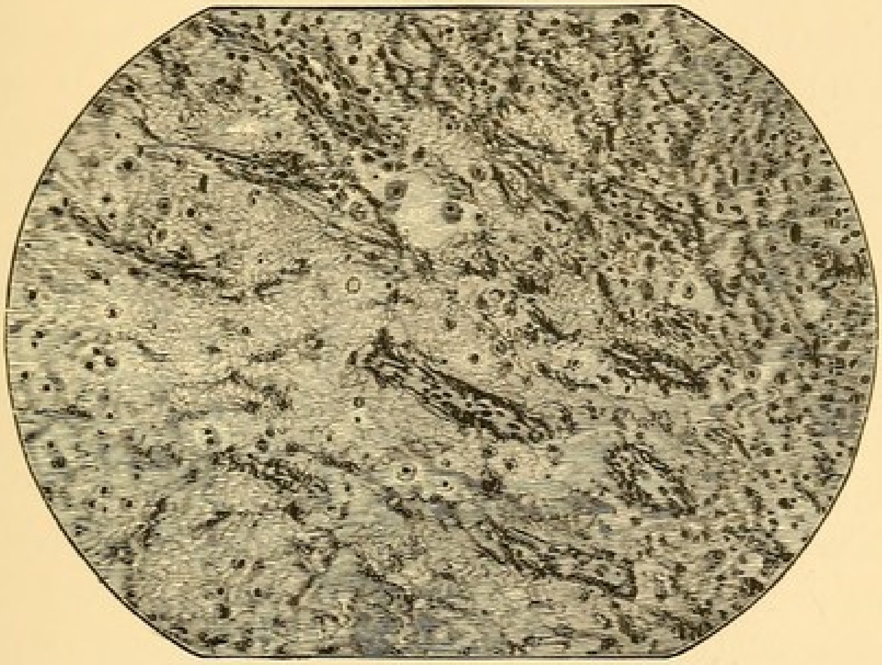

FIG. 7.—Section of the innermost tissue not yet invaded by the tubercular growth. The tissue is swollen, cellular, with young vessels, in fact, in a state of subacute inflammation. This is the structure of the greater part of the tissue which constitutes the swelling of tubercular joints.

primary osseous deposit has burst into the joint, we know from what I have pointed out that the tubercular 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 tubercular 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, which is too tough to yield to the sharp spoon, and if we decide that it is necessary to remove the whole of the tubercular 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 localised primary deposit in the synovial membrane at one part, all that may be 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, frequently closely packed together.

I have only seen one or two instances of this kind, and have only had the opportunity of examining one case. It was that of a lady who had suffered from troublesome synovitis of the knee-joint for some months. On the inner side of the joint a nodule was felt, which seemed like an attached loose cartilage. On cutting down, this was found to be a polypoid thickening of the synovial membrane, and was removed. On making sections of the mass, it proved to be tubercular. The patient remains well.

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 sub-synovial 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. I have in one case of acute tuberculosis examined the synovial membrane of the knee and hip-joints, but failed to find any tubercles.

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 connection 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 tubercular 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 tubercular 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 recognised, 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.

TUBERCULAR DEPOSITS IN BONE.

THE changes which occur in bone as the result of tubercular 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) tubercular deposits with sclerosis of bone and necrosis; (4) superficial tubercular disease of the articular surfaces of bone, in connection 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 connection with tubercular disease; (7) diffuse softening of bone and formation of "red marrow;" and (8) tubercular periostitis and tubercular osteomyelitis of the short bones, one form of which is "spina ventosa." In connection with these tubercular 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 tubercular 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, and Lazarus has recorded five cases of acute general tuberculosis, in which the bones were examined with positive results. In his cases, however, the tubercles were not present in all bones, or in all parts of the same bone. 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 Tubercular Deposits in Bone.

Soft and frequently caseous tubercular deposits in bone are by no means uncommon as the primary condition in tubercular 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. 8) 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 five. 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

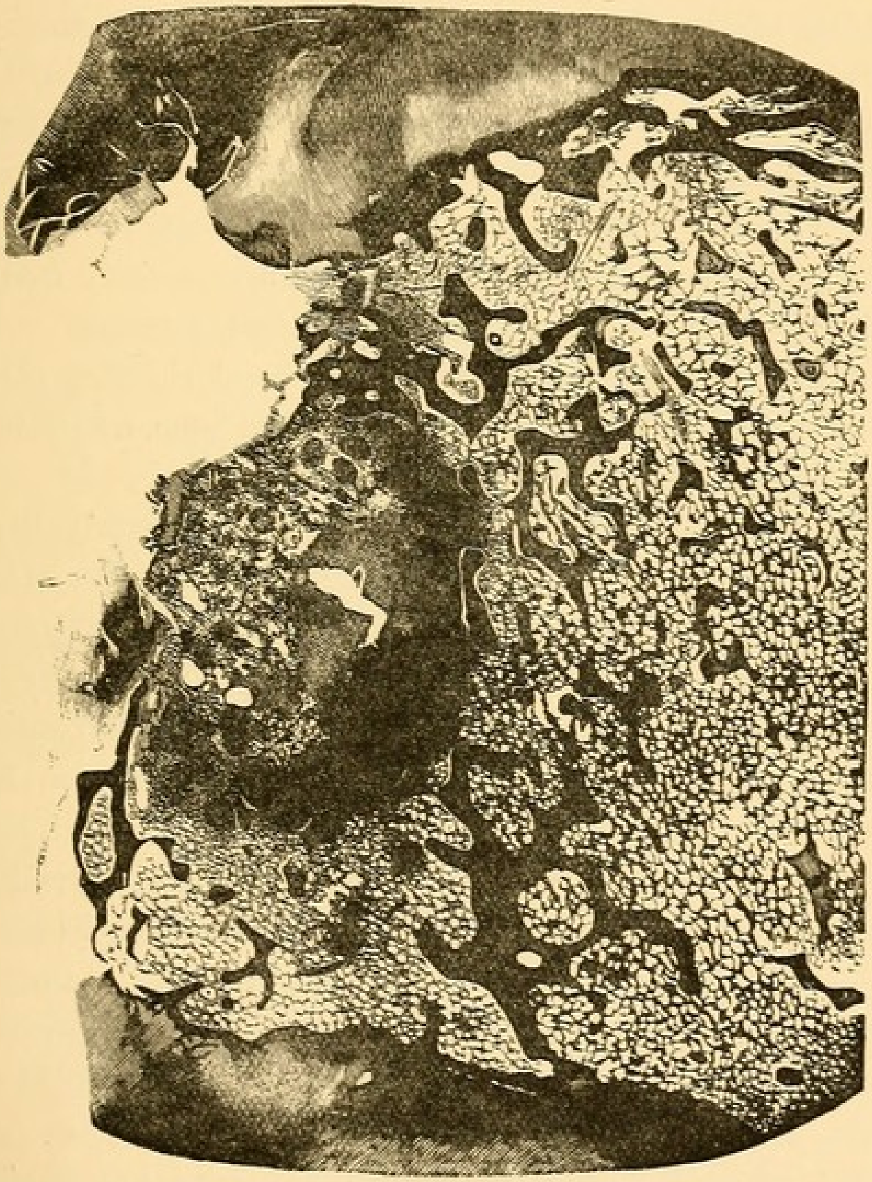

FIG. 8.—Section of the external condyle of the femur, from a case of disease of the knee-joint. Above is the articular cartilage, below the epiphysial cartilage, and between them, on the left hand, is a soft tubercular deposit. (*See* Text for description.)

caseous deposit in the external condyle of the femur, which communicated with the exterior, and to which the sinuses led.

On examining this deposit 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 tubercular infiltration, and elsewhere a number of tubercles. Immediately around the deposit the trabeculæ of the bone are seen to be considerably thickened, and more numerous than at some distance from this spot. In the cancelli around the tubercular 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. 9 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, 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 tubercular 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 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

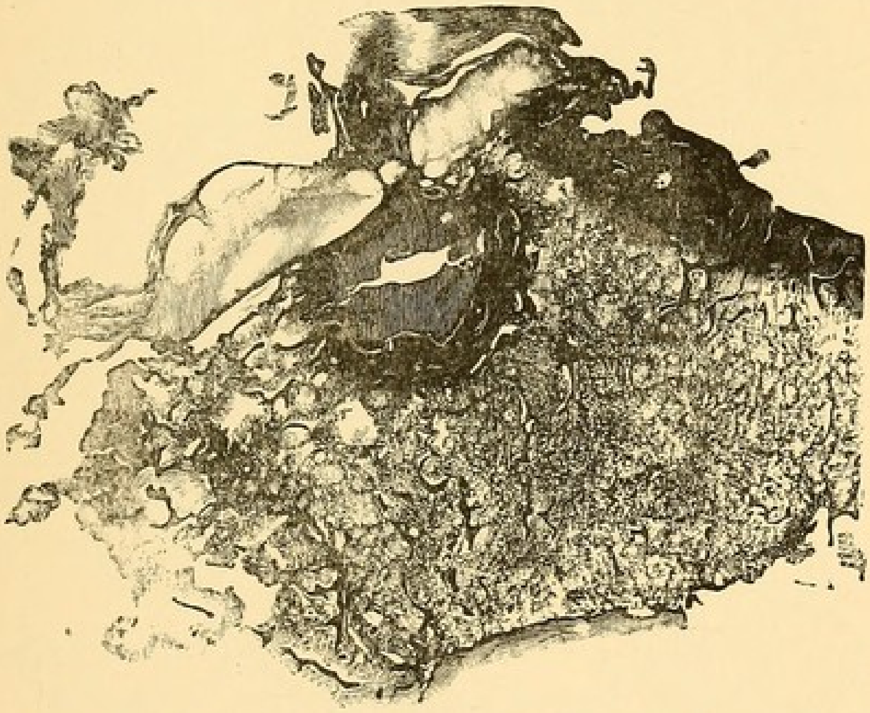

FIG. 9.—Section of the head of the tibia, showing remains of articular cartilage above, and a portion of the epiphysial cartilage below. On the right hand side the surface of the bone is carious. A soft tubercular deposit is present beneath the remains of the articular cartilage, which was perforated at one part. (*See* Text.)

the neighbourhood of tubercular 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 tubercular bone disease.

The process probably progresses somewhat in this way. The tubercular 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 absorption. The

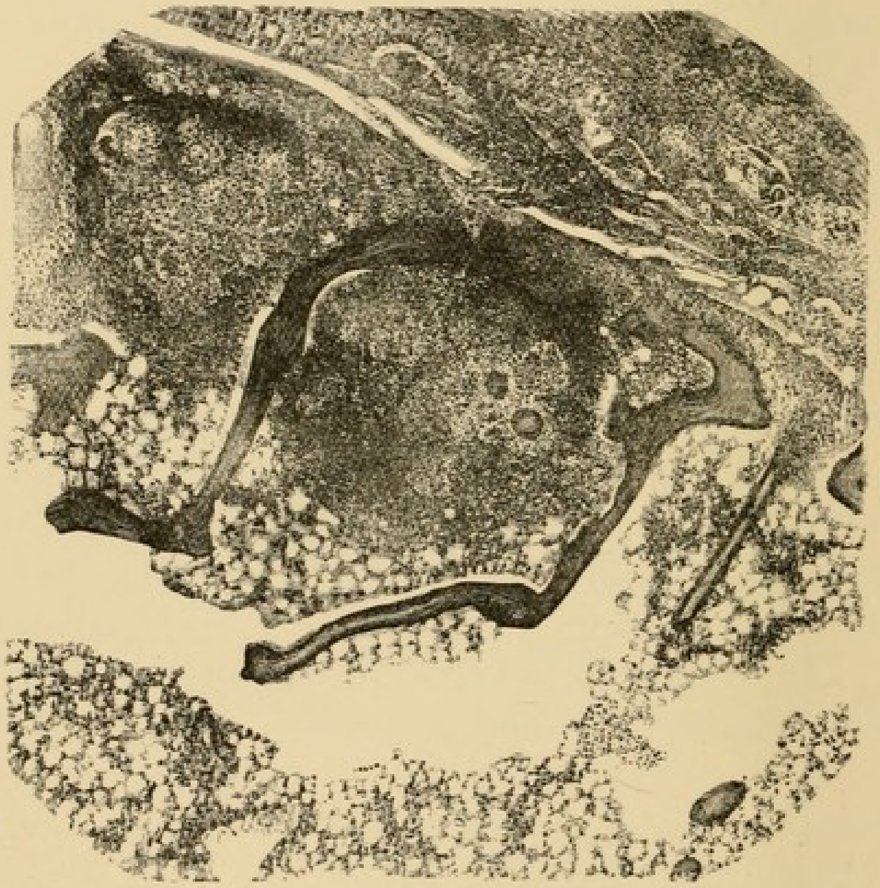

FIG. 10.—Section of a carpal bone, commencement of a tubercular deposit in the superficial cancelli, destruction of the lamellæ of the bone, &c. (*See* Text.)

condition is illustrated in the accompanying drawing (Fig. 10) where we see the formation of tubercular tissue in neighbouring cancelli, and the lacunar absorption of the bone by the granulation tissue around the tubercular 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 tubercular 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 tubercular growth and the granulation tissue, 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 tubercular 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 tubercular 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, usually of the third type occurs, 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. 11. 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 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 articulation between the two carpal bones, which is filled up with fibrous tissue containing tubercular tissue, and here also the cartilage has been almost entirely destroyed. The radio-carpal articulation 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.

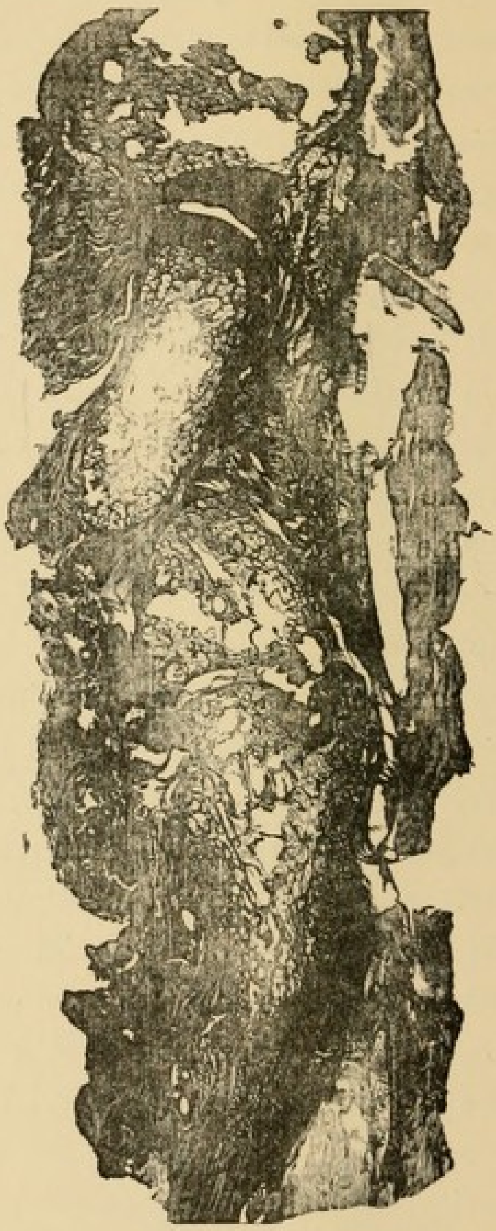

FIG. 11.—Longitudinal section of the wrist joint from a case of tubercular disease. At the lower part is the remains of a metacarpal bone towards the dorsum (right hand side), of which a deposit has formed in the bone, which has burst into the joint, and set up the disease. As we pass upwards we see two carpal bones and the radius. (*See* Text.)

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

The early stage of the process is well seen in Fig. 12, which

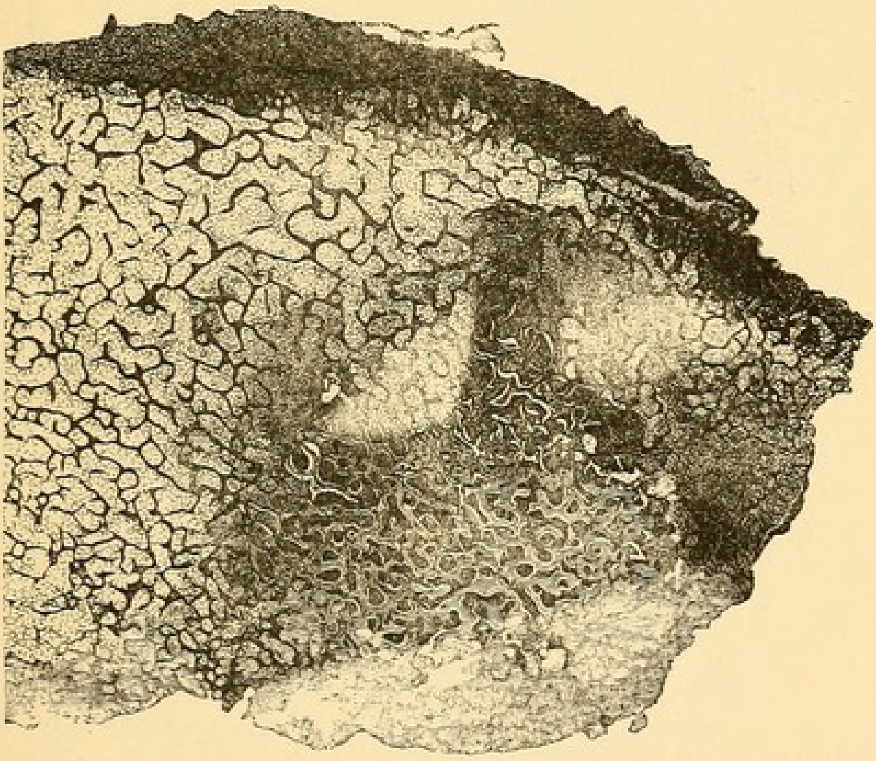

Fig. 12.—Section of patella, showing commencing sequestrum formation at the lower and right hand part. (*See* Text.)

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 tubercular disease, and shows all the stages in the formation and separation of tubercular 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 these parts

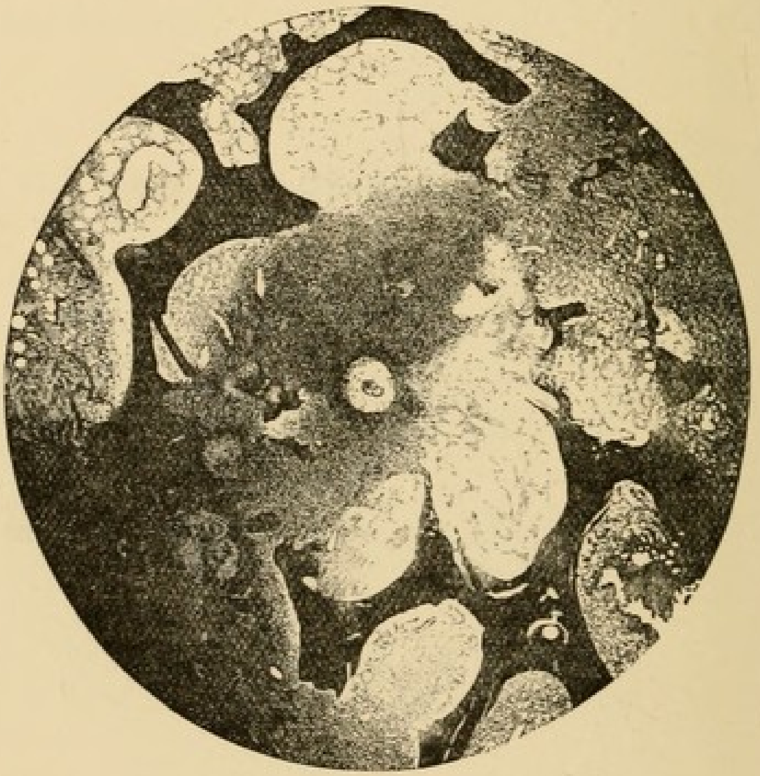

FIG. 13.—Section showing line of separation of a tubercular sequestrum (*see* Fig. 12). The destruction of the trabeculæ by granulation tissue and the formation of a tubercle in this tissue is well seen.

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. 13 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 extremely thickened, and the mass resembles the outer shell of a bone

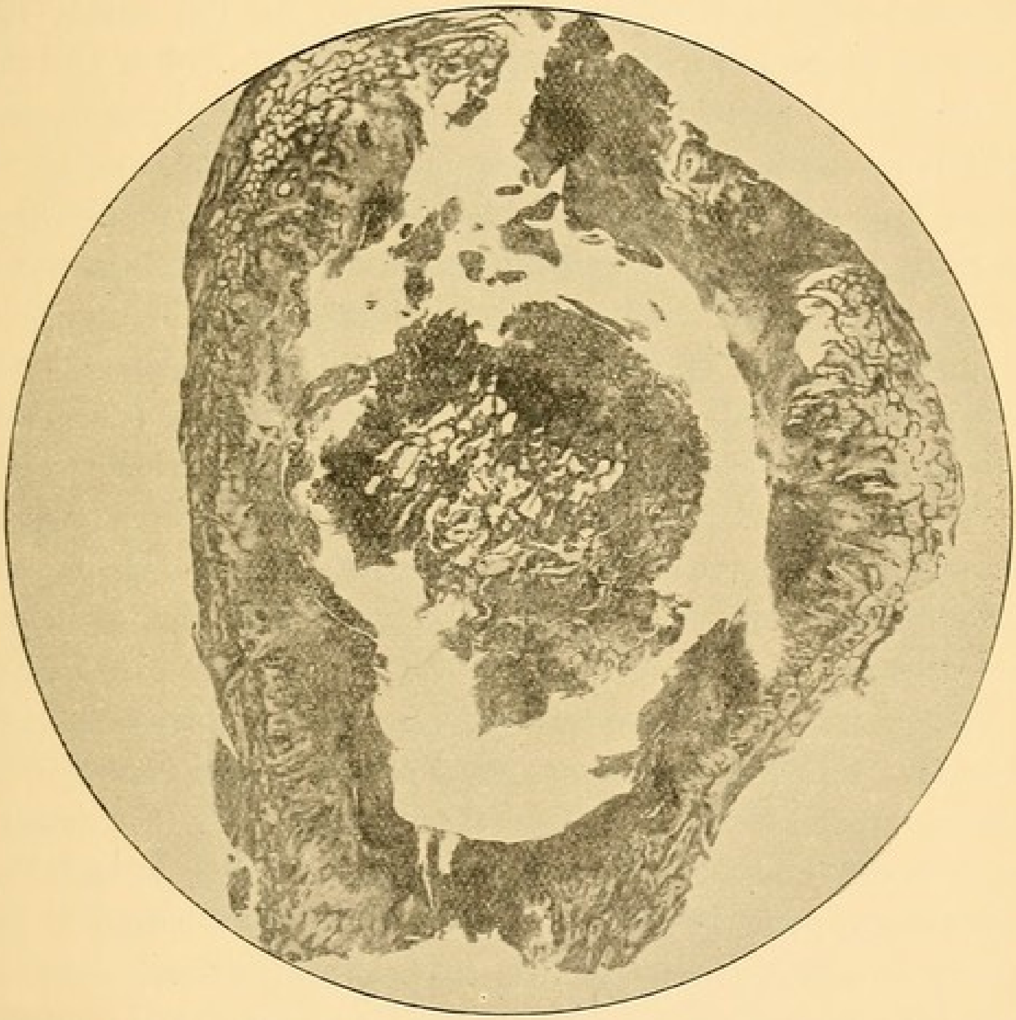

FIG. 14.—Section of head of humerus, showing a tubercular sequestrum completely separated but still *in situ* lying in a cavity in the bone, the wall of the cavity being composed of soft tissue. At the upper part the bone has in parts completely disappeared, and this soft tissue reaches the joint. (From a case excised by Sir William Fergusson many years ago.)

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. 14).

These tubercular sequestra are usually larger than the soft tubercular 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. 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. In some cases, the articular cartilage over them is destroyed, and they project into the joint cavity, and, if the joint has still 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 tubercular growth before caseation 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 tubercular infiltration, which is leading in parts to destruction of the trabeculæ connecting the dead and living parts.

The process of sequestrum formation in tubercular 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 edge. While this fibrous formation and sclerosis of the bone are going on, the tubercular growth is also extending, and, accompanying it, there is reabsorption of the newly formed bone. Caseation of this tubercular 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-bye the process ceases to extend with the same rapidity, and then absorption of the connecting trabeculæ of bone, 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 tubercular 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 tubercular 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 tubercular 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 tubercular 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 tubercular tissue extends or caseates, and according to the course taken by the tubercular growth. Formation of vascular fibrous tissue, with sclerosis of bone, is not uncommon in tubercular 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 tubercular growth.

Various views have been put forward at different times as to the nature 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. The view, however, 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 tubercular 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 tubercular 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 connection with soft deposits as to the further progress of the disease when the tubercular 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 tubercular 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 tubercular material has completely disappeared, and a mass of fibrous tissue has been found in its place.

CHAPTER IV.

TUBERCULAR CHANGES IN ARTICULAR CARTILAGE AND THE SURFACE OF BONE.

THE most common tubercular affection of bone is tubercular 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 connection with tubercular 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 tubercular 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. We might have expected that in the case of a deposit immediately beneath the cartilage the tubercular 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 tubercular 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 tubercular 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 bone is affected. We must, therefore, study the changes which occur in connection 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 as at the edges of the cartilage, or at the points of attachment of the crucial ligaments in the knee, in the neighbourhood of the ligamentum teres in the hip, &c. Its destruction may also begin in the neighbourhood of the opening of the tubercular osseous deposit, 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. 11, p. 38), 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 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. 15, 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. 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

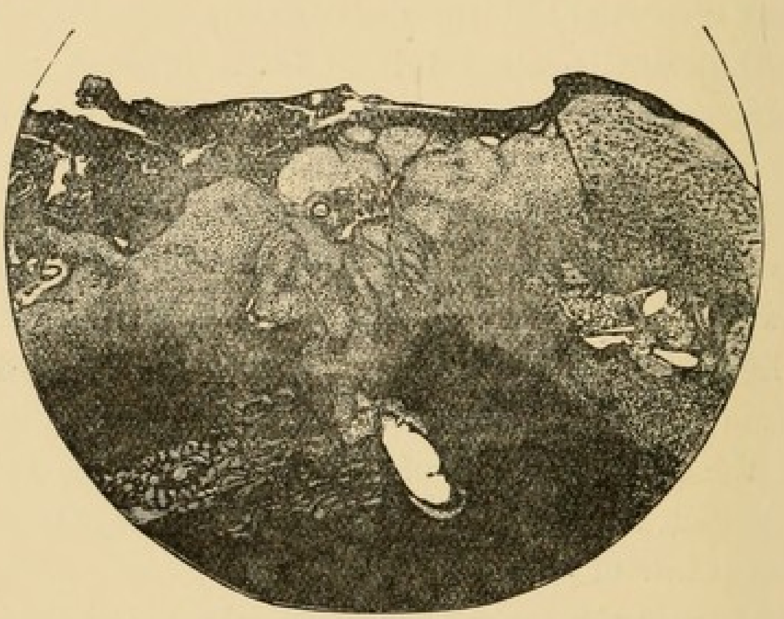

FIG. 15.—Shows the extension of the soft tissue over the surface of the cartilage getting thinner and thinner towards the right hand side, *i.e.*, further from the point of reflection of the synovial membrane.

tissue. This tissue which, in the first instance, may show no evidence of the presence of tubercle, soon presents, in most cases, the character of a tubercular 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 this new 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 tubercular 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 the surface of the cartilage, separated by patches of but slightly altered cartilage and connected by a thin layer of soft tissue

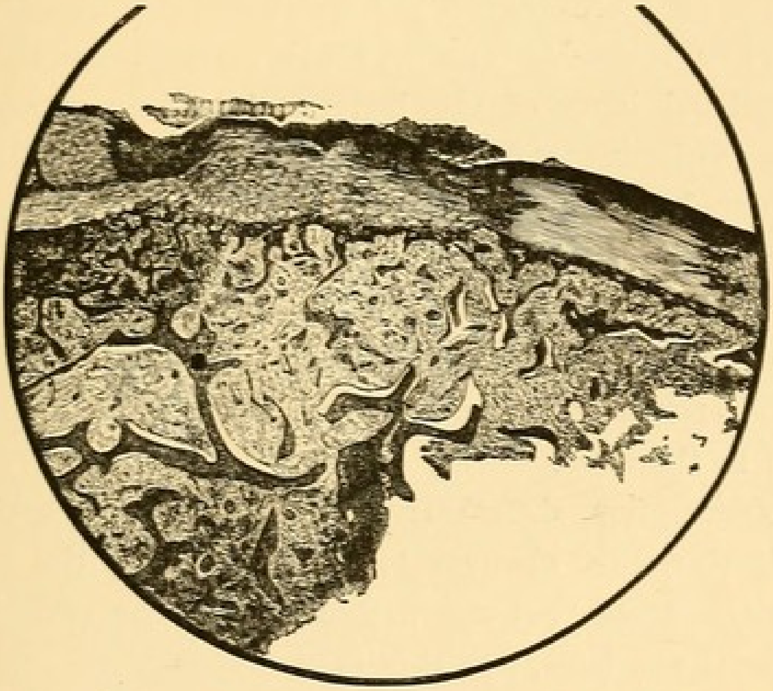

FIG. 16.—Shows the articular cartilage undergoing destruction from the surface, islets of soft tissue being formed giving rise to the pitted and sieve-like appearance so often present.

on the surface of the cartilage. In this way the pitted or completely perforated appearance of the shreds of cartilage is produced. This condition is well seen in Fig. 16, where a number of these depressions are present.

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, 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 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; 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 remains of unaltered cartilage still firmly adherent to the bone.

This description differs from that generally received in assigning the chief changes to the surface of the cartilage; most writers state that the destruction of the cartilage commences next the bone, but this is clearly not the case, or else the specimens I have prepared have all 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. 17, 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 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

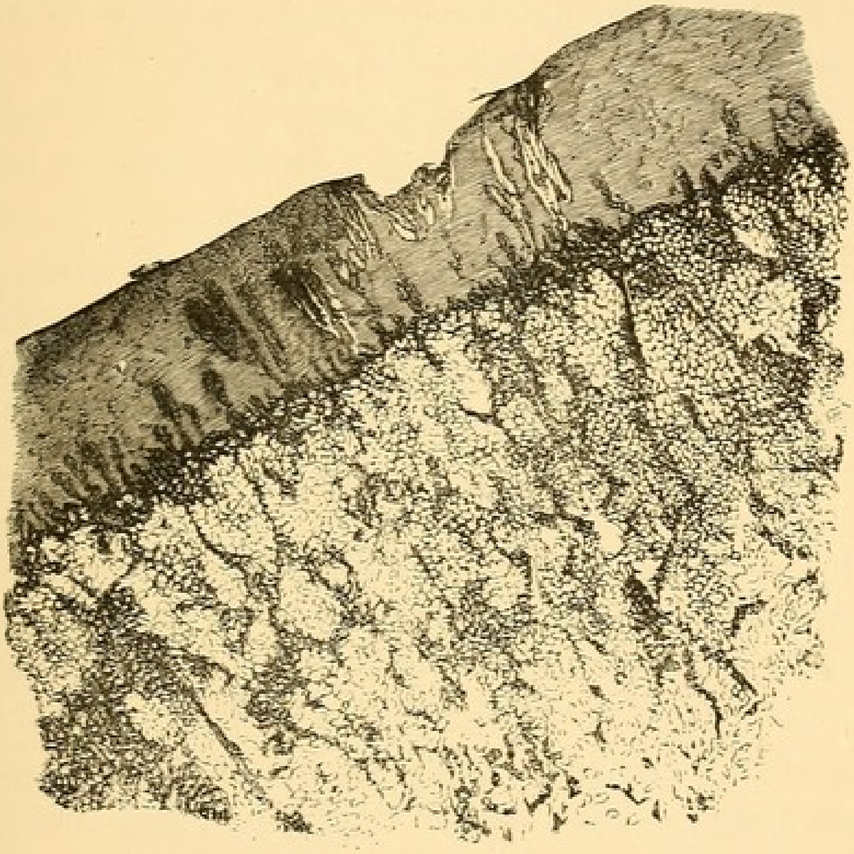

Fig. 17.—Destruction of articular cartilage from the deeper surface, flask-shaped processes containing fibrous tissue shooting into it from the cancellous spaces beneath.

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 to 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 tubercular 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 tubercular 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 tubercular 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 tubercular 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 tubercular 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. 18. On the right hand side of the surface of the bone we see that the superficial cancelli are infiltrated to a depth of about one-eighth of an inch with dense tissue, which, on examination under a higher power, is found to be composed of tubercles and tubercular infiltration, undergoing caseation at the edge. Lying among this tubercular 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 tubercular layer the bone is in a condition of rarefying osteitis, 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 tubercular 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.

This specimen also bears out very well what I have said

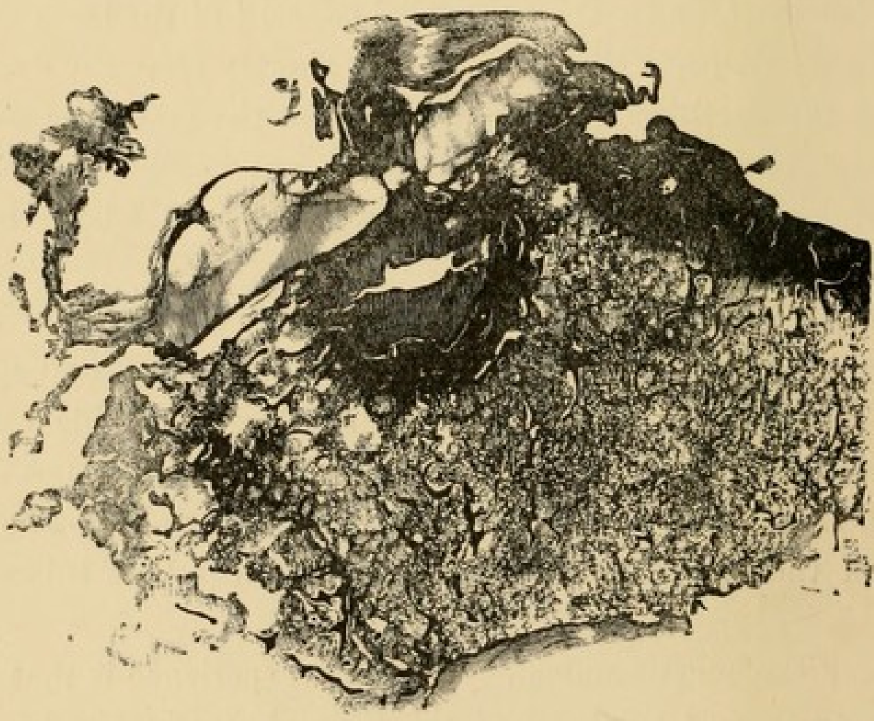

Fig. 18.—Section of head of tibia with a soft deposit under the cartilage. To the right of the upper surface the cartilage has disappeared, and the surface of the bone is carious. (*See* Text.)

about destruction of cartilage in the neighbourhood of tubercular deposits. I have pointed out that although we might have expected that, in the neighbourhood of tubercular 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.

In other cases, the sclerosis and new formation of bone preceding the tubercular growth in cases of caries is very well marked, as, for example, in Fig. 19, taken from the internal condyle of the femur. Here we see that there has been extensive destruction of the surface of the bone, which has been replaced by tubercular tissue, undergoing caseation at the edge. Beneath

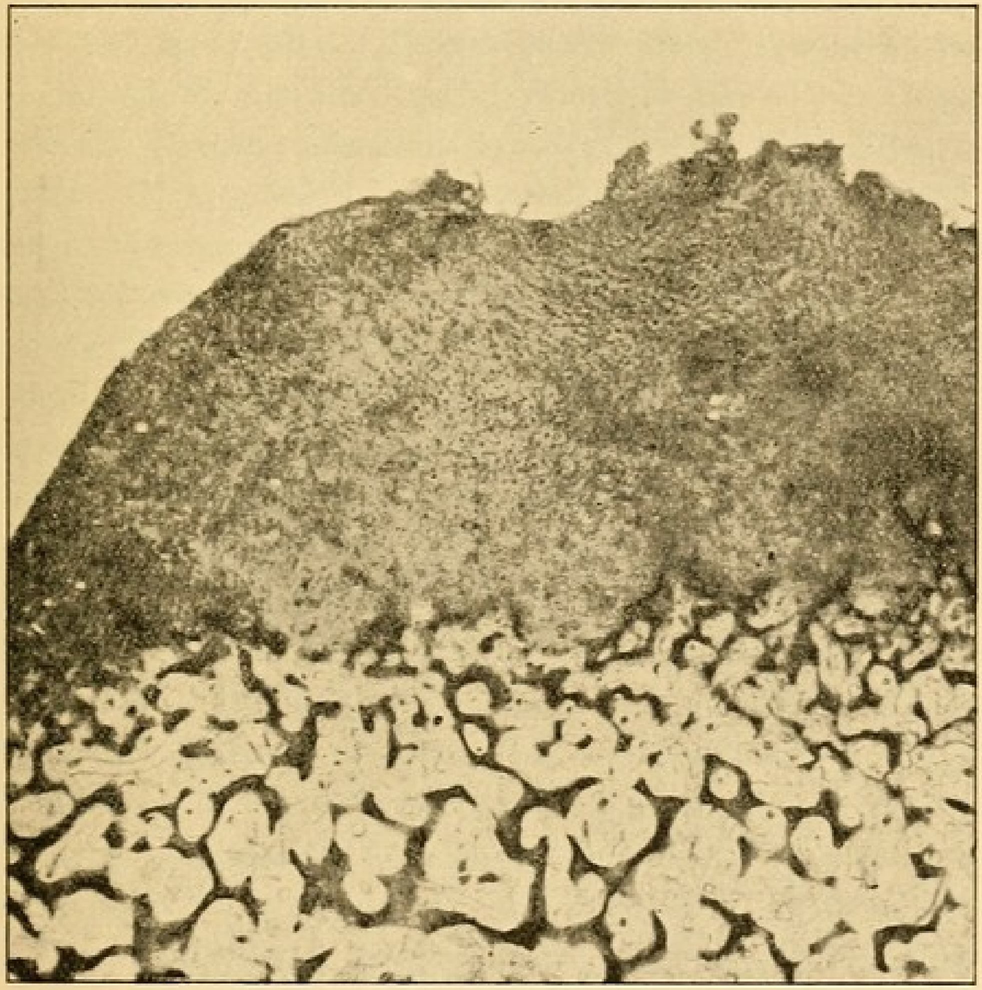

FIG. 19.—Section of the lower end of the femur, showing caries. The cartilage has disappeared, and a quantity of soft tissue containing tubercles is present. Beneath this a network of new bone has been formed.

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 tubercular growth.

This sclerosis of bone in connection 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 tubercular disease of the surface of bone. The first changes occur in connection 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 the spread of 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 tubercular growth soon extends into the superficial cancelli, and young fibrous tissue is formed beyond it, and sclerosis of the trabeculæ occurs. As the tubercular invasion extends, portions of these osseous trabeculæ become detached, and caseation takes place. Beneath the tubercular 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 tubercular 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 tubercular disease extends, seldom more than $\frac{1}{4}$ 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 tubercular 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.

TUBERCULAR PERIOSTITIS AND TUBERCULAR 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 connection with the periosteum, or in the medulla of the bone—that is to say, we may either have a tubercular periostitis or a tubercular osteomyelitis.

Tubercular periostitis as a primary affection occurs most frequently in the ribs and the vertebræ. In the case of the ribs tubercular disease may commence either in the interior of the bone or in the periosteum, in the latter most commonly. Where tubercular 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. This appearance is due to the fact that the tubercular 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 tubercular periostitis is the vertebræ. Tubercular disease of the vertebræ commences either in the substance of the bone as a circumscribed tubercular deposit or a more diffuse tubercular osteomyelitis, or on the surface as a tubercular 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

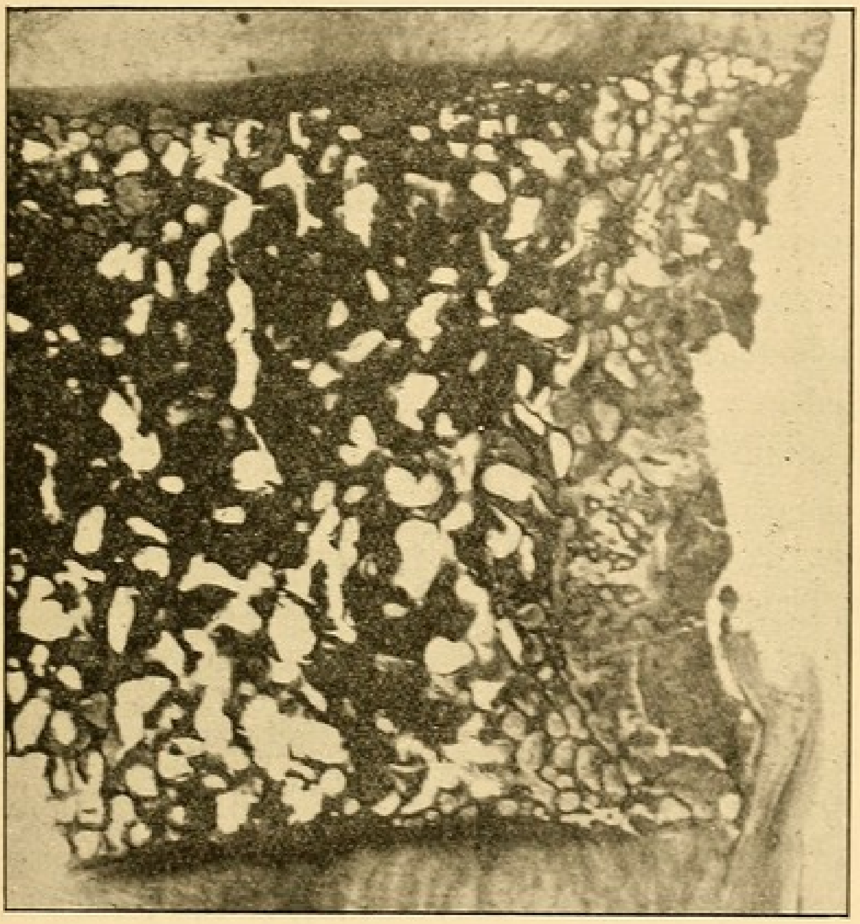

FIG. 20—Section of the body of a vertebra, showing caries of the surface (right hand side), resulting from a tubercular periostitis and great sclerosis of the bone beneath.

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 bone beneath. In Fig. 20 the carious condition of the surface, the result of the tubercular 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 tubercular disease generally commences in the interior of the bone in the form of tubercular 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 tubercular 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 usually they have undergone a good deal of absorption, being thus in parts dense and in parts soft.

More often, however, tubercular 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 tubercular 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 tubercular 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. 21 is an excellent example of tubercular osteomyelitis, with sequestrum formation. It is a complete section through the first phalanx of a finger of a lady, aged twenty-eight, 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 tubercles either isolated or in the form of tubercular infiltration. Beyond this we have a layer of much thickened trabeculæ, which are becoming eroded on the side towards the concavity by the tubercular growth. Beyond this layer of thickened and newly formed trabeculæ, we have at the proximal end fairly normal tissue. Towards the distal end of the phalanx there are one or two tubercles in the cancelli, and in some of the sections the tubercular 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 absorbed there, and the tubercular 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.

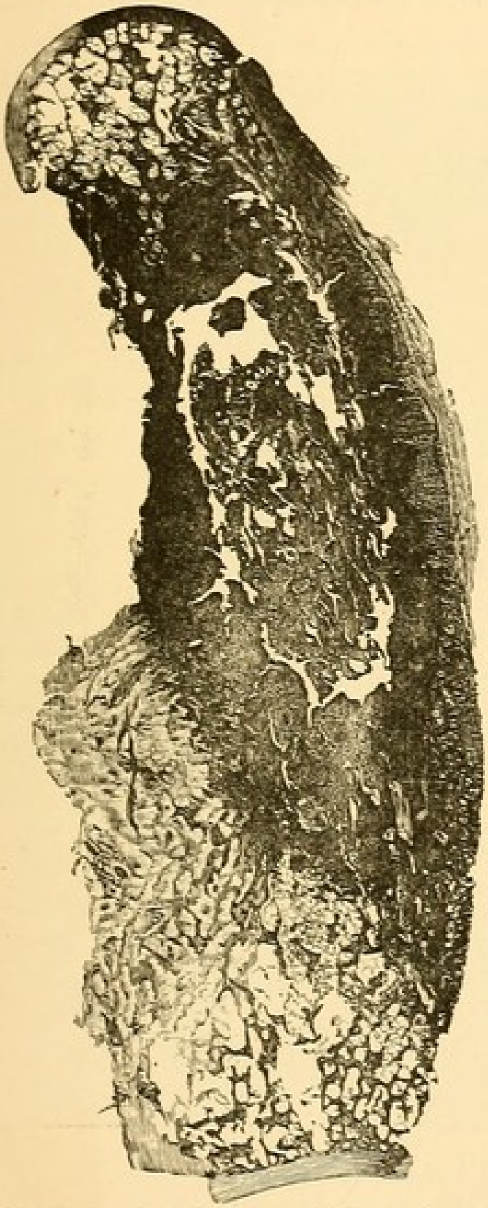

FIG. 21.—Section of a phalanx showing a tubercular sequestrum in the substance of the bone. (*See* Text.)

The most common form of tubercular 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. 22). The

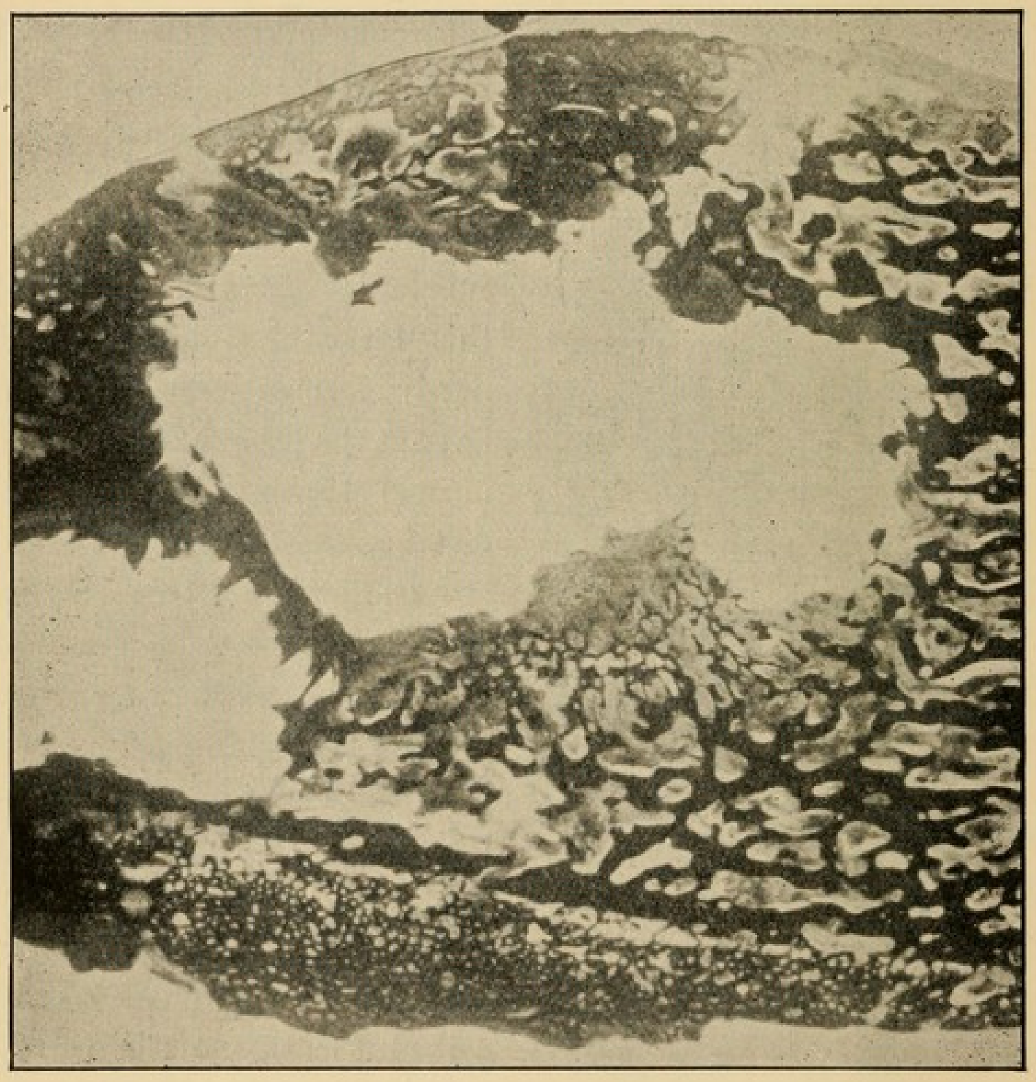

FIG. 22.—Section of the lower end of the ulna, showing tubercular osteomyelitis. The soft tissue in the centre has fallen out. The new bone both in the shaft and in the periosteum is well seen.

patient was a child, aged six, 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 tubercular 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 tubercular 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 from the periosteum. 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 people than the form of tubercular osteomyelitis accompanied by necrosis.

A special investigation, and one worth mentioning, has been made by Renken as to the tubercular nature of the soft material in the interior of the bone in these cases of strumous dactylitis. In five cases he examined this soft material microscopically for tubercle bacilli, and at the same time inoculated guinea-pigs from each case. In every instance he found bacilli, though usually in small numbers, and all the guinea-pigs became tubercular. That the disease in the guinea-pigs was due to the inoculation was shown by the fact that the disease commenced at and spread from the seat of inoculation, and also by the fact that other animals not inoculated but kept in the same cages with those experimented on did not become tubercular.

CHAPTER VI.

RARER FORMS OF TUBERCULAR BONE DISEASE.

CARIES SICCA; DIFFUSE CONDENSATION OF BONE IN CONNECTION WITH TUBERCULAR DISEASE; DIFFUSE SOFTENING OF BONE AND THE FORMATION OF "RED MARROW."

1. Caries Sicca.

This is a rare form of tubercular 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 characterised 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 connection 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 tubercular. More careful microscopical examination has, however, shown that the disease is in reality tubercular, although considerable tracts of the tissue in the bone may not show any tubercular invasion. Tubercle bacilli have been demonstrated in the affected tissues by Wanke in 1884, and by Gutenberg in 1886, and a further proof of its tubercular 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 tubercular 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 tubercular 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 connection with Tubercular 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 tubercular 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 tubercular 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 twenty-seven, 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 was gone 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 tubercular 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 tubercular 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 tubercular deposit.

The sequence of events was, I believe, the following:—A tubercular 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 tubercular infiltration of the bone.

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

The other diffuse change of bone in connection with tubercular 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.

I have only come across one specimen of this kind, obtained from a patient who was under the care of a colleague. The case was that of a child who had previously suffered from tubercular disease of the elbow, ulna and finger, and whose leg was amputated at the knee for disease of the joint. The child ultimately died of general tuberculosis, and the medulla of the bones was red, soft, and, in fact, almost diffluent. All attempts to obtain complete sections of the medulla and bone failed on account of the softness of the tissue, and therefore I had to content myself with sections of small portions. When stained with methylene blue the medulla was seen to be composed of a mass of cells of various shapes and sizes running among which were strands of fibrous tissue. Here and there were light stained tracts of large cells bordered by groups of small cells. The nuclei of these large cells were faintly stained and of an oval form, and it is possible that they may represent tracts of tubercular infiltration. The appearance, however, is not absolutely characteristic, and in none of the specimens did I find any isolated tubercles. It seems to me probable that in some, at least, of these cases the softening of the bone is purely the result of an extreme degree of rarefying osteitis in the neighbourhood of tubercular disease, thus being the converse of the preceding condition.

CHAPTER VII.

PATHOLOGY OF CHRONIC ABSCESS.

In what I have previously said, I have retained the terms "chronic abscess," "suppuration," and "pus" in connection with these tubercular diseases, although, as a matter of fact, these terms are incorrect; for when we speak of suppuration or chronic abscess in connection with tubercular 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 connection with tubercular 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. 23, caseation begins, and a collection of caseous material is formed surrounded by tubercular 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 tubercular infiltration, and further away isolated tubercles. At the spreading margin the tubercular tissue continues to invade the surrounding structures, while not only does the caseation extend around the original cavity, but it also commences in inde-

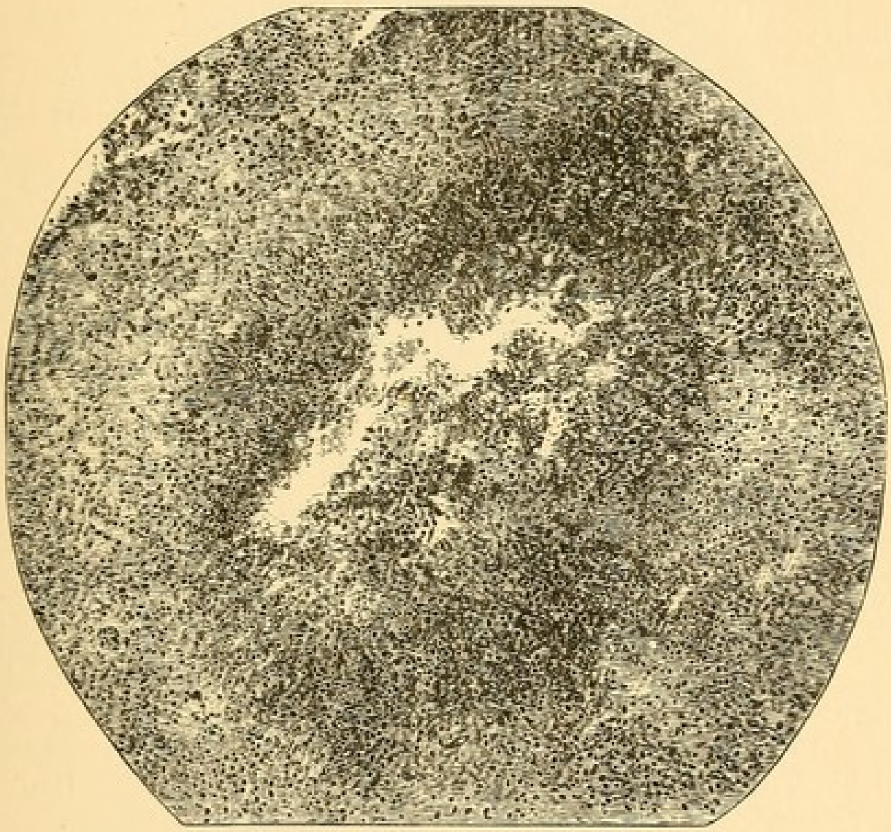

FIG. 23.—Earliest commencement of a chronic abscess. The tubercles have run together, and this tissue is undergoing caseation; fluid is being effused among this caseous material.

pendent 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. 24, 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 become 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 tubercular tissue in the surrounding parts, while caseation goes on in the

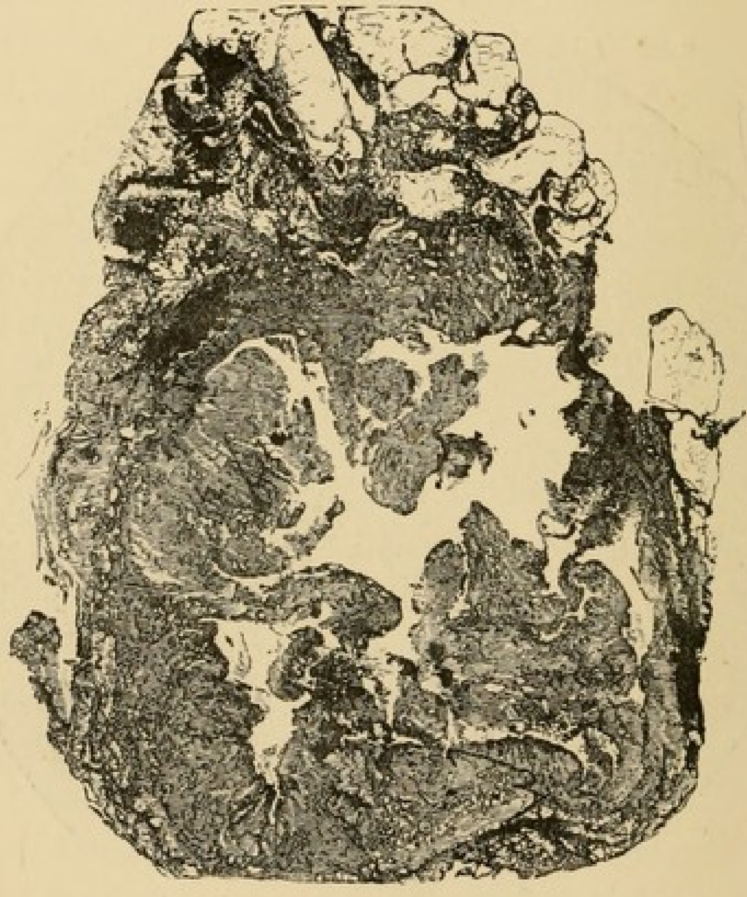

Fig. 24.—Section of a small chronic abscess hardly magnified. (*See* Text.)

centre. Hence, whatever part of the wall of a chronic abscess is examined, caseating tubercular tissue and frequently isolated tubercles will be found, as seen in Fig. 25, which is taken from the wall of the abscess shown under a low power in Fig. 24. 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 tubercular tissue are present.

Exactly the same process occurs in connection with tubercular disease of bones and joints. When suppuration occurs in a joint in connection with tubercular 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 varying numbers. Where

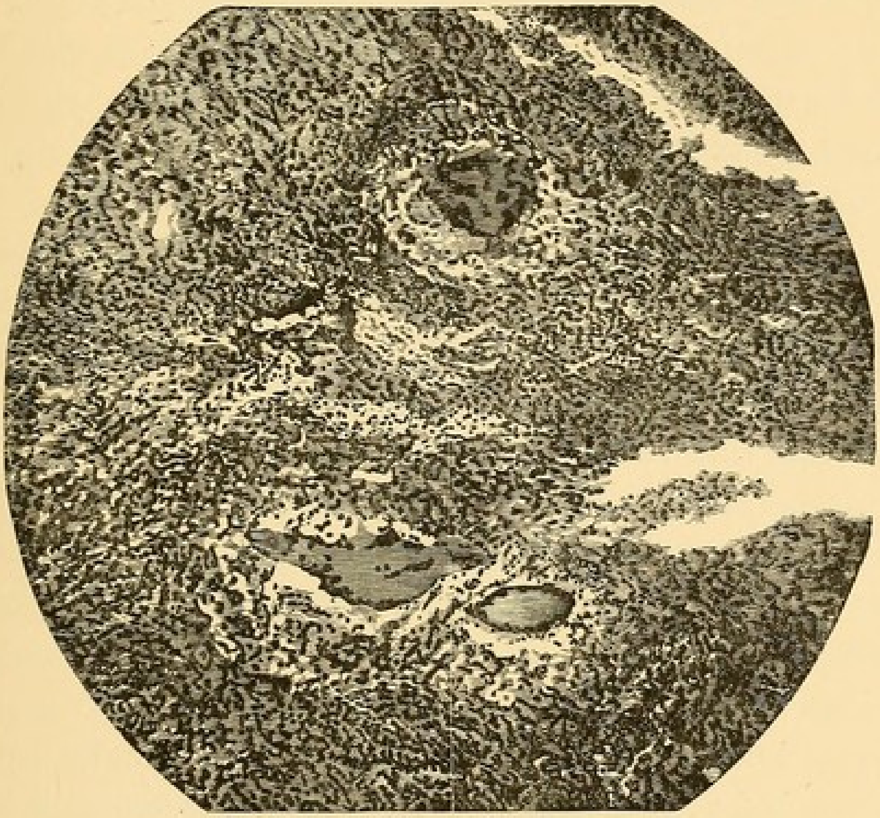

FIG. 25.—Magnified section of the wall of a chronic abscess (Fig. 24), showing the presence of tubercles with large giant cells.

the abscess forms in the substance of the synovial membrane a tract of tubercular tissue caseates, and the abscess spreads in the manner formerly described. Where a tubercular 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 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 tubercular 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 tubercular 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 tubercular process. Caseation is a very constant occurrence in tubercular 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 connection 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 tubercular history, in patients who suffer from multiple tubercular 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. The more definite meaning of these facts must be left for future research, but none the less we must bear in mind the tubercular 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.

THE TUBERCULAR NATURE OF "STRUMOUS" JOINT DISEASES.

At the end of the first chapter, I summarised the chief reasons for regarding "strumous" bone and joint disease as tubercular, and I propose now to enter a little more fully into this matter.

In the first place, many cases are now on record where wounds have become accidentally infected with tuberculosis, and where subsequently various diseases known as "strumous" affections have developed. I may mention a few examples where bone and joint disease developed after the injury.

Verneuil mentions the case of a student who injured the fold of the nail of his right ring finger at a *post-mortem* examination, with the result that a *post-mortem* wart developed. This was treated in various ways without permanent improvement, and after three years' treatment there was still a tubercular ulcer on the finger, and a tubercular abscess on the back of the hand. This abscess was opened, and the ring finger was amputated, but chronic abscesses formed from time to time elsewhere, and the patient ultimately died six years after the injury of spinal meningitis, due to suppuration in connection with tubercular disease of the vertebræ.

Czerny mentions two cases where skin grafting was employed in large ulcers, the skin being taken from limbs just amputated on account of tubercular bone disease, and these patients afterwards became the subjects of tubercular disease. In the one case, the surface of the wound, which extended from the foot to above the knee, became covered with croupous unhealthy membrane, and the granulations became weak and œdematous. After some time a communication formed with the knee-joint;

this sinus closed, and opened again several times, and the patient died of phthisis fourteen months later, but there were no definite signs of disease of the knee-joint. In the other case, the sore was over the thorax, and after a time the patient developed spinal disease with curvature and psoas abscess.

In Middeldorpf's case the patient, a male, aged sixteen, healthy, and with no hereditary tendency to phthisis, received a penetrating wound of his knee-joint, to which he applied his handkerchief, and which healed in eight days. Fourteen days after the accident, swelling of the joint was noticed, with great pain on movement. During the following four weeks he suffered great pain, and had starting of the limb at night, &c., and his condition six weeks after the accident was that there was a scar below the patella, great thickening of the synovial membrane, and slight dulness at the apex of the right lung. Excision was performed, and the synovial membrane was found to be greatly thickened, but there was no disease of the bone. Tubercle bacilli were found in the synovial membrane. Middeldorpf assumes this to be a case of inoculation either from the axe or from the handkerchief, chiefly because the patient's previous health was good, because the course was rapid, and because the time which elapsed between the injury and the commencement of the symptoms, fourteen days, is about the usual period of incubation.

Pfeiffer reports a case of a healthy veterinary surgeon with a good family history, who, while dissecting a tubercular cow, punctured the phalangeal joint of his left thumb. The wound soon healed, but induration of the scar took place, and later the whole joint became swollen, and presented the typical appearance of a scrofulous synovitis, but without the formation of sinuses. Some months later the patient began to show signs of pulmonary phthisis, which rapidly increased, and he died of this disease a year and a half after the injury. The thumb, which was much swollen, but with the skin unbroken, was removed for examination. The joint, on being laid open, showed all the destructive changes of scrofula both in the bones and synovial membrane; and in the latter, as well as in the broken down material which filled the interval between the bones, an unusually large number of tubercle bacilli was present. The microscopical appearance of the diseased tissues was also typically tubercular.

Barner has also published a case of joint disease secondary to a *post-mortem* wart on the hand. His case was that of an assistant in the *post-mortem* room, aged fifty-four, with a good family history, who first contracted these warty growths ten to fourteen years previously, and at that time they healed. Seven or eight years before the date of admission, he acquired another wart, which, however, disappeared under treatment, but had previously extended to the carpo-metacarpal joint. This was followed by tubercular disease of the carpus, for which excision was performed.

A second proof that these strumous diseases are truly tubercular is afforded by the microscopical structure of the tissues affected. In all these affections, tubercles and tubercular tissue are constantly present in the thickened synovial membrane, the osseous deposits, &c., and present all the characteristics already described. The results which I have obtained are similar to those of other observers; to mention one example, König examined 72 specimens in the Göttingen Museum, and, of these, 67 yielded fairly satisfactory results. He found tubercles in bones and joints, in the walls of chronic abscesses, and in the soft tissues at the points of reflection of the synovial membrane, and he points out that the characteristic tubercular tissue is not seen in ordinary granulations, acute osteomyelitis, &c.

The tubercular nature of these diseases of bones and joints is further and definitely shown by the presence of the tubercle bacillus. As is now well known, tubercle bacilli are never found except in connection with tubercular tissues, and when we bear in mind the experimental evidence and the *rôle* which this organism plays in the production of tubercle, we must assume that, whenever we find tubercle bacilli in a morbid tissue, the disease with which we have to do is tuberculosis. Search has accordingly been made for these bacilli in the diseased tissues, and in the caseous material or pus, with the following results—

Koch, in his first work on tuberculosis, stated that he had found tubercle bacilli in small numbers in 4 cases of strumous disease of joints, in 3 cases of strumous glands, and in lupus.

Schuchardt and Krause were the first to make an elaborate investigation on this subject, and they carefully examined 40 cases of surgical tuberculosis in patients of various ages, and with and without hereditary taint, the diseases to which they directed their attention affecting bones, joints, sheaths of tendons, skin, including lupus, walls of tubercular abscesses, lymphatic glands, tuberculosis of tongue, testicle, uterus, and Fallopian tubes. Tubercle bacilli were found in all these parts, but in the great majority of instances they were few in number, and only found after a long search. These authors thought that the small number of the organisms was due to the fact that these diseases are very chronic, and they supposed that the bacilli are most numerous in the early stage, although, as a matter of fact, they had no absolute evidence in support of this view.

These observations have been repeated by several other observers with varying results. Thus, Bouilly always succeeded in finding bacilli, though only after a long search. Mögling examined in all 53 specimens, of which 28 were from joints or bones, and he also obtained positive results, though the bacilli were, as a rule, present only in small numbers, nor were they specially limited to the giant cells, as had been asserted by earlier observers. Kanzler confirmed these statements. Schlegtendal, employing Ehrlich's method, examined the contents of 23 abscesses connected with bones and joints, and obtained 8 positive and 15 negative results, but he did not examine the walls of the abscesses. In the discharge from fistulæ connected with bones and joints, 7 positive results were obtained in 46 cases. In all, including abscesses and sinuses connected with disease of the soft parts, 17 positive results were obtained with the pus of 40 unopened abscesses, and 9 with the discharge of 60 fistulæ or ulcers.

Müller examined from 30 to 35 cases of tubercular disease of bones and joints, the specimens being chiefly obtained by excision, and he confirmed Schuchardt and Krause's statement that, with patience, it is possible in most cases to find bacilli.

In several cases where recovery was taking place, he looked in vain for bacilli. His investigations do not add any support to the view that the bacilli are most numerous in the early stage of the disease, but he states that, in many preparations, whether bacilli were present or not, there were peculiar bodies like drops of oil which retained the red stain, and which he looks on as probably remnants of bacilli.

I have, on repeated occasions, examined the pus, bones, synovial membrane, &c., from strumous joints, for tubercle bacilli, but as I have not always kept notes of the cases I cannot give the precise figures. The general result of my examinations has been that, after sufficiently careful and prolonged search, bacilli could always be found, but that, in most cases, they were extremely few in number.

That the bacilli are present even when difficult to demonstrate by means of the microscope is evident from cultivation experiments, and from the results of inoculation of animals, but it is not easy to explain their apparent small numbers, and various theories have been advanced. Some authors suppose that the bacilli are most numerous at the commencement of the disease, and subsequently decrease in numbers. According to others, they rapidly pass into the spore stage, and are then no longer recognisable by means of the microscope. My own belief is that we do not as yet possess a method by which we can stain all these bacilli at all stages of growth. I found very early in working with the tubercle bacillus that if we took sections, say from rabbits, in which large numbers of bacilli were present, and stained them in simple watery solution of fuchsine, without any aniline, carbolic acid, or other similar body, a considerable number took up the stain, and a few retained it even after a short immersion in the dilute nitric acid. Thus it was evident that the staining reactions of these bacilli differ even in the same specimen, and this is, I think, due to differences in the age and stage of growth of the organisms. At a certain age or stage of growth the sheath is probably more easily penetrated by the stain than at another age, and this corresponds with what we know with regard to other organisms. Thus, in the case of anthrax, stained by Gram's method (gentian violet, iodine, and vesuvin, or other contrast dye), it is by no means uncommon to find some of the bacilli violet and others brown; indeed, I have frequently seen some members of a chain violet, while others in the same chain were brown. In sections of tubercular synovial membrane, stained by Ehrlich's method (bacilli red, tissues blue), I have not uncommonly found that while a few red-stained bacilli were present, there were also some which were blue, but which nevertheless presented the same microscopical appearance as the tubercle bacilli, and bore the same relation to the giant and epithelioid cells, and I have no doubt whatever that these are, in reality, tubercle bacilli in a different stage of development. The first case where this idea occurred to me was that of an undoubted tubercular ulcer of the tongue, in which I failed to find any red-stained bacilli, but, on the contrary, considerable numbers of faintly stained blue organisms, resembling tubercle bacilli both in their situation and microscopical characters. Since that time I have paid great attention to this matter, and have seldom failed in well-stained specimens from tubercular joints to find blue-stained tubercle bacilli, often in larger numbers than those stained red. I believe, therefore, that the apparently small number of tubercle bacilli in these local tuberculoses is mainly due to the fact that they are growing slowly and with difficulty, and that their staining reactions differ at different periods of their existence. We require further research as to the methods of staining of these organisms before we can conclude, because we fail to find them by the ordinary methods of staining, that they are therefore either absent or in the spore stage.

In connection with this matter it is interesting to note that I have found the same difficulty in finding tubercle bacilli in the synovial membrane of animals, in which I have set up typical tubercular joint disease by the injection of pure cultivations of tubercle bacilli, although they were easily demonstrated in the tubercles in the internal organs.

To sum up, we may take it that only few bacilli can, as a rule, be demonstrated in tubercular joints and abscesses, but that they can usually be found in cases where the disease is progressing if the search be sufficiently careful and prolonged, and, further, that our present methods of staining do not permit us to draw conclusions as to the numbers present.

Another point which supports the view of the tubercular nature of these diseases is their frequent association with phthisis, tubercular meningitis, &c. It is a well-known fact that many patients suffering from strumous joint diseases are affected, or are very liable to become affected, with phthisis, while tubercular meningitis and general tuberculosis are, unfortunately, by no means rare terminations of these diseases, especially after operation or injury.

It is difficult to ascertain the frequency of general tuberculosis, phthisis, &c., in cases of tubercular joint disease, for patients who, when discharged, showed no symptoms of phthisis, may and often do develop it in later life. In my own statistics many of the cases were not under observation for a sufficient length of time to be of value in determining this point; the average duration of the disease up to the termination of the treatment was nearly three years, and we find that during this time, of 386 patients, 42, or 10·8 per cent., had become affected with or had died of phthisis or tubercular meningitis. Of a large number of statistics which have been published, I may mention the following:—Billroth and Menzel found, on searching the *post-mortem* records at Vienna for a period of fifty years (1817-1867), that there had been 2106 cases of carious disease of bones and joints, and of these more than half (1143, or 52 per cent.) were complicated with tuberculosis of the internal organs. It must, however, be noted that these were chiefly adults, and also that the *post-mortem* examinations were made at a time when the views on tuberculosis were very imperfect. In Billroth's Zürich statistics, extending over a period of seven years (1860-67), he operated on 71 cases, of which 26, or over 36 per cent., died of tuberculosis or phthisis. Neumeister has put together a large number of cases both from the Würzburg clinique and also from published papers, and gives a total of 438 cases, with 66, or 15 per cent., of deaths from tuberculosis and phthisis, and 10, or 2·2 per cent., from acute tuberculosis. Willemer states that, in the case of the knee-joint, 1 per cent. of the patients die of tuberculosis during the first year of the disease, 6 per cent. during the second year, and 7 to 8 per cent. during the third year.

I believe that, apart from the fact that the cases in the above statistics were observed for a long time, the septic condition of the wounds in many cases aided the generalisation of the disease, but this is a point to which I shall again refer. Suffice it to say that, speaking roughly, something like 20 to 30 per cent. of the patients suffering from strumous disease of the larger joints ultimately die of internal tuberculosis. Further, there is only a comparatively small percentage of the cases—König says about 21 per cent.—in which the joint disease is the only tubercular trouble.

Further proof that these diseases are of a tubercular nature, and the same as tubercular phthisis of the lungs, only modified by the situation and other conditions, is furnished by the fact that inoculation of animals with the morbid products from joints sets up tuberculosis in exactly the same manner as when material from the lungs is employed. I have, on many occasions, inoculated portions of synovial membrane and pus from strumous joints subcutaneously or into the anterior chamber of the eye in guinea-pigs and rabbits, and have invariably produced typical tuberculosis by this means. The same has been the experience of a number of other workers, though in a few cases negative results have been obtained. Much of the success depends on the care taken in introducing the material, more especially care that it shall keep its place, and not slip out again through the opening made, and also on the employment of a sufficient amount of the material.

The last proof of the tubercular nature of these diseases to which I need refer is the fact that similar affections may be induced in animals by the introduction of tubercular material into bones and joints. Tubercular bone and joint affections have been produced by the sputum of phthisical patients, material from tubercular joints, the pus of chronic abscesses, &c. I have obtained absolute proof of their tubercular nature by setting up similar processes in animals by the injection of pure cultivations of tubercle bacilli derived from cases of human tuberculosis. Such cultivations, injected into the joints of rabbits and goats, set up typical strumous disease of these joints; injected into the blood vessels supplying the bones, cause tubercular deposits in the bone and disease of the neighbouring joints; and injected into the epiphyses or medulla of bones, cause tubercular inflammation, with, in some cases, expansion of the bone and new formation of bone from the periosteum, and, where the disease extended to the joints, the typical disease of the articulation.

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 one or two as examples. I may say that the experiments were performed with pure cultivations of tubercle bacilli from man mixed with sterilised water to form an emulsion.

1. *Injection into the knee-joint of a rabbit.*—On January 11, 1888, a small quantity of the emulsion 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

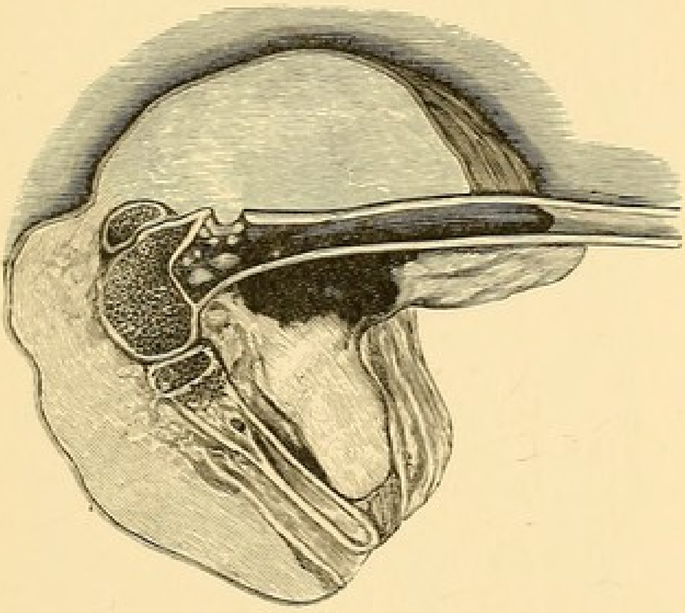

FIG. 26.—Section of the knee-joint of a rabbit after injection of a pure cultivation of tubercle bacilli. (*See* Text.)

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, more especially above the patella and also behind the joint (*see* Fig 26).

On making sections of the bones several small cheesy deposits were seen in the femur just above the epiphysial line, and in front there was a small hole 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.

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 tubercular 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 tubercular tissue was penetrating into it, and there were one or two large tubercular 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 tubercular 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 joint, 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. 27) 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 tubercular 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.

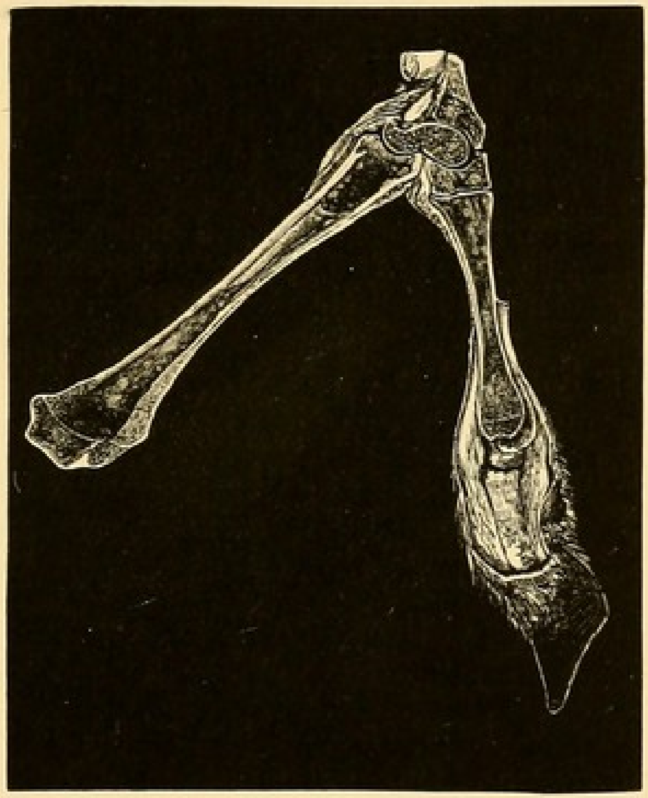

FIG. 27.—Section of the bones of the leg of a goat two months after injection of tubercle bacilli into the nutrient artery of the tibia. Shows numerous tubercular deposits in the various bones. (*See* Text.)

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 tubercular 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 tubercular 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 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 tubercular deposits beneath it. The changes in connection 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 tubercular deposits, very numerous indeed immediately above 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 tubercular 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 tubercular disease of bones and joints in man. And as in man in the 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 condyles. There was no pus in the joint, and nothing abnormal seen in the bones (*see* Figs. 28 and 29).

There was also great swelling of the left wrist-joint, and marked thickening of the synovial membrane. In the proximal end of the

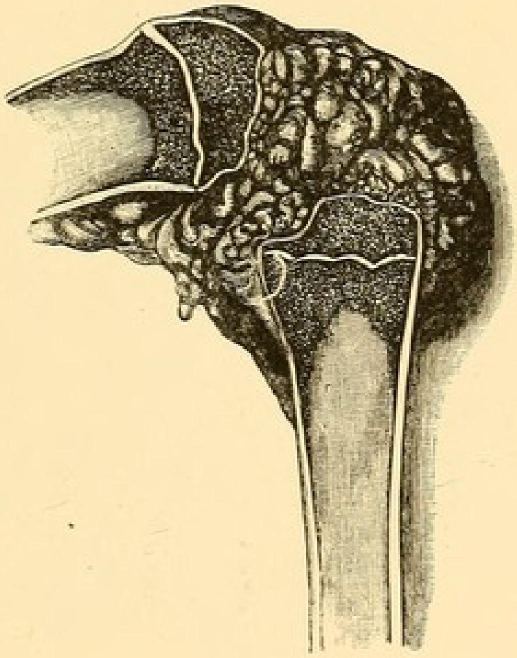

Fig. 28.—Section of knee-joint of goat, after injection of a very small quantity of a pure cultivation of tubercle bacilli. The villous condition of the synovial membrane is well seen.

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 tubercular 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 tubercular infiltration, and a few small giant cells. 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

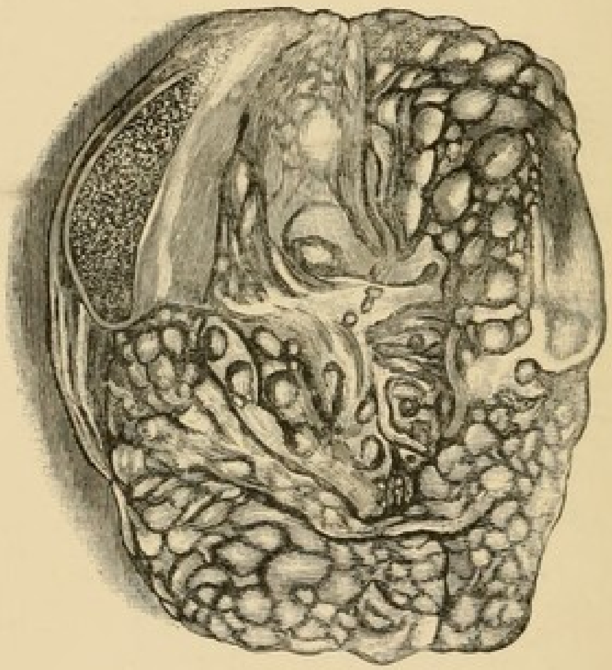

FIG. 29.—The same specimen as Fig. 28, seen from the front. The patella has been turned to one side.

tubercular deposits scattered throughout the fibrous tissue, some of them with commencing caseation. This photograph (Fig. 30) is taken from a complete section of the wrist joint. Towards the posterior part of the metacarpal bone (on the right hand side) there is a tubercular 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, and penetration of the tubercular 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.

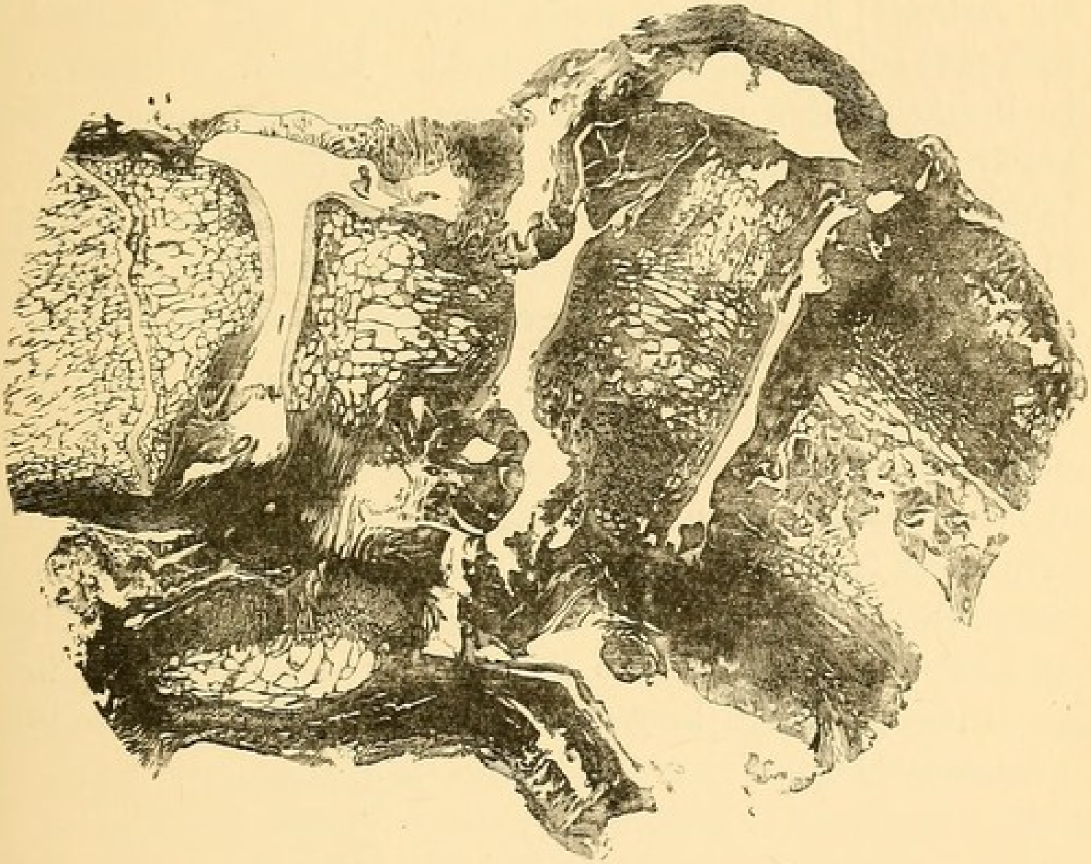

Fig. 30.—Wrist joint of goat after injection of tubercle bacilli into the end of metacarpal bone. A deposit has formed and opened into the carpal joints, and has set up exactly the same sequence of events as is seen in Fig. 11.

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, and slight thickening of the synovial membrane is taking place.

Compare this appearance with the section of the wrist joint (Fig. 11) 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 essentially alike.

These experiments are sufficient to indicate the kind of results obtained, and to establish the causal connection between the tubercle bacillus and tubercular diseases of bones and joints, more especially when taken in connection 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 tuberlar 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 tubercular joint disease, as slighter injuries, like sprains, and he also found that fractures of bones in tubercular animals heal without any trouble. Of joints which were dislocated or severely injured a few became tubercular, 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 tubercular 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 tubercular 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 TUBERCULAR DISEASES OF BONES AND JOINTS.

Having thus studied the changes which occur in bones and joints in the course of tubercular disease in these parts, and having satisfied ourselves of their tubercular nature, more especially by the production of similar appearances by means of the tubercle bacillus, I propose now to refer very shortly to some of the conditions which come into play in the production of these diseases. 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 tubercular 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 tubercular 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 tubercular 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 these 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 connection 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 tubercular disease.

The points of entrance of the tubercle bacillus are very various. I have already referred to instances in which the bacilli 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 tubercular 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 tubercular virus on 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 tubercular virus is simply rubbed into scratches in the skin the blood containing the virus quickly dies, 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 tubercular 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 tubercular ulceration of the intestine. Klebs states that the presence or absence of tubercular ulcers in the intestines of animals which are fed with tubercular material depends to a great extent on the size of the particles of the tubercular matter. He found that finely divided particles of tubercular 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 even passed them, and lodged in various internal organs. On the contrary, and this was also demonstrated by Chauveau, where the animals were fed with large and firm tubercular 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 tubercular 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 Apart from the local effects on the nasal passages, as manifested by the production of ulceration, &c. (grouped under the term scrofulous ozæna), it is not uncommon for the virus to be inhaled into the lungs, and either set up disease in the pulmonary alveoli in the first instance, or, as in the case of the intestine, pass through the alveolar epithelium and be carried to the bronchial glands, and set 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 tubercular 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, infection resulting in the production of a sore at the point of entrance. This mode of infection is much more likely to occur in the female than in the male.

Lastly, it is held by many 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 tubercular 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 tubercular 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 connection 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 with tuberculosis of various internal organs, and the hen after 2½ 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 came 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 4½ months, and in all of these, with one exception, tubercles and tubercle bacilli were found after death in the internal organs. The tubercular 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 tubercular 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 tubercular 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 must be extremely slight. It is difficult, for one thing, to see how the bacilli get into the ovum, seeing that they are motionless; one must almost suppose that they remain in the uterus, and grow in the decidual membranes, and thus enter the blood, but here we should expect evidence of tubercular disease of the decidua or placenta. It is hardly conceivable that this can be a common, or, as is held by some, the most common mode of transmission of tubercular disease, especially when we bear in mind the greater frequency of tuberculosis in adult life, otherwise we must suppose that the bacilli are stored up in the body for years till some condition comes into play which enables them to develop. This is most unlikely, for we know by experiment that the most resistant spores cannot live in the healthy animal body longer than a few months. It is quite a different matter where the bacilli are enclosed in a caseous mass, which becomes encapsuled, for there the spores are protected by the caseous material from the action of the living cells, and juices of the body.

The infection of the fœtus from the side of the mother must also be equally 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 tubercular 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 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 tubercular 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. We must, therefore, conclude that whether from the father or the mother transmission of the tubercular virus to the fœtus must be an extremely rare occurrence, though it is possible that some cases of tuberculosis in infants may have originated in this way.

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, 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 recently been made by others, it seems that the same laws hold good in this disease. Thus Gebhardt experimented with the milk of tubercular cows, and found that in cases where the original milk was virulent, it produced no effects whether 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 from the blood, 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 connection 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 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 that one, why the disease should be only in one part. Besides, both from Jani's observations, 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 with advanced tuberculosis. So far as I can find, 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 localisation 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 tubercular subjects, tubercular disease does not occur at the seat of injury. I can recall more than one instance of a patient suffering from tubercular joint disease who sustained fractures, in one case of the shaft of a bone, the epiphysis of which was the seat of tubercular disease, and yet, although the injury occurred in the immediate neighbourhood of an extensive tubercular deposit, the fractured ends united without the development of any tubercular disease at the seat of injury. It is probable, as I pointed out in connection 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 tubercular 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 tubercular 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 tubercular 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 had the opportunity of examining by the microscope specimens from several cases where disease of bones was distinctly referable to an injury, and I have found that the disease set up in these instances was undoubtedly tubercular. To mention two examples—(1) a female child, *æt.* 5 years, with no phthisical family history, no evidence of previous tubercular disease, but with a strumous type of face, fell and struck the lower part of the sternum on a stone five weeks before admission. There had been no swelling or pain in the sternum before the accident. After the accident she began to complain of pain over the seat of injury, and a swelling formed, evidently affecting both the bone and the soft parts over it. On incising the swelling a drop or two of thick pus came out. The thickened soft parts were dissected away, and it was found that the bone had become extensively softened and infiltrated with caseous material. In this case there was no mistaking the clinical appearances as indicative of tubercular disease, and the microscopical examination confirmed the diagnosis. (2) A little girl, *æt.* 2½ years, of a healthy family, and herself previously healthy, was sitting on a doorstep five weeks before admission, and a blind man in passing trod on her ankle. As a result the ankle became painful and swollen, and these symptoms increased up to the time of admission. On examination of the ankle joint there was evidently tubercular disease of the synovial membrane, and the thickening was especially marked in front of the external malleolus. The intense pain caused by movement and by pushing up the heel, showed that the bone was also affected. I proceeded to perform arthrectomy by König's method, and after removing the whole of the anterior part of the synovial membrane, I found that the unossified layer of cartilage on the surface of the astragalus on the outer side had become detached, and examination of the bone beneath showed that there was a caseous deposit in the interior of the bone which communicated with the synovial membrane at this point. I accordingly excised the astragalus, and found on sawing through the bone that there was extensive caseous infiltration of its substance, and a partially detached sequestrum in its interior. On microscopical examination many of the cancelli were seen to be filled with caseating tubercular tissue and tubercles, and there was sclerosis of the trabeculæ in the centre. I could mention several cases of a similar kind, but I may now allude to another proof that injury has a direct causal relation to tubercular joint disease, viz., that derived from statistical facts. I need not go into detail as to my statistics, but I may say that an investigation of the history of 293 cases of tubercular disease of the larger joints showed the following facts :—

1. That where there is no history of injury, the proportion of cases 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 ten years of age their liability is the same. In correspondence with this the proportion of uninjured and injured females below ten years of age is about the same as that of males, while in later life there is an increase after injury, of above 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 being equal 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 was 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 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 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 gives a fair estimate of the distribution of the disease including all ages. It has been obtained by adding together the figures given by Jaffe, Schmalfuss, Billroth and Menzel, and 602 cases of my own, partly composed of the cases previously referred to, and partly of cases which have occurred as in- and out-patients in the practice of Mr. Stanley Boyd and myself at Paddington Green. 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 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 tubercular 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 tubercular from the first? In the case of tubercular 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 tubercular 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 tubercular disease has commenced chronic inflammation is set up in the vicinity, and the tubercular 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 follow aseptic incisions into tubercular 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 tubercular 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 tubercular 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 tubercular 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 tubercular 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 tubercular 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 tubercular 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.

The influence of sepsis in keeping up the tubercular process is well seen when we compare the result of the aseptic drainage of abscesses, connected with tubercular disease of bones and joints, with that obtained in septic cases. Taking the cases of spinal abscess in the foregoing statistics, 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 tubercular 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 tubercular 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 tubercular sputum (*i.e.*, septic tubercular matter) is used, than when a small number of tubercle bacilli 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 re-infection soon occurs from the diseased portions left behind.

It has also been pointed out by König and others that tubercular meningitis is more frequent in septic than in aseptic cases; thus, of sixteen cases of tubercular 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 wound. Thus Billroth gives the proportion of deaths from phthisis and general tuberculosis in cases of tubercular 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 tubercular disease, including tubercular 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

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

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 percentage 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 which 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 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 tubercular 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 tubercular 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 pro-

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

portion of cases of disease in each of the seven larger joints, commencing in each decade.

Thus, of 149 cases of tubercular 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 tubercular disease of bone during the first decade of life. Thus, taking the surgical out-patients seen at Paddington Green up to June 1888, we have a total of 2997 at or below 10 years of age, and of these 190 were cases of tubercular 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, unless when abscess was present, and we know that suppuration in connection with spinal disease is not common in 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 tubercular 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 tubercular disease of any kind 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 localised 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 is also, no doubt, to a large extent due to the increasing proportion of cases in which the disease commences primarily in the bone, and also 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. 112). 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 tubercular disease. As I have previously said, it must, in my opinion, be extremely rare that the disease itself is inherited, nevertheless, it is more apt to occur, and is more severe in families where there is a tendency to the disease as indicated by its occurrence among several members, this tendency not being altogether accounted for by increased opportunity of infection. It is, however, not the disease itself, but the peculiar collection of conditions which renders the patient liable to infection, which is transmissible to the 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 tubercular 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 tubercular 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 tubercular 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 localisation 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 localised 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 an increasing tendency to believe in the possibility of recovery from tubercular lesions.

Recovery may take place either after the formation of a communication between the tubercular deposit and the exterior, or without any such communication. Where a tubercular 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 act, the probability is that the tubercle will disappear and leave practically no trace behind, the amount of fibrous tissue resulting from the organisation 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 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 tubercular synovial disease recovering with complete restoration of movement, are of course rare, but I have had two or three 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 tubercular tissue is massed together, and then, if complete recovery of the tuberculosis do take place, a greater or less amount of stiffness is left behind, owing to the larger amount of new fibrous tissue formed.

Where the tubercular 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 tubercular material disappears, or is converted into fibrous tissue, but where the mass of tubercular 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 recognisable tubercular structure, but in both cases it has been found that tubercle bacilli, or their spores, are generally 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 tubercular virus in an active state, from the frequency with which the tubercular 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 tubercular 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 tubercular 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 tubercular 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 connection with the local disease, which has remained up to that time very much *in statu quo*, and this due not, as is supposed by some, to mixed infection from the accidental entrance of pyogenic organisms, but to extension of the tubercular process. In connection 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 tubercular process predisposed them to the cancerous invasion, or the occurrence of cancerous disease led to the cessation of the tubercular 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 tubercular structure, or as encapsuled deposits, generally cheesy or calcareous, but sometimes still showing tubercular elements. The frequency with which these evidences of arrest of tubercular 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 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 tubercular 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 tubercular 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 tubercular glands we frequently see, that while some suppurate, others remain enlarged and, as years pass, gradually diminish in size; while we know, as the result of operations for the removal of tubercular 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 tubercular 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. In fact, although I have examined microscopically a considerable number of bones with old standing quiescent tubercular 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 tubercular tissue except where tubercular deposits were present in the bone, I have, in most cases of fibrous anchylosis, found remains of tubercular tissue somewhere or other. This is a point of great importance in connection with the practical question of breaking down these joints with the view of obtaining better position or possibly movement. Experience has taught the great danger of such procedures and the explanation is furnished by the fact which I have just stated.

In considering the causes which oppose recovery in cases of tubercular disease, in other words, the points to which we must direct our attention in treatment, we find that they may be conveniently divided into two groups, viz., those affecting the power of the tissues and the body generally in overcoming the parasite, and those more directly connected with the parasite itself. In tuberculosis the factors on the part of the body which aid or resist the efforts of the parasite are perhaps of greater importance than in the case of any other infective disease, and it is seldom that the bacillus of itself can overcome the body, unless the conditions on the part of the host, both local and general, are favourable or, at any rate, not unfavourable to its action. I must therefore enumerate the more important of these factors in the first instance, and I shall do so under two headings—1. Those common to the body as a whole; and 2. Those peculiar to the part which is the seat of disease.

1. General Causes.

Perhaps the most important general cause affecting the spread of the tubercle bacillus is the peculiar constitutional condition present in patients who have inherited a tendency to the development of tuberculosis. While, as I have already pointed out, there seems no real ground for believing that the actual tubercular disease itself is transmitted from parent to child, except in extremely rare instances, it is certain that for some reason or other the children of tuberculous parents are very liable to contract the disease. This fact admits of two explanations. In the first place, the members of a tuberculous family are very often more exposed to infection than those of healthy families. Take a family in which one of the parents is dying of phthisis. The constant association of the members with the patient inseparable to family life, the use of the same food utensils, the inhalation of dust containing dried sputum, kissing, &c., means that the healthy members are exposed to infection in an unusual degree, and explains to a great extent the occurrence of the disease in the others. And this great exposure to infection continues after the death of the patient, especially if the family continue to live in the same house and use the same bedding, &c., without any attempt at disinfection. Cornet, in the account of his elaborate researches on the distribution of tubercle bacilli, has shown the great infectiveness of the dust in rooms where phthisical patients have slept, and by the statistics of Prussian convent life the great danger of family life in the same building where individuals are affected with or have died of phthisis. And it is no answer to this to point to the results in consumption hospitals where nurses escape to a large extent, for the infection is not conveyed by the breath, and in these hospitals the nurses insist on the patients expectorating into suitable vessels, they do not use the same food utensils, nor do they kiss the patients. And there are numerous instances where the only members of a tuberculous family who have escaped the disease are those who have been sent away from home in early life, and kept away under the idea that it was the climate or situation of the house which led to the disease; such persons being in reality thus removed from this prolific source of infection.

Apart, however, from the greater risk of infection under these circumstances, there can be no doubt that the children of tuberculous parents, as a rule, yield more readily to the attack of the parasite than others, and that even though their hygienic surroundings are excellent. In explanation of this general tendency we may suppose either that some peculiar form of tissue change has been acquired and transmitted, which renders the body a better soil for the growth of the tubercle bacillus; or that a condition of the tissue cells has been transmitted in which they are not so sensitive in their reaction against

9

tubercle bacilli, nor so powerful as antitoxic or antiparasitic agents. It is quite possible that both of these conditions may be at work, and frequently there is some local peculiarity, more especially affecting the size and shape of the chest, the rapidity of the lymph flow, &c., which is present as well. Transmission of cellular peculiarities and of peculiarities of tissue change are well known in the heredity of gout, of hæmophilia, of progressive muscular atrophy, of colour blindness, &c. So also in the case of acquired pathological conditions as in Brown-Séquard's hereditary epilepsy in guinea-pigs, in ichthyosis, polyuria, and even in immunity against infective diseases. Some authors are so impressed with the importance of this hereditary tendency that they look on everything else, even the tubercle bacillus as of secondary importance.

It must also be borne in mind with reference to this question that children with a marked hereditary tendency are often sickly, apt to take cold, or suffer from sore throats, quite apart from any existing tubercular disease, and they are, therefore, kept too much in the house and in badly ventilated warm rooms, and in this way their tendency is increased and their bodily vigour diminished.

The bad results of confinement in close and badly ventilated localities, such as the foul alleys of cities, of want of fresh air, &c., as predisposing agents, need not be dilated on. They act partly by imperfect aeration of the blood, partly by loading it with noxious materials, which interfere with the healthy action of the tissue cells, and possibly also in the case of disease of the air passages, by leading to the introduction of other organisms which, by their growth side by side with the tubercle bacillus, enable the latter to grow better and aid the destructive changes. Not only the local conditions of the air but also the climate is of importance, either because it may not suit the general nutrition of the patient, some doing best in a cold climate, others in a warm one, some at the seaside, others inland, &c., or because certain peculiarities of the climate, more especially cold and excessive moisture, may predispose certain organs to attack by setting up a catarrhal inflammation, or weaken them when they are attacked. In the case of the lungs such a climate will predispose them to attack by setting up bronchitis and congestion, and in the surgical tuberculoses it may also exert an important influence. For example, tonsillitis is not uncommon under these conditions, and this may be followed by inflammation of the cervical glands and subsequent tubercular infection. Similarly with regard to diseases of bones and joints, such a climate is liable to set up rheumatic inflammations, which in some cases may pass into tubercular disease, the part weakened by the rheumatic attack being rendered liable to tubercular infection. I have certainly seen several cases where a tubercular joint disease has been left after an undoubted attack of acute rheumatism, showing that there is no real antagonism between these diseases.

With regard to this matter, however, we must not assume that all cases which commence with febrile disturbance and pain in more than one joint, &c., are in the first instance rheumatic; Wiesner, Brissaud, and others have published cases in which the tubercular joint disease commenced in this way, and I have had one where the disease was ushered in by fever and pain and slight swelling, both in the shoulder and the knee, and where finally only the knee became diseased.

The quantity and quality of the food are of considerable importance. Of course, if the food is insufficient in quantity and of poor quality, the general nutrition of the patient suffers, and he becomes more liable to infection and less able to resist the progress of the disease. Further, I have already referred to Bidder's view, that an excess of potash in the food favours the growth of the bacilli, and is probably in part the explanation of the much greater susceptibility of herbivora as compared with carnivora to tuberculosis, and it is certainly quite conceivable that by having an excess of certain substances derived from the food in the tissues of the body, they may be thereby rendered a better or worse soil for the growth of the bacilli or less effective destructive agents. Brehmer also lays great stress on the quantity of the food in relation to phthisis, stating that small eaters are especially predisposed to this disease, the explanation he gives being, however, a mechanical one, depending on the effect which a frequently distended stomach may exercise on the shape of the chest during the period of growth.

Attacks of certain diseases not only predispose to the tubercular infection, but also, occurring during the course of the disease, often aggravate it very much. This is especially the case with measles, and also with scarlatina, whooping-cough, &c.

The frequent occurrence of strumous glands in the neck, and of mastoid disease following on otitis media after measles is well known, and similarly an attack of measles will often cause a very grave exacerbation of a joint disease. Not long ago I had two cases in the ward at the same time, which illustrated very well the bad effect which an attack of measles may exert on the progress of the disease. Both were cases of knee-joint disease, in which I had done a partial arthrectomy, dissecting away the whole of the synovial membrane in front and at the sides of the joint, but only scraping away what I could of the diseased tissue behind, without dividing the crucial or lateral ligaments. The wounds had healed and everything promised well, till just as the children were about to leave the hospital they were attacked by measles. As a result the scars rapidly broke down, and the disease recurred to such an extent that in the one case I had to do a complete arthrectomy, and in the other an intra-epiphysial excision. Even in the case of a mild disease, like a mild attack of chicken-pox, I have seen marked recrudescence of disease which had up to that time been steadily improving. The same predisposing effect of acute fevers to infective diseases is well known in the case of other affections than tuberculosis; for example, in the occurrence of acute suppurative periostitis and osteomyelitis, after typhoid and other fevers, &c.

2. Local Causes.

Passing now to the local causes which interfere with the action of the tissues in repelling the parasite, 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 tubercular 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. Of the causes which increase the chronic inflammation, apart from the presence of the tubercle, 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 tubercular 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 tubercular deposit or, where this fibrous tissue is only small in amount, to lead to 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 is favourable to the growth of the bacilli. Dr. Wayland Chaffey has laid great stress on lymph stasis as a factor in the production of tubercular disease and in the exacerbation of existing disease, and though I am not inclined to go so far as he does with regard to the former view, the arrest of the lymph in the part seems to me to be a factor of great importance in connection with the spread of the disease.

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.

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 tubercular 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 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, 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 tubercular 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 TUBERCULAR DISEASE OF BONES AND JOINTS.

METHODS WHICH ACT ON THE BODY—PROPHYLAXIS—GENERAL HYGIENE—VALUE OF REST AND EXTENSION.

BEFORE going on to the consideration of the methods of treatment, I may say a few words as to prophylaxis. The subject of prophylaxis belongs especially to the physician, but it has also to be considered by the surgeon, for many patients with surgical tuberculoses are also affected with phthisis, while in external tuberculosis there may be a certain amount of danger where the diseased tissue communicates with the surface of the body. To carry out a complete system of prophylaxis is a very difficult, indeed an impossible, matter under our present social conditions, but nevertheless a great deal can be done without any special inconvenience, provided the patient understands and cordially co-operates. As we now know, it is the dried-up secretions containing tubercle bacilli, which are the chief source of danger. In the case of phthisis, I doubt if the breath is at all dangerous, and there is no real risk in associating with a phthisical patient so long as one does not come in contact with or inhale the discharges from the seat of disease, and then only in all probability if there is a weak spot which may form a point of entrance. Hence isolation of the patient, as advocated by some, is not at all necessary if only he himself will aid in the matter intelligently. In the case of phthisis, which interests us in so far as it not unfrequently complicates cases of surgical tuberculosis, the chief stress must be laid on disinfection of the sputum, which should always be discharged into a proper receptacle, containing a small quantity of fluid, preferably 5 per cent. carbolic acid solution. Spitting into handkerchiefs, on the floor, into spittoons, &c., must be absolutely prohibited, and after spitting, the mouth must not be wiped by a handkerchief which is afterwards put in the pocket, but by cloths or other material which can be at once placed in a disinfectant solution or burnt. Kissing should be absolutely prohibited. The patient should also have a set of dishes, cups, knives, forks, &c., which should be reserved for his own use. It is also clear from Cornet's researches that the sleeping-room should be thoroughly cleaned out and disinfected from time to time, and therefore there should be no more furniture in it than is absolutely necessary. From time to time he should move into another room, and have the one he has left thoroughly disinfected and aired; the bed and bedding should also be disinfected, more especially the pillows, which are so apt to become soiled. I believe that if precautions of this kind were employed, we should hear less of member after member of a family succumbing to this disease. In surgical cases such precautions are, of course, only needful where phthisis is present, or where there are open sores. In the latter case, it is possible that clothes, bedding, floors, &c., may become soiled with the discharge, and therefore the same precautions as to disinfection of rooms, bedding, &c., should be carried out as if phthisis were present. On the part of the predisposed also it is of importance that all food should be well cooked, milk boiled, injuries avoided, &c.

It is interesting to note that more than one hundred years ago laws of extreme stringency were promulgated at Naples, which show most advanced views as to the infectiveness of phthisis. Among them I may mention that doctors had to notify every case of phthisis under a penalty for the first offence of 300 ducats, and on a second conviction of banishment for ten years; poor patients must be at once sent to hospital; all clothes worn by phthisical patients must be kept separate; an inventory must be taken of all the clothes and linen of the patient, and this had to be accounted for after death, the punishment on default being imprisonment or even the galleys. All possibly contaminated furniture had to be burnt or thoroughly disinfected, the rooms papered and painted, doors and windows burnt, and those selling the clothes and effects of phthisical patients were liable to severe punishment. The result was that houses in which phthisical patients had lived could not be let, many people were ruined, and the law was evaded in every possible way, and was ultimately repealed as being useless after about sixty years.

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

1. Methods which act on the Body and not directly on the Tubercular 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 connection 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 connection 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-tubercular 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 tubercular 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 tubercular 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-tubercular 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 connection 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 connection with a sojourn in the country is the question of exercise. 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 outbreak 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, however, I do not think that attempts at walking are good. Under these circumstances patients are usually fitted with an apparatus to keep the joint at rest, and provided with crutches and a patten on the sound side, and told to get about as much as possible. In other instances, especially in some cases of knee-joint disease, an immovable apparatus of silicate or plaster is applied, and the patient is allowed to walk about; this is radically wrong. It is no doubt unavoidable in the case of poor patients that they should be allowed to get about, but it is not, I believe, good treatment in the majority of cases. As we know from the clinical history of ulcers and inflammations of the leg, the dependent position of the limb interferes with the circulation and nutrition of the part very much, and the same must be the case where there is tubercular joint disease, and it must be still worse where the weight of the body is borne by the diseased joint. In such cases 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 them to do what is necessary.

As to diet, it should be as nutritious and easily digested as possible, the meals should be more frequent than normal, 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, of which, according to Dr. Weber, potatoes are especially bad. 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 — 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 tubercular virus, and not with the view of acting directly on the tubercular disease.*—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 tubercular 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 immobilisation of tubercular 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 got in knee-joint disease as compared with hip-joint disease, partly to the lesser degree of movement which has been permitted in that joint. I doubt, however, if even Schede's name will suffice to lead surgeons to give up such a generally accepted view as the necessity of placing parts which are affected with tubercular disease as completely at rest as possible.

In the case of tubercular 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 in most cases, no separation of the joint surfaces can 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 9 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 lbs. 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 tubercular 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 tubercular 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

10

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 realised, 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 recognised, 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 6th April 1888. Three years and a half previously the child developed a tubercular 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 lbs. at each part, and the patient was put on 20 grain doses of benzoate of soda every four hours. On April 12th 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 25th 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 2nd 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 14th.

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 27th, 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 8th, 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 has 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 lbs. each were applied to head and legs and the body fixed between sand bags.

On January 13th 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 29th 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 15th, 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 connection with Dr. Barnardo's homes, on the 1st of October 1891. In December 1889 her left foot was amputated on account of tubercular 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 connection 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 1st October 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), and 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 head and legs till I could arrange to come down, and if necessary operate. This was done on November 30th, weights of 4 lbs. 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 had also improved. 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 tubercular 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 has 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 tubercular 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 TUBERCULAR DISEASE OF BONES AND JOINTS—*Continued.*

METHODS WHICH DO NOT ACT DIRECTLY ON THE BACILLI—COUNTER IRRITATION—ARTHROTOMY—PRESSURE—MASSAGE—KOCH'S TREATMENT—LOCAL INJECTIONS.

BENEFIT is also derived in some cases from other measures, which are of known value in cases of chronic inflammation uncomplicated with tuberculosis. In a case of chronic osteitis or periostitis, the first thing 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 tubercular 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 tubercular disease, yet, under the erroneous idea that the only object of local treatment in these cases is to act directly on the tubercular 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. In cases of pure synovial disease improvement sometimes follows the application of several blisters in succession, but where the bone is inflamed and is deep-seated, the most effectual method is the application of the actual cautery.

The most suitable parts for its use are the hip and shoulder joints and the spine. I have not seen much good result from the use of the cautery in pure synovial disease, and in the case of superficial joints, such as the knee, I should fear that it would do harm by increasing the congestion of the synovial membrane. 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 tubercular diseases of bones and joints of which I could find notes, which had been under the care of Sir Joseph 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. I may mention one or two examples.

In the case of the hip-joint, the cautery was applied in 7 cases, in 4 of which improvement followed and no further operative treatment was required, while in 3 no permanent good resulted, and, in these, abscesses were subsequently found in connection with the joints. I may mention one of the successful cases. It was that of a female, *æt.* 21, in whom the disease began 5 years previously, but had evidently followed a very chronic course. Four months before admission the pain increased and became constant, with starting of the limb at night. A Sayre's splint gave her temporary relief. On admission there was great pain on attempting movement, there was flexion and adduction, and 1 inch of shortening. A long splint was applied with relief to the pain, but for some reason or other it was left off at the end of six weeks; the pain at once recurred, and the splint was re-applied, but on this occasion without success. Extension by weight and pulley was then employed also without success, and accordingly, seven months after admission, the cautery was applied in front of and behind the joint, and the wound kept open for six weeks. The result was the almost immediate cessation of pain, and the patient was ultimately discharged seven months later free from all symptoms of active disease.

In 6 cases of spinal disease, without abscess, the cautery was also employed, being freely applied on each side of the middle line, in all cases with improvement. In 4 of these cases there were commencing signs of pressure on the cord, and pain and sense of constriction around the waist. I may mention two of these cases. A man, *æt.* 43, was admitted with the history that, four years previously, he began to suffer pain in the lower dorsal region. About a year before admission a curvature was discovered, and of late he had suffered not only from pain in the back but also from a feeling of constriction around his waist, and pain shooting down both thighs. The cautery was freely applied on each side of the spine, and two days later he had lost all his pain, and when discharged from the hospital seven weeks later, wearing a support, he was quite free from his symptoms.

A male, *æt.* 21, was admitted with the history that, seven years previously, he first noticed curvature in the dorsal region, and since that time the deformity gradually increased, but he had no pain till twelve months before admission, when he began to suffer from pain and a sense of constriction around the waist, and this sensation had become worse of late; the pain in the back was worse at night. No treatment had been employed. On admission, there was marked antero-posterior curvature in the dorsal region, pain on percussion and other signs as mentioned. Three days after the free application of the cautery, the pain in the back had entirely disappeared and also the sense of constriction, but these symptoms began to return about four weeks later as the sores healed. The sores, therefore, were opened up with potassa fusa and the pain again disappeared, and the patient left the hospital three months after admission quite free from his symptoms.

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 Sir Joseph Lister attempted to apply this same principle to the treatment of chronic synovial disease (the tubercular nature of the disease not being at that time thoroughly understood), and with a certain amount of success. To illustrate this matter of simple arthrotomy, let us take the knee-joint, which is the one most suited for this method of treatment. In performing arthrotomy of the knee-joint, in cases of tubercular disease, free aseptic incisions, 3 to 4 inches in length, are made on each side of the patella, the joint being thoroughly opened for the whole length of the incisions, and if the bone is thickened at any part, portions are gouged away. If there happens to be pus in the joint, it escapes, but in any case nothing further is done in the way of operative procedure. Drainage tubes are then passed fairly into the joint on each side, the wound is left gaping, aseptic dressings applied, and the limb placed on a posterior splint. In the cases to be mentioned presently this was the whole procedure; there was no washing out of the joint, no scraping, &c., and the after-treatment was simply the ordinary treatment of a wound, the dressings were changed when necessary, and the tubes were left out in the course of a week or ten days. These wounds generally heal, if they are going to heal, in from six to eight weeks, though in some cases while the greater part of the wound heals rapidly, a small sinus remains for several months. The treatment acts, as I have said, probably by relief of tension, and the consequent subsidence of inflammation. That there is a considerable amount of tension in the part is evident from the manner in which the wound gapes when the incisions are small. It is possible, also, that the treatment may be efficacious in another way, for as the wound heals the young tissue contracts, and this pressure may exercise a beneficial effect. Where the result is partially successful, it is not unusual to see a depressed scar at the seat of incision, with little or no thickening in its immediate neighbourhood, great improvement, or even cure of the disease having occurred around the incisions, but not elsewhere. Lastly, there may possibly be some meaning after all in the old formula of the induction of healthy action in the part. It is possible that the fact that the process of repair is going on actively and well at one part, may in some way that we do not understand, exercise a favourable influence on the neighbouring diseased parts.

That good results may follow simple incisions into joints, the seat of tubercular 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 tubercular peritonitis, and yet there are now numerous cases on record in which the abdomen has been opened in cases of tubercular 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. To go back on old statistics, Kümmell has collected thirty cases of this kind, and of these only two died as the immediate result of the operation, both of them apparently from sepsis; in three cases the patients died of general tuberculosis, five months, eight months, and one year later; in two cases lung trouble, which was previously present, progressed, but there was no return of the local disease; the remaining cases improved both locally and generally, and the improvement continued up to the date of the last account published. The length of time that these cases had been under observation varied from some months to twenty-five years; in ten or eleven of the cases the tubercular nature of the disease was confirmed by microscopical examination. König has since analysed 131 cases, of which 107 were cured, or, at any rate, much improved by the operation. I have lately had three cases of this kind where improvement, in all but one, however, only more or less temporary, followed the operation, and I can offer no reasonable explanation of the facts; the results appear to be better where the tubercle is in the form of largish masses, even when caseating, than where there is a general eruption of small grey tubercles over the intestines and peritoneum, at least that is my experience from my own cases, and from those I have seen.

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 tubercular 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 is 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.

As regards the results, I may say that in the case of the knee-joint, which is the one most favourable for this treatment, there is in my statistics a record of nineteen cases treated in this way, and of these nine got well without further operative treatment; in most of the other cases pus was found in the joint when it was opened, and in these either repetition of the arthrotomy or a partial arthrectomy was necessary, in three, indeed, amputation was ultimately performed. I may mention one or two of the cases:—

1. A female, *æt.* 22, had suffered from disease of the knee-joint for thirteen years, which was, I should think, synovial in its origin. During the last seven months the swelling had increased, and the patient had suffered pain. On admission the joint was found to be much swollen, and there was pain on movement and on pushing up the leg. Blisters and posterior splint, extension and Saxtorph's apparatus were all employed without avail, and therefore free incisions were made into the joint on each side of the patella; no pus was found in the joint. This was followed by great improvement and complete relief of the pain. The wounds healed in about two months, and the patient was discharged, wearing a water-glass apparatus, and much improved.

2. Take next a case without pus in the joint, but with abscess outside. A female child, *æt.* 7, had suffered for two years from disease of the knee-joint, commencing after an injury. When admitted the knee was flexed; there was an abscess of

considerable size at the lower part of the thigh in front; the synovial membrane of the joint was thickened, and there was pain on movement. The hamstrings were divided, the limb brought straight, the synovial membrane incised, and the abscess opened and drained. There was no pus in the joint, but the surfaces of the tibia and patella were felt to be in parts rough. The case did well, and the patient was discharged nine months later with the wounds healed, the knee much improved, and wearing a starch apparatus. This was removed two months later, when the knee was found to be normal in size.

3. A male, *æt.* 17, with abscesses in connection with the right knee-joint, which were opened and healed. The patient was readmitted eighteen months later with swelling of the joint and a fresh abscess. The abscess was opened, and incisons were made into the joint, which contained some serous fluid. These wounds healed in about a month, but he began to complain of pain over the internal condyle of the femur, which became enlarged. An incision was made on the inner side of the joint, and a hole gouged in the bone (no cheesy deposit, however, being found), and at the same time the scar on the outer side of the patella was opened up, and the joint scraped. This treatment resulted in a cure. It should be mentioned, as regards this patient, that he had tubercular disease in various other parts of his body.

The advantage of gouging the inflamed bone, quite apart from the removal of an osseous deposit, is also well shown in the following case, which, as a matter of fact, is the last in which I have performed arthrotomy pure and simple.

4. Female, *æt.* 19. Disease of six months' standing, no history of injury. Has had swelling and pain since the commencement; been treated in a variety of ways, but has steadily got worse; amputation strongly urged in another hospital. Considerable thickening of the synovial membrane of a firm character, and enlargement of the inner condyle of the femur, and of the inner tuberosity of the tibia. Free incisions were made

into the joint, and holes were gouged in the inner condyle of the femur and inner side of the head of the tibia; no tubercular deposits were found in the bones. Healed in less than two months, and the pain disappeared after the operation and did not return. She was sent out about three months after admission, wearing a water-glass apparatus, and still remained well when last seen about two years subsequently.

Of the other two methods of overcoming chronic inflammation I need say nothing. Pressure has been long employed in the treatment of tubercular joint disease, more especially in the form of Scott's dressing, and some years ago Saxtorph recommended firmer 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.

2. Methods which act more or less directly on the Tubercular Disease.

So far the methods considered do not act on the bacilli directly, they only aim at improving the general nutrition of the tissues, or diminishing or removing the inflammation around the tubercular deposit, thus putting the tissues in a better position to resist the invasion and destroy the parasite. We must now pass on to the consideration of the means which act more directly on the parasite and the tubercular tissue.

Intermediate between the two stands Koch's tuberculin treatment—I say intermediate, because it is not yet known how it acts, whether simply by setting up inflammation and causing infiltration of the tubercular tissue with leucocytes, or by some more direct action on the bacillus, or by breaking up its poisons, or by producing immunity by strengthening the cells of the body. I need not go into the matter of Koch's treatment in any detail, in fact I have nothing new to say about it, but I may mention the conclusions at which I have arrived. These are practically those which I stated in a paper read at the Medico-Chirurgical Society in 1891. At that time I held that the direct risks of the treatment were much overrated, more especially the risk of acute tuberculosis, and I still think that this is the case. In none of the cases in which I have used tuberculin, some sixty in number, did acute tuberculosis occur, while curiously enough three out of nine cases in which I was consulted on, or considered the advisability of using tuberculin, but decided against it, died of acute tuberculosis, and one developed a joint trouble shortly after the question was considered.

In my opinion the two great dangers in this treatment are (1) its use where there are septic suppurating cavities or surfaces, and (2) leaving it off too soon. As regards the first, the chief trouble lies partly in the increase in the inflammation as the result of the action of the tuberculin, and partly in the weakening of the tissue by this inflammation, thus enabling the pyogenic organisms to penetrate further and more rapidly. As regards the danger of leaving the treatment off at an early period, it certainly is the fact that under such circumstances recurrence rapidly takes place, and in my experience the disease seems to progress with greater rapidity than before the treatment was employed. I am not sure that I can say the same where the treatment has been continued for some months and then left off. At any rate, speaking of lupus, while under these circumstances it has come back in places pretty quickly at first, it has afterwards seemed in several cases to come then more or less to a standstill, or even to improve somewhat. Certainly in several of the cases the condition of the patient some months after the treatment was stopped, has not been so bad as before it was commenced, nor so bad as it seemed likely to become when recurrence first began to take place.

As to the remedial powers of tuberculin there can be no doubt that in many cases where the conditions are favourable, as in lupus and tuberculosis on a free surface, a certain amount of remedial effect follows its use, which, however, but rarely ends in a cure of the whole area within a reasonable time. In only three of my cases where no operation was performed has the improvement been complete over the whole surface, and lasting after the treatment was stopped. These were two children with synovial disease of the knee-joint and one patient with phthisis. In all three cases the treatment was continued for about five months, and these patients remain well. Four other cases where sinuses were present which healed at the time also remain healed. In all the others in which the treatment has been stopped recurrence has taken place, but in the case of lupus, where one can see what occurs, this recurrence has not as a rule taken place over the whole of the previously affected area. In several bad cases of lupus considerable tracts have remained free, though in other parts the recurrence has been rapid and extensive. This shows that tuberculin has really the power of causing the permanent disappearance of tubercular tissue under certain conditions, and, from the microscopical appearances, I conclude that the main condition is that the tubercles shall be isolated and not aggregated into masses. Isolated tubercles seem to be readily infiltrated with inflammatory cells and disappear, while only the external portions of tubercular masses are in relation with the blood stream. As it is very rarely that in the tubercular area there are only isolated tubercles, or very small groups of them, it is very seldom that a complete cure will occur, at any rate within a short time.

Although, however, larger masses are not destroyed by tuberculin their growth is brought to a standstill, for a time at any rate, and the question is for how long this condition of standstill can be kept up. This seems to vary very much in different cases, but on the whole, when the injections are given frequently in the manner which I recommended in my paper, I think that the disease may, in a good many cases, be kept in check for a long time. In only two of my cases are the patients still going on with the treatment—viz., in two doctors with phthisis, and these patients, though very ill and rapidly going down hill when the treatment was commenced, quickly picked up, even though staying in London during thick and very foggy weather, and have now for a considerable time been at work as surgeons on board steamers, with practically no symptoms of disease. They inject themselves every day, or every other day, and if they follow my advice will continue to do so indefinitely. On the whole, I think, considering the danger of leaving off the treatment too early and the length of time that it must be employed, that it does not come into play in those cases of external tuberculosis which are accessible to other local measures. On the other hand, in phthisis, I think that the treatment has been unduly discredited and too hastily abandoned, and in some cases of surgical tuberculosis where little else can be done, as in the case of bladder tuberculosis, the use of tuberculin, or of one of its constituents, may be of service in retarding the progress of the disease.

I have already referred to the alteration of the chemical constitution of the fluid of the tissues by means of diet, &c., and this might also be done by other substances. I have attempted to carry out the idea of loading the tissues with soda, by resorting to the benzoate of soda, which formerly had a short-lived reputation as a specific against tuberculosis. Formerly it was used on the view that it had a direct destructive action on the tubercle bacillus. I have, however, used it with the view of saturating the tissues with soda in the hope of rendering them an unsuitable soil for the bacillus, and for this purpose have administered the drug in doses of 20 grains every two hours night and day. In several cases improvement seemed to follow immediately on commencing this treatment, but in the great majority no apparent effect was produced. I have not, therefore, thought it worth while to continue the use of this drug, but I believe that something might be done by trying to saturate the tissues with substances, non-poisonous in themselves, but when in excess inhibitory as regards the growth of the tubercle bacillus.

Substances have also been employed locally, not with the view of destroying the tubercle bacillus, but with the view of acting on the tubercular tissue. For example, Kolischer published a method of treatment by injections of neutral phosphate of calcium into numerous parts of tubercular synovial membrane, with the view of causing calcification of the tubercle, and as has often happened in the history of these new remedies for tuberculosis, his first results seemed to be so good that he was quite enthusiastic in the matter, but in a later paper he confesses that his further results have not come up to his expectations, and he mentions so many circumstances under which his treatment will not be successful, that apparently very few cases are left in which it is likely to be of any value. The injections cause great pain, and not uncommonly gangrene of the tissues, and I do not think that the method is one to be recommended. Again, Lannelongue last year stated that he had had good results by injecting chloride of ziňc into the tissues around the tubercular mass, with the view of causing encapsulation, but although I have the greatest respect for Lannelongue's opinion in the matter of surgical tubercular diseases, I cannot think that this is a method which is likely to lead to a satisfactory result.

CHAPTER XIII.

TREATMENT OF TUBERCULAR DISEASE OF BONES AND JOINTS—*Continued.*

Methods which act directly on the Tubercular Tissue—Various Injections—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 tubercular 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 tubercular tissue with the view of destroying the bacilli, for example, carbolic acid, creasote, 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 tubercular sputum did not necessarily become tubercular, 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 with 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 recently 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 tubercular 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 lately, which seem to confirm this view, where tubercular 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.

We next come to the consideration of the various operative measures by means of which the tubercular 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 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 tubercular deposit must be a source of danger to the body generally, seeing the great tendency of the tubercular virus to get into the lymphatic or blood-vessels, and that the thorough removal of the tubercular 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 that disease will save the patient from fresh tubercular 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 tubercular 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 recent cases, while I have, I think, twice lost patients from tubercular 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.

As regards phthisis, also, while some cases may be arrested by early and radical operation, others may be precipitated by partial operation. Thus Middeldorpf found that, after 12½ years, 16 per cent. of those amputated (whether through or above the diseased part is not stated) had died of tuberculosis, 14 per cent. of those excised, and 30 per cent. of those where caseous deposits were scraped out. Hence, except in the case of existing phthisis, 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 age of the patient influences, also, 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, that certain operative procedures, such as excision, are practically prohibited, &c. The existence of marked hereditary taint or of phthisis or tuberculosis elsewhere is also of importance, seeing that they are often aggravated by the local disease, especially if sinuses are present, and are, *vice versâ,* often much benefited by complete removal of the local affection.

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 tubercular 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 tubercular deposit. Cases in which chronic suppuration has taken place are at once excluded from purely expectant treatment, because operative treatment of the abscess at least must be carried out; what that operative treatment should be we shall presently consider. 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 tubercular masses, as described by König, but sometimes in the form of limited thickening of the synovial membrane. Where such cases are seen and recognised 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, 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, at any rate 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 also often the question which will be most speedy, 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 localised 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.

CHAPTER XIV.

GENERAL PRINCIPLES OF TREATMENT.

Choice of Operation.

The modes of complete removal of the disease in cases of tubercular joint disease are three in number, viz.—1. Complete removal of the diseased tissues, along with as little as possible of the healthy structures; what is understood 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. I have already referred to another operative measure, viz., arthrotomy and intermediate between it and complete arthrectomy, is partial arthrectomy, where portions of the diseased tissues only are removed, parts being left behind intentionally. I may say with regard to simple arthrotomy that it seems to me that if once a joint is freely opened, we may as well try to take away at least as much of the disease as we can without disadvantage, and therefore in cases where I would formerly have performed arthrotomy, I have usually of late done a partial arthrectomy, thus combining the principle of removal of the diseased tissue with that on which we suppose that arthotomy acts, viz., relief of tension, and consequent diminution of the inflammation.

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, and of these I may refer to three, viz., the influence of age, of the general condition of the patient, and of the local condition.

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

The occurrence of chronic suppuration in connection with tubercular 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 the 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 tubercular 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 suppuration greatly complicates the case, much can be done in many cases by less severe procedures than excision or amputation. Thus, if we take the case of spinal abscesses, where one must persevere to the end without the possibility of complete removal of the disease, I found some years ago, in Sir Joseph Lister's practice and my own, a record of 58 cases of spinal disease with abscess, in patients of various ages, but mostly adults, and of these 38, or over 65 per cent., had been cured by aseptic drainage, and several were under treatment. Of these 58 cases, however, 9 had become septic from one cause or another, and as in these another very important factor, viz., sepsis, is introduced, we obtain the true effect of chronic suppuration by omitting them, and thus we are left with 49 cases, of which 38, or 77·5 per cent., were cured, 6 were going on well, but had not yet healed, and 5, or 13·1 per cent., had died. Several of these cases had more than one abscess. In these cases nothing was done in the way of operative interference, except to open the abscesses, and hence it follows that a chronic abscess in connection with bone disease is not such a hopeless thing as is supposed by some. In the case of joints we are not restricted to drainage of abscesses, but can often hasten the cure by various operative measures; hence the results are not so striking, because if healing did not occur pretty soon, something more was done. Now, omitting the spinal abscesses, we had 105 cases in which chronic suppuration was present in connection with the six larger joints; in 37 of these, excision or amputation, were ultimately performed, leaving 68 cases in 42 of which drainage alone was employed, in 18 partial arthrectomy, and in 8 simple arthrotomy. Of these 68 cases, in which no radical operation was performed, 50, or 73·5 per cent., had healed when the statistics were made up, and only 3, or 4·4 per cent., had died, all of tubercular disease elsewhere. We thus see that although the occurrence of chronic suppuration undoubtedly increases the gravity of the cases, and implies a graver form of the disease, there is no absolute necessity for performing a serious operation such as excision or amputation at once, just because suppuration has occurred. At the same time, considering the length of time that is required for healing when aseptic drainage is employed, on an average eight to twelve months, the probability that caseation is going on elsewhere, and all the facts of the case, I believe it is best in most instances to treat these cases in a more radical fashion.

A chronic abscess is, as I showed in Chapter VII., nothing more or less than a tubercular tumour with softened centre, and therefore no treatment is complete in which an attempt is not made to remove the wall. By simply opening and draining a chronic abscess, the essential part of the disease, the wall, is left untouched, and the main curative work has to be done by nature. The first outcome of this more exact pathology was the attempt, after removal of the contents of these abscesses, to apply some bactericide to the wall, and as at that time iodoform was much thought of as an anti-tubercular agent that was the substance chosen. Mickulicz was the first to act on the recent pathology, 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 either the puncture wound breaks down and a sinus forms which is some time in healing, or the fluid reaccumulates and the performance has to be repeated, sometimes several times. Since these first attempts to act in accordance with the pathology of the disease, it has become generally recognised that some more energetic treatment of the wall of the abscess was desirable, and there are three ways in which this can be carried out.

1. The most radical and satisfactory method is to dissect out the swelling, without opening it, as if it were a cyst. This can be done in many cases, for example, in most glandular abscesses, in the subcutaneous tubercular nodules of children (gommes scrofuleuses), in many abscesses connected with the ribs, in some connected with bones, &c. Where this is done a clean cut wound is left which heals by first intention.

2. If the abscess is too large or the connections such that it cannot be dissected out in this way, the next best thing is to lay it freely open so as to see its interior, and then remove the wall by clipping, cutting, &c. This is possible in a good many cases of abscesses, especially in the extremities, and in this way again we can often get a healthy wound which heals by first intention.

3. Failing either of these two methods we can still get rid of the greater part of the wall by making a smaller incision into the abscess, scraping away the wall by a spoon, or rubbing off the degenerated tissue by means of rough sponges, &c. The following is the best plan to adopt where only a small opening can be made into the sac. The necessary antiseptic precautions are, of course, taken, and a small incision is made into the abscess, somewhat larger than can admit the finger, which is then introduced, and the cavity thoroughly explored to ascertain its connections, &c., and any septa present in it broken down. A sharp spoon is then introduced, preferably one of Mr. Barker's flushing spoons, and the surface of the abscess wall is gently and thoroughly scraped, free exit being allowed for the fluid; I believe that it is well to introduce the finger from time to time and guide the spoon to fresh parts of the wall. 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 sponge into the cavity and rubbing the surface with it. Any loose piece of bone is removed or carious bone scraped or gouged as thoroughly as possible. At the same time the cavity is thoroughly flushed out with warm 1-10,000 sublimate solution, the excess of fluid is squeezed out, 1 to 2 ozs. of a 10 per cent. emulsion of iodoform in glycerine, containing a small proportion of sublimate is injected, allowing as much to remain in as will do so, and the wound in the skin and deeper parts stitched up. This is the plan which must be adopted in some large and deeply seated abscesses, especially in psoas and iliac abscesses. In a good many cases the wound heals by first intention and remains healed, in others a sinus may form and remain open for a few weeks, or may even necessitate a repetition of the performance. I have always looked on the injection of the iodoform as of doubtful value, and have in several cases omitted it: I am inclined on the whole, however, to think that the cases in

which it has been employed have done better than the others.

This method, while on the whole very satisfactory, is nevertheless not unattended with risk in the case of large abscesses, especially of large psoas abscesses, the danger being from shock or from hæmorrhage.

Applying these methods to diseases of joints the treatment of chronic suppuration in connection with joint disease, and the influence which it will exert on further operative measures, will depend on the relations of the pus and the general extent of the disease. As examples I may mention the following:—

1. The abscess may be unconnected with the joint at all, having formed in connection with a tubercular deposit in the bone which has reached the surface outside the joint, and there may be no thickening of the synovial membrane. Under such circumstances where the connections are such as to render it possible, the best treatment is to dissect out the abscess and remove the bone deposit. Where it is impracticable to dissect out the abscess the second method should be employed.

2. A similar condition may be present with, in addition, thickening of the synovial membrane. Here, so far as regards the abscess and the osseous deposit, the treatment may be the same as in No. 1. Whether anything further might be required on account of the synovial thickening will depend on the local condition, and on various circumstances which cannot be reduced to rule, some of which will be alluded to presently.

3. The abscess may have originated in connection with the synovial membrane, and may or may not communicate with the joint. In such a case we generally find caseous patches in other parts of the synovial membrane, and though, from our experience with aseptic drainage, it is clearly possible to get a good result, in some cases, without any radical operation, I believe it is on the whole best, in most cases, to look on the presence of such an abscess as an indication for complete removal of the diseased tissues, either by excising the abscess

wall and complete arthrectomy in children, or excision or amputation in adults. This rule holds good in most cases of disease of the knee, elbow, and ankle joints; in the case of the hip and shoulder, however, I should, in a good many cases, be content with treating the abscess in the 2nd or 3rd way, removing only so much of the diseased tissues as was easily accessible in the first instance, unless there was some special reason for performing a more radical operation at once.

The same rule, I believe, applies to the wrist joint, and also, to some extent, to the tarsus, though, in the latter, where one of the bones is primarily diseased, it is often possible, at the early stage, to get rid of the disease by removal of the affected bone and synovial membrane.

4. 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. Here, again, the decision must vary with the joint affected.

5. 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, in the first instance, what can be done by as thorough removal of the tubercular tissues as possible, persevering in the treatment so long as the wound remains aseptic and the general health does not suffer.

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 tubercular 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 tubercular 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 tubercular meningitis, and of phthisis, in septic cases as the result of the depression of the tissues 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 connection 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.

Hence, in treating a case of tubercular joint disease with septic sinuses, it is, I think, advisable in most cases, to do more than merely put the part at rest, some operative treatment must, as a rule, be adopted. Where it is not deemed desirable to proceed to 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. 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 tubercular 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.

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 arthrectomy, 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 can usually 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 connection 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 tubercular 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 eradication 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 right hip for three months, complete limitation of movement, great 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 tubercular 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 tubercular 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.

While it is self-evident that in these cases, with localised patches of disease, the removal of the affected tissue is the proper treatment, provided it is 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 arthectomy, 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. 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, now-a-days 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 all operations by which the whole of the tubercular 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 tubercular 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 ($\frac{1}{4}$ in.) of the bone beneath. Very often the cartilages are covered with a thin layer of soft tissue, and this must be got away either by scraping the surface with the edge of the knife, or by scrubbing it with a nail brush. 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 tubercular tissue only extends into the bone for about one-eighth of an inch ; this layer can usually be removed by the knife. 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 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 tubercular 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. 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 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 sometimes remains after excision. In the case of the knee-joint, excision, of course, leads to firm stiff joints, and arthrectomy 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 it reached eleven inches. 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 TUBERCULAR DISEASE OF THE VARIOUS JOINTS AND BONES.

CHAPTER XVI.

DISEASE OF THE HIP JOINT.

TUBERCULAR 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 tubercular disease, and taking adults and children together, disease of the hip joint occupies the third place in the total order of frequency.

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 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. In some cases, it is further out in the neck and even in the trochanter, 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, 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, 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. 31). 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,

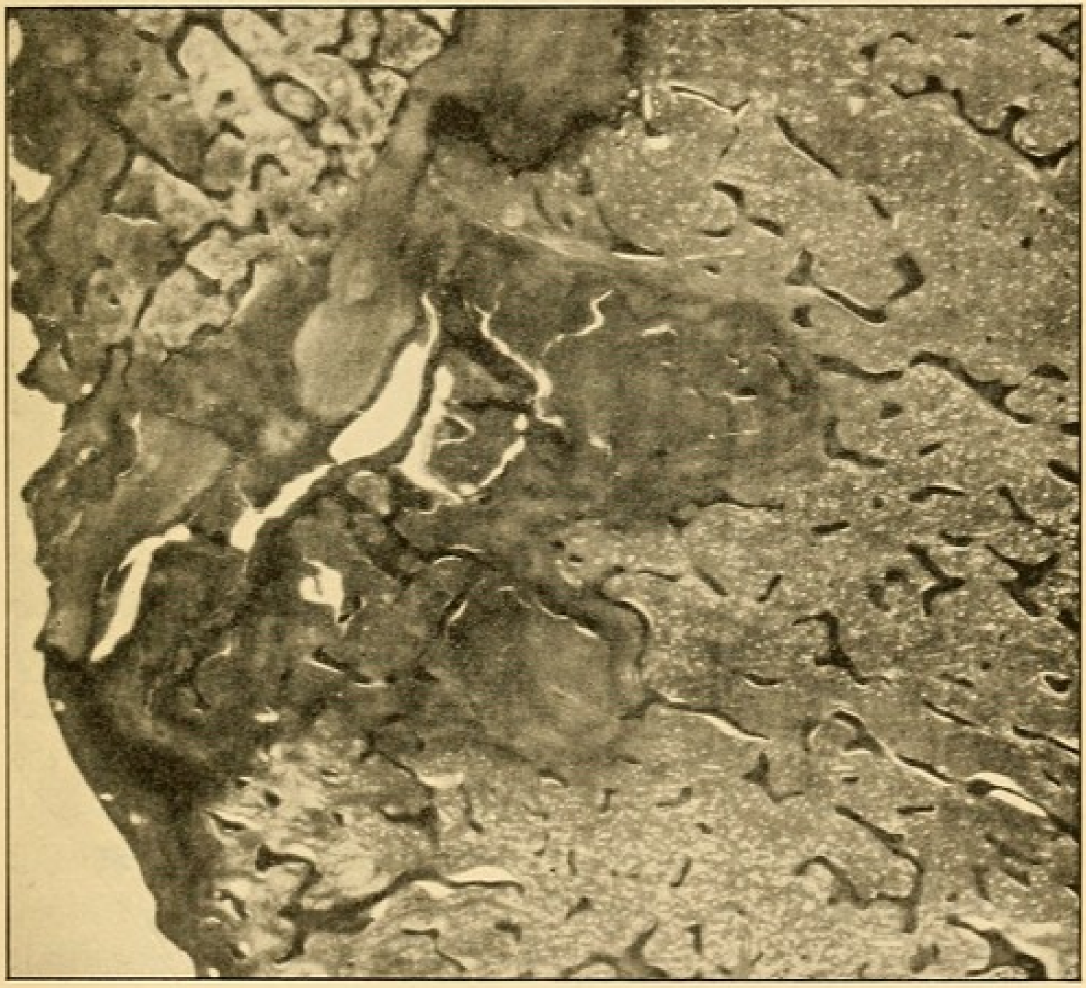

FIG. 31.—Soft deposit in the neck of the femur, just outside the lower part of the epiphysial cartilage. It is destroying this cartilage, which is, at one part, completely perforated. It has also spread into the joint, and set up synovial disease. The rest of the neck is in a state of rarefying osteitis.

reaching the surface of the bone, produces the condition of caries. The affection of the 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, and not necessarily tubercular in the first 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 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; 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. 32). This enlargement or " wandering " of the acetabulum, as it is termed in Germany, often goes on to a very great extent, and great 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

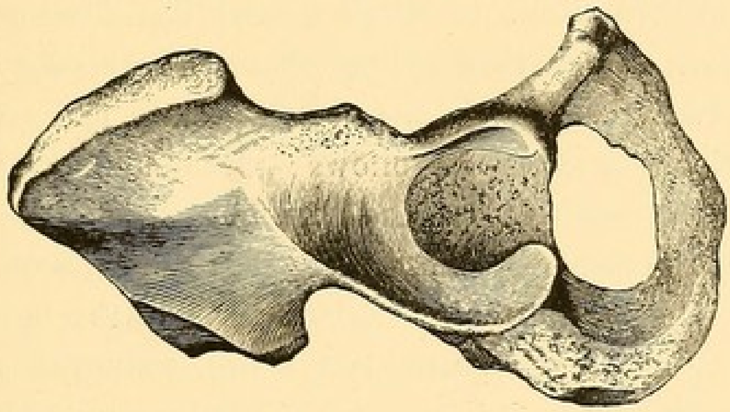

FIG. 32.—Enlargement of the upper and back part of the acetabulum (" wandering of the acetabulum "), as the result of hip-joint disease. (After BRADFORD and LOVETT.)

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 tubercular mass. Dislocation in hip-joint disease almost always occurs upwards and backwards. 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 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 tubercular 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.

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 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 as well as 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; 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 recognise. 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 ground in walking, but bears weight on the ball 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 towards the affected side, 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. 33). 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. 34), which is such a constant and early accompaniment of all synovial inflammations. The muscles 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 flat table, and when the lumbar spine lies flat on the table, it will be seen that the thigh is bent to a varying degree, while, when the thigh is placed flat on the table, the lumbar spine becomes arched forwards (*see* Figs. 35 and 36). 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.

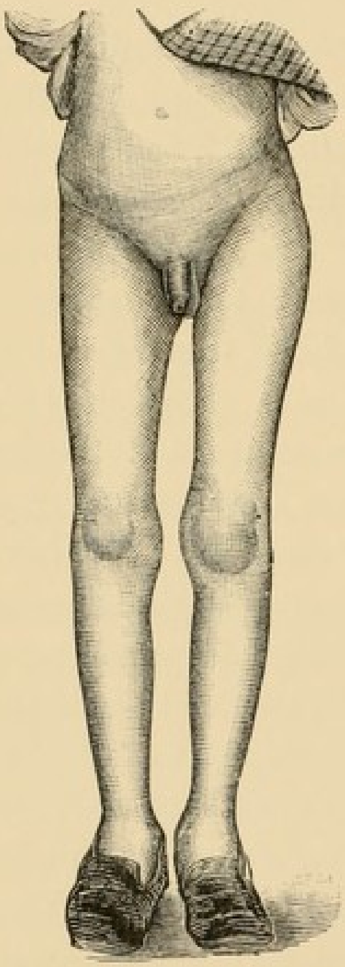

Fig. 33. — Hip-joint disease on the right side, obliquity of the pelvis towards the affected side, and slight flexion of thigh.

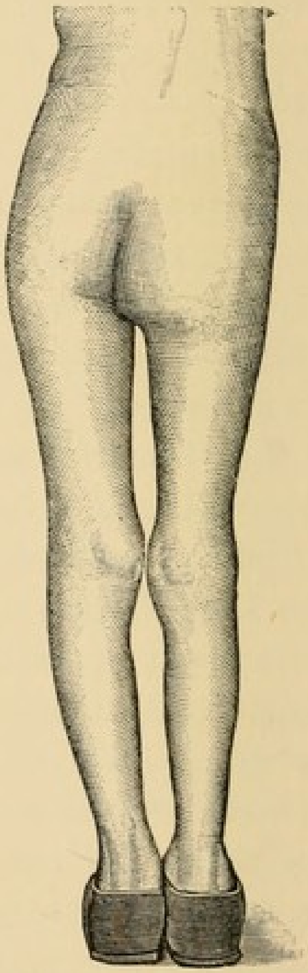

Fig. 34. — Same case (as Fig. 33), seen from behind, showing the flattening of the buttock and the obliquity of the pelvis.

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. The other thigh is then flexed gently and slowly, and it will be found that when, or before, a right

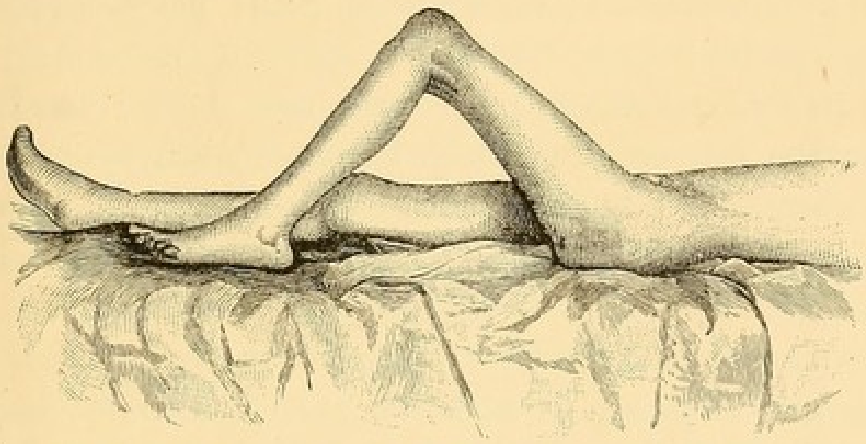

FIG. 35.—Hip-joint disease, showing the degree of flexion of the thigh when the spine is lying flat on the table.

angle is reached the flexion ceases, and on attempting to push it further, the pelvis rises from the table. 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

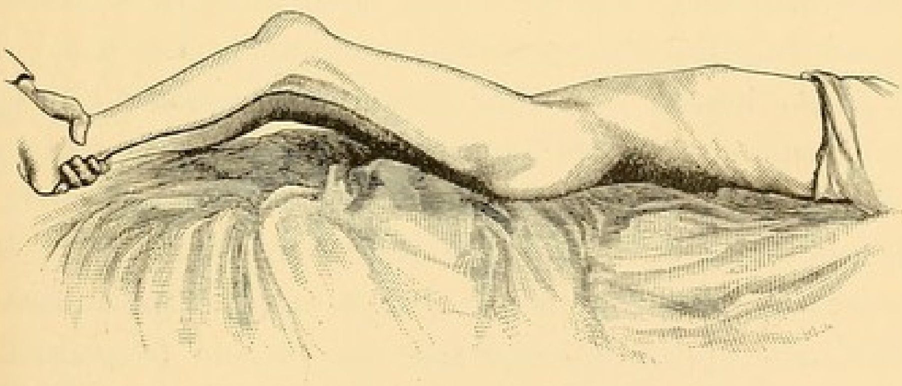

FIG. 36.—Hip-joint disease, showing the arching of the spine when the flexed thigh is pulled down (*see* Fig. 35).

movement of the pelvis; if that is the case, the diagnosis of disease of the hip-joint may be safely made. 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 diagnosis of tubercular 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 tubercular 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 tubercular 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 tubercular, 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.

In older patients commencing monarticular rheumatism and rheumatoid arthritis must also be borne in mind. As a matter of fact, in old patients tubercular 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 tubercular 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 are 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 connection 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 fever which very rarely occurs to any great degree in tubercular 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 characterised by swelling, tenderness, powerlessness of the limb, and other signs of congenital syphilis.

It is usual in giving the differential diagnosis of tubercular 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 semiflexed 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.

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 tubercular 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 trochanters 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 the symptoms are 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 inside the acetabulum. Where the disease commences in the acetabulum, the whole substance 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.

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 in practice 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 becomes higher than on the other.

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. 37 and 38). 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.

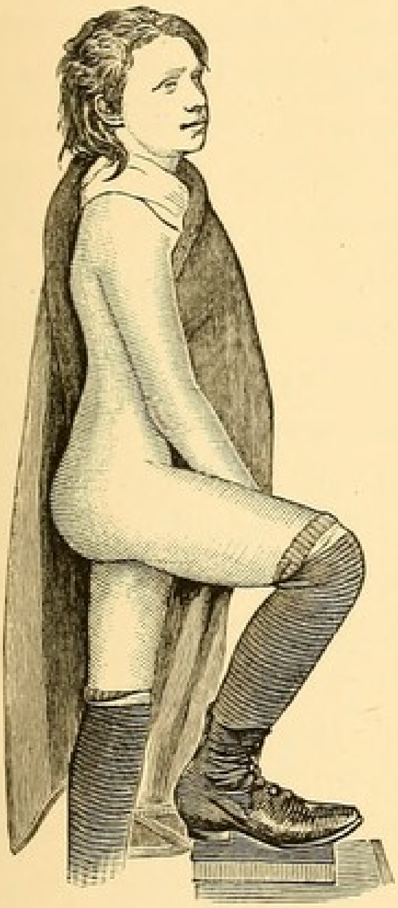

FIG. 37. — Hip-joint disease, showing the degree of flexion. (After BRADFORD and LOVETT.)

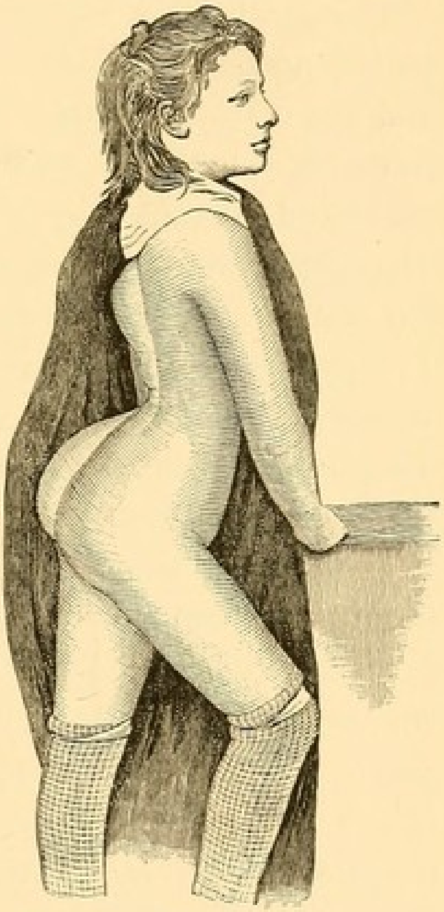

FIG. 38.—Hip-joint disease (*see* Fig. 37), showing extreme lordosis, when an attempt is made to bring the foot to the ground. (After BRADFORD and LOVETT.)

The angle 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 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 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, 22½ inches. Length (from umbilicus) of right leg, 25 inches; of left leg, 23 inches. Real shortening, ½ inch ; apparent shortening, 2 inches. Difference between real and practical shortening, 1½ inches. Distance between anterior superior spines (pelvic measurement), 7 inches. If we follow the line for 1½ 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 unfrequently 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 ¼-inch to 2 or 2½ inches; the average is 1½ 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

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

Difference in inches between real and apparent shortening.

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 and 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 surface 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 connection 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 increased 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.

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.

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 tubercular 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.

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. In some cases the abscesses begin in the outer part of the capsule, and spreads outwards rather than inwards to the joint. 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 outwards, 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. Usually, 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 connection 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-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 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.

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 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 stage may follow the previous ones or, while recovery is 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. 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 great lameness and deformity, and where adduction is at all marked the pelvis is much tilted and the practical shortening greatly increased. The combination of the two deformities cripples the patient, sometimes entirely, and calls for operative treatment.

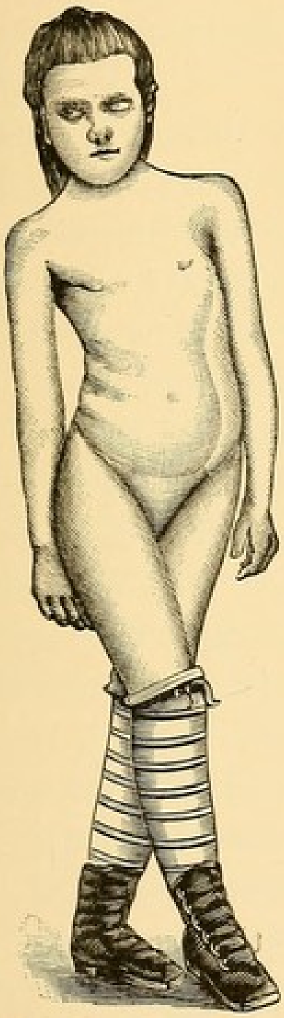

Fig. 39.—Cross-legged deformity, the result of disease of both hip-joints. (After Bradford and Lovett.)

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. 39). 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 disease, 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 great. 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 tubercular disease elsewhere, usually phthisis or tubercular 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 tubercular disease elsewhere when admitted. Of these, 6 died, 4 from tubercular 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 tubercular 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 tubercular 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 tubercular 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 for 3 or 4 years after recovery, the growth of the limb as a whole being somewhat retarded.

1. Treatment of the First Stage.

In discussing this question, it will be best, even at the risk of some repetition, to consider the treatment 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 of rest both as regards movement and muscular contraction, and of 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. The methods of expectant treatment consist either of extension or the employment of some suitable apparatus without extension. Whether extension is necessary or not will depend, first, on the degree of rigidity, *i.e.*, of spasmodic contraction of the muscles surrounding the joint; in other words, on whether the disease is primarily and purely synovial, or whether the bone is affected, in addition or alone; and, secondly, on the amount of pain.

Where the disease is purely synovial, and pain is not marked, then extension should not be employed, or if used the weight should be very light. In these cases, the muscular contraction is very slight, and the effect of extension would merely be to stretch and irritate the already inflamed capsule, and thus increase the inflammation without any corresponding advantage. The only reason for employing extension in these cases would be the presence of a certain amount of deformity, and it should be discontinued as soon as the deformity has been overcome. It is at this stage that Thomas's splint is especially useful. This splint is now well known, and I need only refer to it shortly. The splint consists of a long flat bar of wrought-iron, which runs straight down the back from just below the level of the axilla to the buttock. 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 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's 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 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. 40).

Thomas gives the following rules for applying his splints:—
"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 and abduction, more especially adduction. Although the latter comes, as a rule, under the

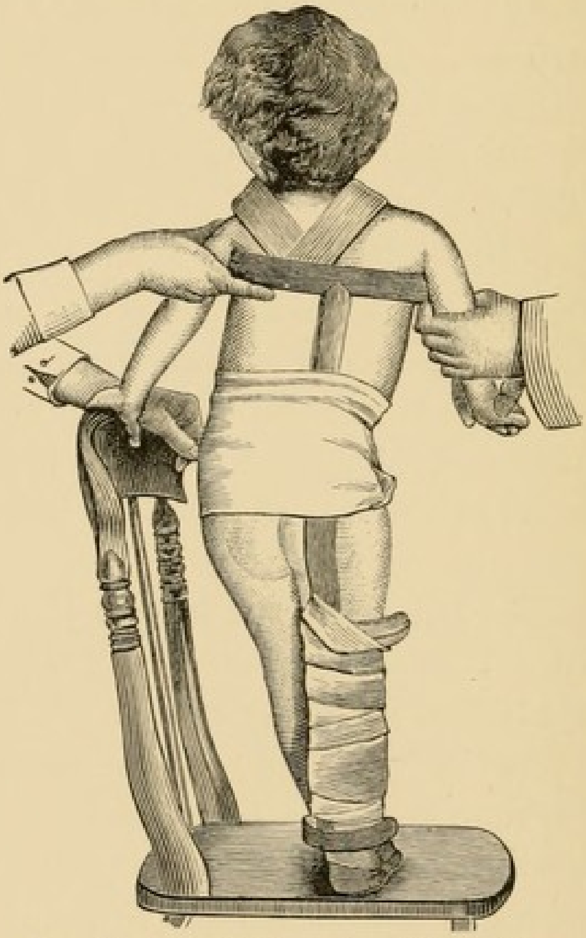

FIG. 40.—Single Thomas's splint applied.

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. In young children I believe a double Thomas, with pelvic band, is much more efficient than a single Thomas, and is much more likely to overcome the adduction, but even with that one does not get the exaggerated degree of abduction which, as I shall point out in considering the second stage, one desires to have.

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 all the acute symptoms have passed off, indeed till the condition of the joint is well advanced on the road to cure. 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 joint becomes quite easy.

In cases where there is much rigidity of the joint and starting pains, I believe that the judicious employment of extension in the first instance is much better practice than the use of Thomas's or any other splint. 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 is not properly done by means of Thomas's splint, and is, I believe, best accomplished by moderate extension. 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 therefore when employed in cases of marked muscular contraction, the case must be closely watched, and the weight diminished or left off in favour say of Thomas's splint 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 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 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 body is kept at rest by sandbags, or if the patient is very restless, a Thomas's splint may be worn in addition to the extension. The line of extension should at first be in the direction of the deformity, the limb being gradually brought into the proper line. 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; 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 a properly fitting single or double Thomas's splint may then be substituted for it. In this stage, then, I believe that extension holds a secondary place to such forms of apparatus as Thomas's splint, Bonnet's wire cuirass (*see* Fig. 41), or best of all, Phelps' box.

In the general remarks on treatment I have referred to the use of the actual cautery, and in a certain number of cases in adults this method of treatment has been of considerable benefit. The broad cautery is applied at white heat in a vertical direction in front of the joint and behind the trochanter, boracic poultices are then used till the slough separates, and then savin ointment, either pure or diluted with vaseline. The sores are kept open, if possible, for about six weeks, and then dressed with weak boracic ointment and allowed to heal. As a rule the use of extension is also indicated in these cases, and the two measures therefore generally go together.

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 183 a case in which a deposit was removed from the neck of the femur, and on page 208 I have indicated how the presence of these deposits may be recognised. 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, page 183). 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

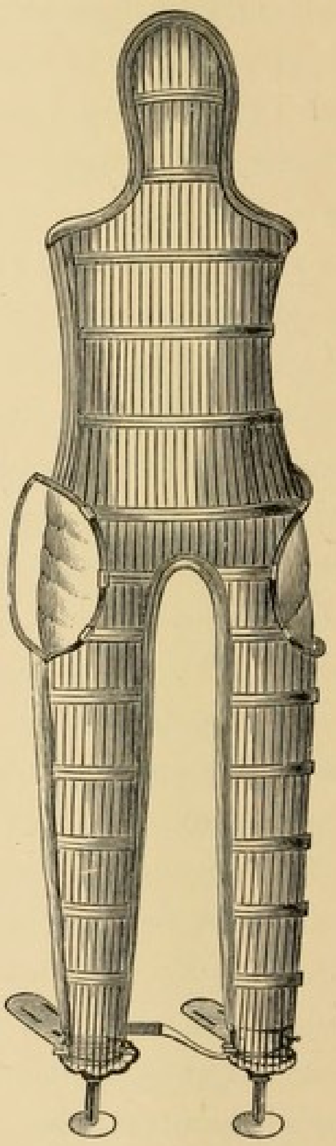

FIG. 41. — Bonnet's wire cuirass for hip-joint disease. This may also be used in cases of spinal disease. (After BRADFORD and LOVETT.)

the capsule, it is necessary to make an oblique incision behind in the line of the fibres of the gluteus maximus, and by utilising 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, the relative position of splints and extension is the reverse of that in the first stage, and now, in my opinion, 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 slight 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 adduction 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 sand-bag being also applied to the upper part of the pelvis on the affected side; or it may be done by placing the patient on a Thomas's splint. 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 Thomas's splint, Thomas himself advises that 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. Much better than the single Thomas's splint at this stage of the disease 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 many cases, is the Phelps' box, which I shall describe in connection with spinal disease. By having the leg piece on the affected side 3 to 4 inches longer than the leg, extension can be readily kept up by means of elastic bands fastened to the strapping on the one hand, and the foot-piece 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.

Another good arrangement is Bonnet's wire cuirass, of which Fig. 41 is a drawing which explains itself. In America the favourite method of treatment is by means of so-called "traction" splints, which essentially consist of an arrangement grasping the thigh and leg, and, moving on this by means of rack and pinion, an upper part with an internal band or bands getting a purchase on the tuber ischii and the perineum. The one most commonly employed is the Davis-Taylor traction splint. The objection to these splints is the pressure on the perineum, which is very apt to lead to ulceration. The other forms of apparatus, metal or leather splints, and plaster of Paris, are inferior, but encasing the trunk and both limbs in plaster of Paris may be useful in some cases of advanced disease with sinuses, openings being, of course, left for dressing the latter.

In some cases, especially where the bone is thickened and the pain great, the combination of the actual cautery with the extension is of evident service. The best situations for the cautery wounds are in front of the joint just inside the line of incision for the anterior operation of excision, and behind the trochanter. It is best to apply it in both places at the same time, and to make the sores about an inch in breadth and 3 inches in length. The iron is brought to a white heat, and passed two or three times rapidly over the part. Boracic fomentations are employed till the slough separates, and then the sores are dressed with savin ointment, pure or diluted, and kept open for about six weeks. Should they tend to heal sooner it is well to apply nitrate of silver to them, or to open them up with potassa fusa.

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 of late 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 urged 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, however, a very difficult matter to thoroughly remove the whole of the affected synovial membrane, 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 tubercular meningitis had been precipitated by excision. König states that of 18 cases of tubercular meningitis, 16 occurred after operation. Metaxas and Verchere, in the statistics of 55 cases of tubercular 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 tubercular 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 tubercular meningitis directly followed excision of the hip. And if in a certain number of cases tubercular meningitis may be set up, it follows that there must be a larger number in which a smaller quantity of the tubercular material gets into the blood and sets up deposits in other parts of the body. The risk of forcing tubercular 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 very tempted to scrape the surface. In examining the question of the occurrence of phthisis after operation on tubercular 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 was 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 tubercular) 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 nonoperative 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 its place 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. 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 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 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 to me in two instances.

I have already described the more recent methods of treating chronic abscesses, and in the case of abscess connected with the hip-joint one can frequently remove a large portion of the wall by dissection, especially where the abscess is on the anterior and outer surface of the thigh. A long incision is made over the abscess, the wall exposed and carefully separated, without opening it, to as great an extent as possible. It is then cut off at the deeper part, the contents carefully washed away, and the further connections of the abscess examined. It will generally be found to pass into the joint at some part often, however, through a very narrow canal. A probe passed along this canal will ascertain whether there is any sequestrum, and if there is it can be removed after dilatation of the opening in the capsule. If no sequestrum is felt, then, I think, it is best not to dilate the communication with the joint at this time, but to thoroughly scrape and peel away the remains of the abscess wall outside, fill the wound with iodoform and glycerine and stitch it up. Where the abscess is deep-seated it is best to lay it freely open, and then holding the wound apart peel off the wall as far as possible, scraping away the remainder with the flushing spoon. It is far better to make too large incisions in the skin than too small ones. We must see thoroughly what we are about, and as the skin incision is not in a noticeable place and heals by first intention, a little extra length is of no consequence.

Where we have to do with abscesses which have originated in the pelvis in connection with disease of the acetabulum, excision of the head of the bone at once is usually 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.

By treating the abscesses in this way, 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 caseate and less to recovery. In a certain

16

number of cases with abscesses treated as above, 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. In any case 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.

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 tubercular 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 not unfrequently 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 stuff daily with cyanide gauze powdered with iodoform or soaked in balsam of Peru. By adopting these measures some of the cases heal without further trouble, and if not, the septic condition is much diminished and sometimes entirely abolished. 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.

The anterior incision begins just below the anterior superior spine of the ilium, 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 the vessels and the tendon of the psoas and iliacus there is not usually any difficulty in clipping away the anterior part of the synovial membrane. 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. As portions of tubercular 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 6 or 8 weeks, and then fitted with a Thomas's splint and crutches, and not allowed to bear any weight on the limb for at least 6 or 8 months.

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 1½ 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.

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.

In all the forms 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 10 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, the gauze may be impregnated with balsam of Peru instead of iodoform. This stuffing of tubercular wounds and sinuses with iodoformed 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.

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.

4. Treatment of the Fourth Stage.

During this stage recovery with or without 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 under the treatment of the third stage, great care being taken not to strain the joint, nor break up any anchylosis. A free incision is made over the abscess, and as much of the wall dissected or peeled away as possible, the remainder being thoroughly scraped with the flushing spoon.

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. If, however, there is much discharge, they must be laid freely open, thoroughly scraped out, any sequestra removed, sponged with undiluted carbolic acid, and packed 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 result is most satisfactory 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.

CHAPTER XVII.

DISEASE OF THE KNEE JOINT.

In patients of all ages affected with tubercular 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 next 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 tubercular 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.

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 advanced life, the conditions over 20 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. In none of the specimens which I have cut has a deposit been found on the diaphysial side of the epiphysial line, but I have seen bottle specimens showing this, 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 communication with the surface outside the capsule, and lead to the production of extra-articular abscesses. It is in this joint, also, that Kocher thinks he has observed primary disease of the fibro-cartilages.

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

A rare condition, but one which it is well to bear in mind, is the localised tubercular deposit in the synovial membrane. This may occur in two forms:—(1) a localised thickening of the synovial capsule, and (2) one or more pedunculated tubercular 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 realised 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 localised, 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 suprapatellar 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 tubercular 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 tubercular disease elsewhere, or the co-existence of other tubercular lesions.

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.

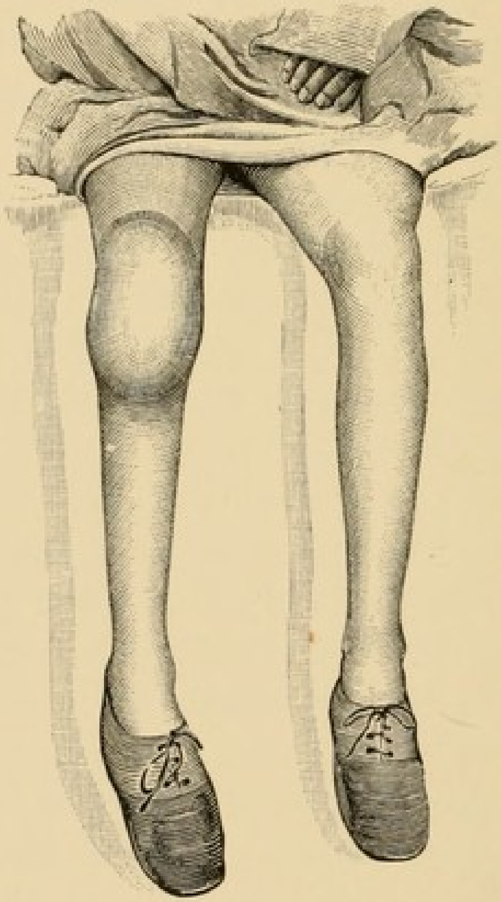

Fig. 42.—Synovial disease of the right knee joint, showing the great swelling co-extensive with the synovial capsule.

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. 42). As time goes on the swelling increases,

and also the stiffness, but it is often remarkable what a degree 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 reflection of the synovial membrane on to the bones, where 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 difficult to be quite certain, without operation, in these cases whether or not there is disease in the internal condyle, but the following 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 pointed out in the general pathology of synovial disease, the tubercular 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 matting together of the walls of the synovial cavity. Accompanying this rigidity there is, if no treatment has been adopted, gradually increasing flexion of the joint, ending in further deformity, to which I shall presently allude. 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, and after division of the hamstrings or complete removal of the capsule by arthrectomy or removal of a portion of the bone. 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* Fig. 43). At the same time the muscles of the thigh atrophy, but the leg, more especially, shows signs of wasting and, where the deformity has occurred early, and lasted some time, of deficient growth. 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

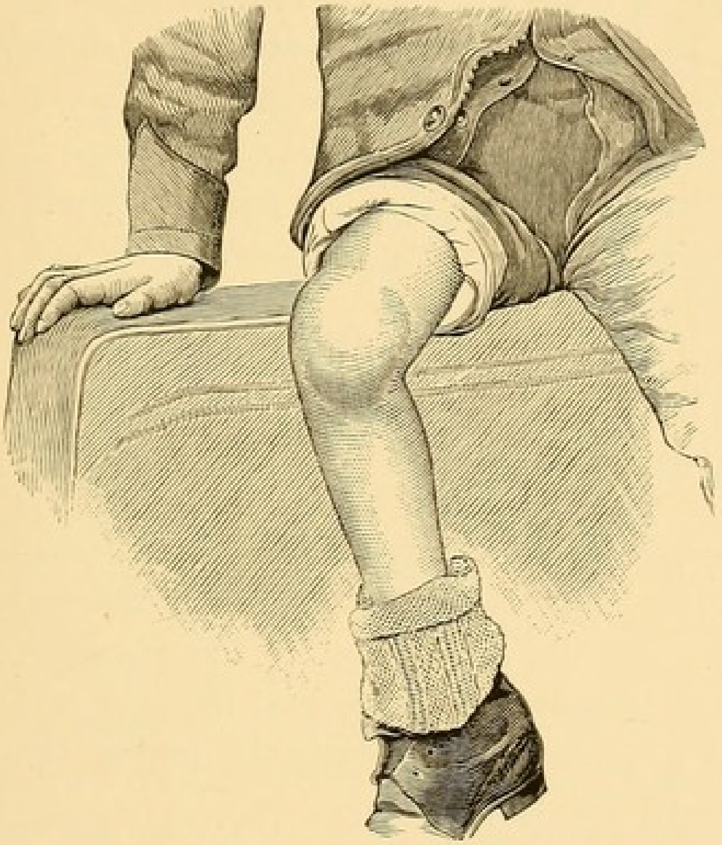

FIG. 43.—Old standing disease of the knee joint, showing the typical deformity, viz.—flexion, drawing up of the tibia behind the femur, and rotation outwards of the leg.

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. Suppuration

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 connection 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 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 flaky material in it. In the case of these abscesses arising in connection with the synovial membrane, after being opened a communication may form with the joint, but this is not usually 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 generally 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.

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 recognise 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 note 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 the bone 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 tubercular disease with pus in the joint. In this case the tubercular 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 connection with the knee-joint but in other joints, and while some of them might be referred to the sudden deposit of a tubercular 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 Tubercular Disease of the Knee Joint.

Acute synovitis.—The only cases in which acute synovitis and tubercular disease of the knee-joint are difficult to distinguish are either where the tubercular disease begins acutely or where an osseous deposit has burst into the joint. In some cases tubercular 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, where 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 tubercular meningitis. In other cases the acuteness of the symptoms 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 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 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 tubercular 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 was tubercular 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 tubercular 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 tubercular 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 tubercular 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 polyarticular.

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 characterised 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 tubercular 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 other symptoms of knee-joint disease are absent. 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 tubercular disease. Diffuse gummatous infiltration of the subsynovial tissue is excessively rare. 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 tubercular 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 tubercular 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 tubercular 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 localised 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 localised 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, partial or complete arthrectomy, treatment of abscesses alone, excision and amputation. We must consider shortly the circumstances under which these various forms of treatment are applicable. I may at once say that the knee-joint being a much more accessible joint than the hip, it is not now considered advisable to continue expectant treatment for so long a time, because much can be done to shorten the disease and get a good functional result by comparatively early operation.

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. 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 subsequent difficulty in getting the foot flat on the ground. 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. The splint should reach from the fold of the buttock above to about 4 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, more especially the internal condyle of the femur and the malleoli. To avoid the latter, the pads do not reach further than the base 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, 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 inclosed 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.

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 way 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, slung from the shoulder by a strap, is by far the best apparatus. 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, and the patient gets about with crutches. The plan of putting the leg up in waterglass, and allowing the patient to walk about is bad, because there is constant pressure on the joint, and this method should not be adopted unless in very exceptional circumstances, and then only when the disease is purely synovial, and well on the road to cure.

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 certainly does 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 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.

In the early stage of hip-joint disease, as I pointed out, we had not to consider the question of operation except in those cases where it was probable that a deposit was present in the neck of the femur, which had not yet opened into the joint, but in the case of the knee the matter is different, and in certain cases of pure synovial disease great advantage may be obtained by operation at an early stage before the articular cartilages have been destroyed. These operations consist of arthrotomy and partial or complete arthrectomy in children, arthrotomy and excision in adults. In a certain number of cases the swelling does not subside under rest, but either remains stationary or increases; the swelling in these cases is usually soft and gelatinous, hence the name "gelatinous degeneration of the synovial membrane," and abscesses are very apt to form at an early period. In such instances the cartilage will soon become affected, and the surface of the bone carious, and it is in certain cases wise to make an effort to cut short the disease by operation before this has taken place, so as to get a certain amount of restoration of function. In the case of children, at any rate, I should not waste time with arthrotomy, but at once employ partial or complete arthrectomy. It must, of course, be remembered that complete arthrectomy of the knee-joint is an operation by no means devoid of danger (shock), and therefore not to be lightly undertaken, but where a case is advancing in spite of proper rest, and especially where there is evidence of breaking down, this question of arthrectomy should always be considered before there are signs of destruction of cartilage. The objection raised by practitioners to the question of operation at this early period is that these cases often ultimately get well without operation by prolonged treatment by fixation, frequent trips to the country, &c. This is no doubt true, but a considerable number of the class of cases of which

I am speaking do not get well in this manner, abscesses form and burst or are opened, and septic sinuses are left, the patient becomes worn out by pain and discharge from these sinuses, disease of the lungs sets in, and a time comes when the question lies between amputation and leaving the patient to die. Further, in cases in which the disease advances in this way, if recovery does take place, the joint is anchylosed, and years are passed as an invalid, during which time the education of the child is neglected, and the confinement tells on his general physique. On the other hand, where arthrectomy is successful, the disease is brought to an end at once, the patient is able to get about in a comparatively short time, and in a considerable number of the cases a certain amount of movement (sometimes marked) is ultimately obtained. I think, therefore, that, as I have already said, this question should always be considered comparatively early in those cases where the disease is steadily advancing, where the thickened synovial membrane is soft, and where there is a tendency to abscess formation. In coming to a decision, the risk of the operation (shock) and the general state of the patient must be thoroughly weighed. In these rapidly advancing cases in children, arthrectomy, if done at all, must be complete, and I shall now describe the best way of doing it in the case of the knee.

Numerous incisions are recommended, but the method which seems to me best is, in the first instance, to make a long vertical incision on each side of the patella. These incisions run from a ½ to 1 inch from the border of the patella, according to the size of the part and the degree of the synovial thickening, commencing above at the level of the upper part of the supra-patellar pouch, and ending about an inch below the level of the upper surface of the head of the tibia. These incisions are deepened throughout their whole extent till the outer surface of the capsule is exposed, and the flaps are then lifted to each side, care being taken not to cut into the tubercular tissue, till the whole of the synovial membrane in front of the joint is exposed. The suprapatellar pouch of synovial membrane is then freed, where it overhangs the front and sides of the femur, up to the point of attachment to the articular cartilages, the ligamentum patellæ being also raised, and freed from the fatty pads and the tissues beneath. The synovial membrane is then cut away all round the patella, and if fluid is present in the joint, it is sponged or washed out. The membrane is then detached at the point of attachment to the articular cartilages of the femur and the tibia, and divided as far back at each side as possible. In a certain number of cases I have done the whole operation by means of these two incisions, dislocating the patella over one or other condyle in turn; but this sometimes causes a good deal of bruising of the edges of the wound, and, therefore, I now usually make a transverse incision over the middle of the patella, saw through the bone, and turn the flaps up and down. The objection I at first had to that was the fear lest the cut surface of the bone should become infected, but this has not happened in my cases. The joint is now bent, and the soft tissue covering the crucial ligaments and in the condyloid notch cleaned away as thoroughly as possible; this is one of the most difficult things to do. The crucial ligaments are then divided about the middle, and also the lateral ligaments, and the thickened synovial membrane is sought for at each side, and its outer surface defined. This outer surface is separated from the vessels and structures in the popliteal space as high as its attachment to the femur above and the tibia below, and is then cut away at those parts. In detaching the posterior part of the capsule, it is well, if a tourniquet has been employed, to remove it, in order that one may have the pulsations of the popliteal artery as a guide. The inter-articular fibro-cartilages are then removed, and the whole of the edge of the articular cartilage carefully gone over, to make sure that no pieces of diseased synovial membrane have been left attached. The whole surface of the cartilage is now carefully inspected, and if there is any sign of pitting or disease anywhere, the affected piece is scooped out. What one very commonly finds, without any definite destruction of cartilage, is that the surface of the cartilage is covered with a dull velvety layer, which is not readily detached. This must be removed as far as possible, and that I do either by scrubbing it thoroughly with a nail-brush, or, where still more adherent, by scraping it away with a knife. Having thoroughly satisfied one's self that the disease has been removed, catgut stitches are put in the crucial and lateral ligaments, the patella drilled and wired together, the wounds stitched up—if one likes, after filling the joint with iodoform and glycerine, but I do not think that is necessary—antiseptic dressings applied, and the limb placed on a back splint. If the operation has been done aseptically, 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's knee 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. In performing the operation, it is a question whether a tourniquet should be used or not. It is no doubt easier to distinguish the diseased and healthy tissues while the blood is circulating through them, and the after bleeding is less, but where the child is weakly, perhaps less blood, on the whole, is lost where a tourniquet is used. If it is employed, it is well, as I have already said, to remove it before the dissection of the posterior part of the synovial capsule is proceeded with, in order to have the pulsations of the popliteal artery as a guide.

While in these rapidly spreading cases my experience is that complete arthrectomy is the proper procedure, yet in a certain number of cases a partial operation will yield a good result.

Cases, for instance, which do not improve with rest, but where the progress of the disease is slow, and the thickening of the synovial membrane not very great. These are the cases which are improved by simple arthrotomy, but, as I have already said, I believe that, if one is to cut into the joint, it is well to remove as much of the disease as possible. In cases of this kind, therefore, I dissect away the whole of the anterior synovial membrane, but do not divide the crucial or lateral ligaments, and thus the joint remains firm, and I have had some excellent recoveries with movable joints after this procedure. In some cases, however, I have been disappointed in the result, and the course I adopt now is to be guided not so much by the external appearance of the joint as by the character of the synovial membrane when it is cut into. If it is firm and uniform in appearance, without signs of caseation, and if the cartilages are intact, then I sometimes content myself with a partial arthrectomy; but if the synovial membrane is speckled with yellow points, or if the cartilages are becoming affected, then I do a complete arthrectomy.

In the case of adults I would not advocate such early interference, because the results of arthrectomy of the knee-joint are not so favourable in them. 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 till during the second stage.

Another method of treatment during the early stage of joint disease, especially in the case of the knee, is now much employed in Germany, viz., the injection of iodoform emulsion into the joint. I cannot say, however, that I think very highly of this plan.

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 especially 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. As regards operations during this 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 tubercular 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 more. 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, I believe, 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 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 tubercular 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 practically appreciable. 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. Now-a-days, 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:—

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. 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, 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 till the supra-patellar pouch has been completely passed. The flap is then held up, and the supra-patellar 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 a portion 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, 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, the cavity washed out, and the bones pegged together by ivory pegs. I usually put in two, one on each side, driving them upwards and backwards. 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, and hence it is easier to drive the pegs upwards from the tibia than downwards from the femur. In some cases I have used a third peg in the centre, and thus got great steadiness. 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 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.

The question of amputation during this stage may also arise, but it will hardly concern the young. Some years ago, 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 pegged 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 an attempt should in most cases be made to dissect the abscess out altogether without opening the joint, or if the abscess is extensive, it may be washed and scraped out and injected with iodoform and glycerine. Where there is more than one abscess, or where the condition of the joint is otherwise bad, the question will lie between arthrectomy and amputation. While amputation is, of course, to be avoided in children if at all possible, an arthrectomy 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 tubercular lesions elsewhere, amputation may be the preferable procedure. In some cases, however, where the joint disease is the only lesion, and where the general state of the patient is good, one may begin by washing out, scraping and injecting the abscesses, and then if it becomes necessary at a future time to perform arthrectomy, it will not be nearly such an extensive and dangerous operation.

In adults, similarly, excision becomes a more serious operation, 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 excising or washing out the abscess, and where excision of the joint seems desirable 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 tubercular 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 matters very much on account of the risk of sepsis, where arthrectomy or excision is performed. I have, however, now done a number of these operations successfully, where septic sinuses were present, and have thus been led to modify my former opinion that the presence of septic sinuses practically precludes the performance of arthrectomy. No doubt, however, it makes one hesitate to undertake it till all other means have failed.

In children, unless deformity is present, or the suppuration profuse, or the pain great, we may, in the first instance, see what can be done by thorough fixation of the limb for a lengthened period. If there is no improvement, and the discharge slight, arthrectomy is indicated. Similarly if the discharge is slight, and the deformity marked, arthrectomy is the best procedure. If, however, the pain is great, the discharge profuse, and no improvement occurs under expectant treatment, amputation is often necessary, and this is more especially the case if there is tubercular disease elsewhere, or if the health is suffering. If arthrectomy is done, the incisions are irregular, and one begins by dissecting out the sinuses entirely, and, before opening the joint, thoroughly sponging out their tracks with undiluted carbolic acid, and, if they communicate with the joint, sponging out the whole joint with carbolic acid before closing it. Drainage tubes should always be employed in this case lest the wound should become septic. Where it is deemed advisable to employ expectant treatment, the healing of the sinuses is often expedited by laying them freely open, scraping or clipping them out, applying undiluted carbolic acid, and stuffing them with gauze sprinkled with iodoform or soaked in balsam of Peru.

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, or if the discharge is profuse, the pain great, or tuberculosis 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 under chloroform; it is rarely that extension 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 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. 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, either 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, or, where the deformity is great, to divide the femur above the joint, and bring the leg straight. If the former 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. A very good wire splint is described by Bradford and Lovett, which will be sufficiently explained by the accompanying figure, taken from their book. 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 (*see* Fig. 44).

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

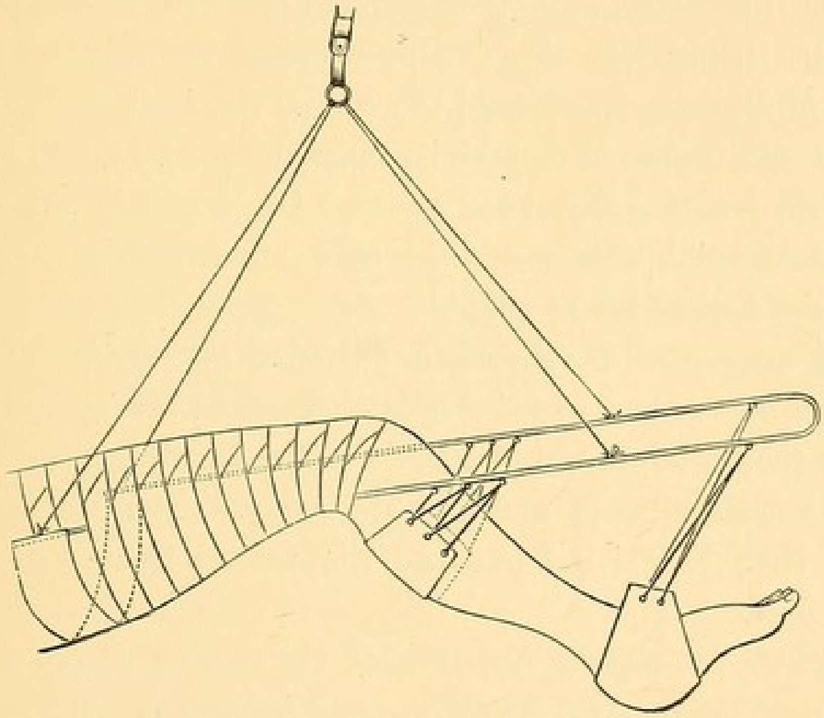

FIG. 44.—Arrangement for straightening a bent knee. (After BRADFORD and LOVETT.)

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. In cases where there is reason to suspect a tubercular deposit (tubercular disease elsewhere, pain not a marked symptom, absence of much aching at night, &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 discharges. Should the wound not heal, and evidently become tubercular, 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 perfect 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.

CHAPTER XVIII.

DISEASE OF THE ANKLE, TARSUS, AND METATARSUS.

In adults the ankle and tarsus combined come fourth in the list of frequency of tubercular 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 tubercular 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 tubercular 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 unnecessary 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, fulness can usually be made out. There may also be fulness 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 fulness 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 noticable when one or other malleolus is affected; and where the synovial membrane is not at the same time thickened, the appearance at first sight is as if the foot had been displaced to one side, being where the internal malleolus is involved 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. In some cases, however, one can make the diagnosis by the pain and rigidity and marked localised thickening of the synovial membrane at the part where the deposit has reached the surface, usually in front of one of the malleoli.

Where no retentive apparatus is employed, the chief deformity which occurs is pointing of the toes. A condition of inversion or eversion, especially the latter, is also sometimes produced where the lateral ligaments have 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 fulness 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 localised thickening with pain on movement of the joint, and tenderness on pressure (where the deposit is in the astralagus): or a more acute affection of the joint with great pain on movement, 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.

In the later stages of joint disease, in whichever way originating, the whole region of the joint is swollen and spindle-shaped (*see* Fig. 45), 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. It is not uncommon also at this stage for the extensor tendon sheaths to become affected, and then we have a tubercular 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 pushed over to the inner or outer side by the other bone in which the growth is more or less normal.

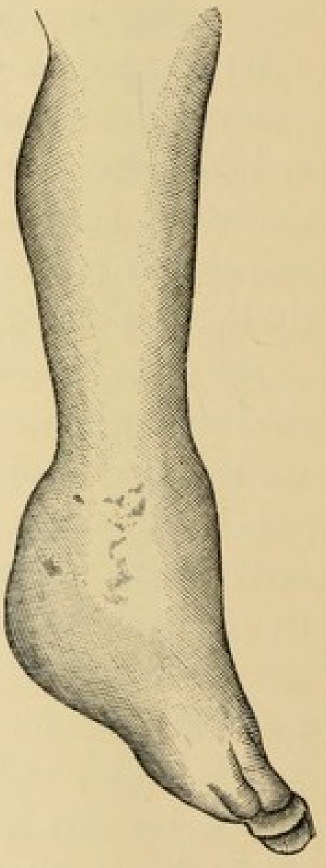

Fig. 45. — Disease of the ankle-joint. (After Bradford and Lovett.)

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, and the posterior epiphysis to which the tendo achilles is attached usually escapes. It may, however, begin near the astragalo-calcanean joint, and open into it or under the periosteum, giving rise, in the latter case, to a tubercular periostitis, with abscess and caries of the surface of the bone. It is rare for the disease to begin in connection 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-bye 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 connection with the periosteum, there is only a localised 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 joint 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 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 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 recognise 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 of the disease. 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 connection 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 or steam (in a bacteriological sterilising 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.

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.

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 localised deposits, advancing synovial or bone disease, and cases where suppuration is present.

Practically the only localised deposits which come under observation are those in the malleoli, which have made their way outwards instead of into the joints. 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, 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, the bone deposit cleared out, and if a sinus has been previously present, it is best afterwards to stuff the cavity with iodoformed gauze and make it heal from the bottom.

Where the joint is affected with or without a deposit in the bone, the usual operation for childhood is arthrectomy. There are numerous ways of performing arthrectomy of the ankle-joint (some thirty-seven or thirty-eight), 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 objection to division of the malleoli is the risk of interference with the epiphysial lines, and this is a real objection. 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, 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. 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 another, 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 thoroughly clear the posterior part of the joint 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 other means, 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 tubercular disease. Where excision is performed without removal of the astragalus, the incisions and procedure are 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. 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 tubercular 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 of tendon sheaths, presence of phthisis, &c., the choice usually lies between Syme's operation 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 and portions left, 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 localised 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 recognise 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 iodoformed gauze and make it heal from the bottom. The same is the treatment where a sinus is present. Excision of the entire bone becomes necessary where healing will not occur (*see* Fig 46); where the disease is extensive, several abscesses or sinuses being present; or where it has spread to the neighbouring joints, either

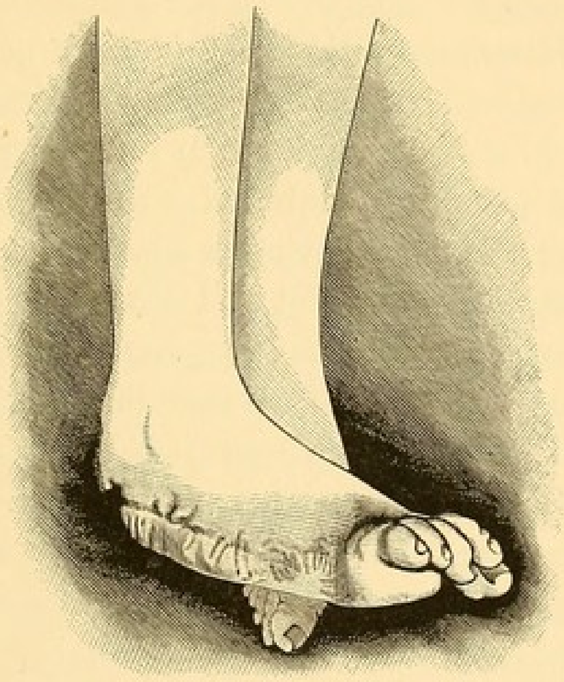

FIG. 46.—Result of excision of the os calcis.

calcaneo-cuboid or -astragaloid. Where, on the other hand, the disease is periosteal, an immediate cure can generally be obtained by dissecting or clearing out the abscess and removing freely the affected area of periosteum and the surface of the bone.

(*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 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 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. The incision may then be stitched up and the patient 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 internal or middle cuneiform 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 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 at 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 the disease is more diffuse, and especially where it affects the synovial membranes, it may be possible to do good in cases where operation is necessary by less typical removal of affected tissue. 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 were present the tendons may be reunited, 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 would be left open and stuffed with iodoformed gauze. The result is really very good, the 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 the individual case. 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. 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 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 between amputation (Syme, or in 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-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 wire sutures 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, 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.

TUBERCULAR 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, and 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. 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 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. Where the bursa under the deltoid is involved in the disease, as sometimes happens, there is, of course, marked fulness around the outer side of the joint.

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 tubercular disease is extremely rare, but cases have occurred.

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 show 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. 64, and may be looked on as a tubercular 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. Rigidity also occurs very early, and the trouble ultimately ends in bony anchylosis.

The diagnosis of tubercular 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 tubercular synovial disease the presence of marked swelling of the soft tissues of the joint and 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 the rheumatoid arthritis there is a good deal of movement, and grating or crackling in the joint without very much pain. The pain occurs in exacerbations, and is worse after a period of rest, and often also at night. Of course the presence of other tubercular lesions increases the probability of tubercular 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, tubercular disease, or rheumatoid arthritis. 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 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.

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 completely 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, extending down to the elbow.

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.

In some cases, especially of bone trouble and in caries sicca, the use of the actual cautery is of great benefit in 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. 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 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 completely 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 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, where 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 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.

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 localised either in the bone or the synovial membrane. Of the bones the most likely place is the olecranon. 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 localised bone deposit should be looked for is in the external condyle of the humerus. Localised 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 localised deposits is the same here as elsewhere. When the deposit in the bone reaches the surface, it

Fig. 47.—Disease of the right elbow joint.

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, 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 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. 47.) 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. 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 localised 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 localised 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, and in that where there was a localised thickening in the synovial membrane in the neighbourhood of the head of the radius. 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 wrist-joint: 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. 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 mass of synovial membrane over the olecranon fossa isolated, and the same is done on each side of the olecranon and over the 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. 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. 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.

In adults, I believe comparatively early excision is the better 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. 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 is to put on extension at night to 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 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 tubercular bone and joint disease. It is, I think, most often 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.

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.

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, displacing it laterally, is pathognomonic of tubercular 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, the fingers and thumb side by side, there is a marked swelling on the back of the wrist, and all around as well (*see* Fig. 48), 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 movement 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 weaker, 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 applied to the fingers.

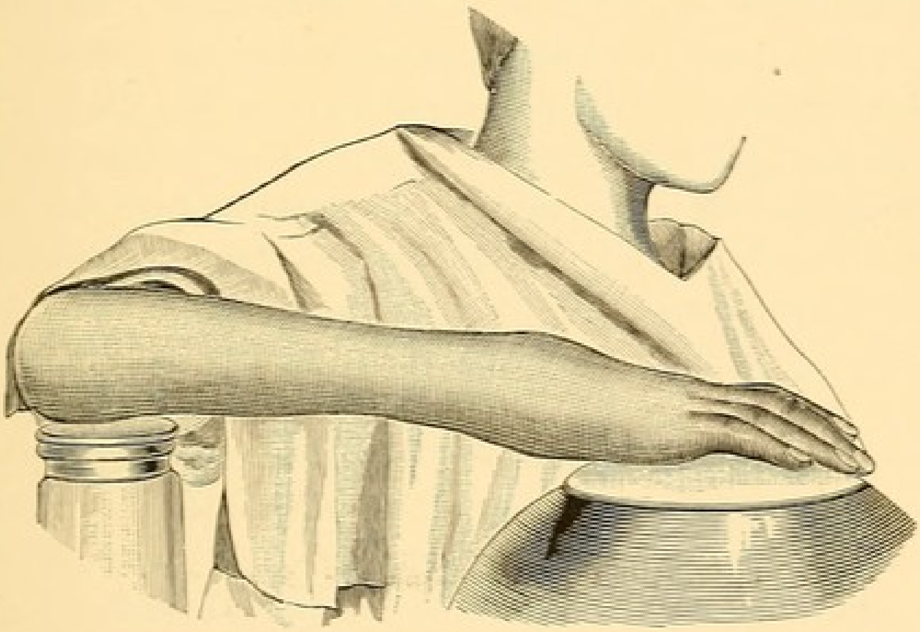

Fig. 48.—Disease of the carpus.

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 became tapering, glistening, and somewhat purplish. When suppuration occurs the sinuses are generally formed on the back of the wrist. 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, 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.

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 tubercular 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 now-a-days, 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. 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 cauterise it thoroughly with the thermocautery, and to fill the wound with iodoform and glycerine. Afterwards the hand is put on the splint designed by Sir Joseph 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.

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 attached. I shall refer shortly to some of these.

1. *Fingers and Toes.*—Tubercular 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. Tubercular osteomyelitis of the shaft of one of these bones in children usually gives rise to the typical appearance of strumous dactylitis or spina ventosa (*see* Fig. 49), where there is a fusiform swelling of the bone due, as shown in Fig. 22, 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 without leaving any trace behind. Sometimes, however, the epiphysial line becomes destroyed or ossified, and a shortened condition of the bone remains. 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 just remarked, in the majority of cases a cure is obtained.

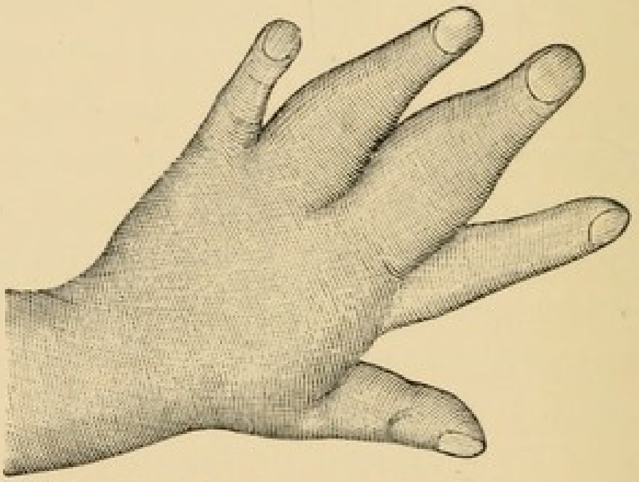

Fig. 49.—Strumous dactylitis.

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 tubercular periostitis is more common, or if the medulla is primarily affected, it is often associated with the necrotic form (*see* Fig. 21). 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 tubercular disease. Thus, in Billroth and Menzel's table of

1996 cases of *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 cases. The ribs most usually affected are the fourth to the eighth, generally about their middle. Tubercular disease of the ribs is essentially an affection of adults, and seldom occurs in children, and it may occur either primarily in 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 tubercular pleurisy especially where an incision has been made, or suppurating tubercular axillary glands; it is not uncommonly associated with phthisis. Here, however, we have only to do with the cases where the disease begins in connection 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 tubercular 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. 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. Much more rarely the disease begins in the interior of the bone, expanding it, and giving rise, in a slight degree, to the appearance of spina ventosa, referred to in connection with the fingers.

The early symptoms of tubercular 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 especially inside 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, even pointing in the loin or running down in the sheath of the psoas muscle, and forming a typical psoas abscess. The disease not uncommonly affects more than one rib or part of a rib.

The treatment of tubercular disease of a rib, once an abscess has formed, should be thorough, and if thorough, will lead to a speedy cure. The treatment consists of 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 (a ⊤-shaped incision being generally necessary,) the abscess is thoroughly isolated up to its point of attachment to the rib. It is then cut away, a strong stream of weak sublimate solution playing over the part at the time, so as to wash away all the pus from the wound. The extent of the affected bone is then defined, the rib divided beyond it on each side, and the whole diseased part removed. There then remains a mass of tubercular tissue, corresponding with the deeper surface of the rib, which must be very thoroughly scraped away; this is easily done. The wound, having been well washed out, 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 unfrequently the seat of tubercular 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 posterior surface, where the abscess formed in connection with it spreads upwards and downwards behind the bone before it makes its way forwards between the ribs or upwards into the neck, and infects the periosteum and the surface of the bone along its course. Deposits in the bone are also not uncommon, leading either to necrosis of portions, or to the formation of a cavity containing soft caseous material.

Tubercular disease of the sternum begins usually with a little aching in the bone, succeeding which is some swelling where 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 tubercular 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 localised empyema, but careful examination of the chest and of the bone will soon reveal the true condition.

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 tubercular 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 tubercular 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 importance from its situation. The following is a description of the disease taken from the few cases published, and two 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 dulness, 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 tubercular material, often undergoing caseation.

As a rule in these cases, there are symptoms of tubercular disease in the other bones of the body, and apparently this affection only occurs in the course of very severe tubercular 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 tubercular sequestra have already been fully described.

As these cases are not recognised 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 medulla, 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.*—Tubercular disease of the mastoid process is very common in connection 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 would lead us quite away from the objects of this book. The chief complication related to the tubercular nature of the disease is the occurrence of tubercular glands in the neck, which are very common, and where they exist, along with discharge from the middle ear, the mastoid antrum and process ought, I think, to be opened up without delay and the diseased bone removed and treated on the same lines as elsewhere.

8. *Bones of the face.*—Tubercular 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. 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 elsewhere.

In some cases of scrofulous ozæna the tubercular 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 tubercular 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 cauterisation repeated on any appearance of fresh disease.

CHAPTER XXIII.

DISEASE OF THE SPINAL COLUMN.

TUBERCULAR disease of the vertebræ is the most common tubercular 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 tubercular 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 tubercular. 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 tubercular 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 tubercular disease. Among my out-patient cases I had 4 which were only a few months old when they came under observation, 3 were a year old, 8 were 2 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 stating that the first lumbar is 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 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. 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, 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 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. When it reaches the intervertebral cartilages it spreads inwards along them and destroys them. This leads to a gradual curvature of the spine, which 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 tubercular 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-bye the aching pain in the back becomes more marked, especially on running, jumping, going down stairs, &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-bye 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, and ending ultimately in complete paraplegia. At the same time abscess, usually psoas or lumbar, appears, and by-and-bye bursts and leaves a discharging sinus. Ultimately the patient dies of exhaustion from the prolonged discharge, of phthisis, of tubercular 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 down stairs, &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 tubercular 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 tubercular 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 atloaxoid 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-bye, as the intervertebral cartilages are destroyed, the back becomes, in the first instance, flattened (where there is naturally a curve forwards), 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. Here, as a rule, the curvature is not nearly so extensive as in the former case, but it is 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 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 tubercular disease elsewhere, the formation of a chronic abscess is a frequent accompaniment of tubercular 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 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 the 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 the 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 connection 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 connection 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. 50). 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

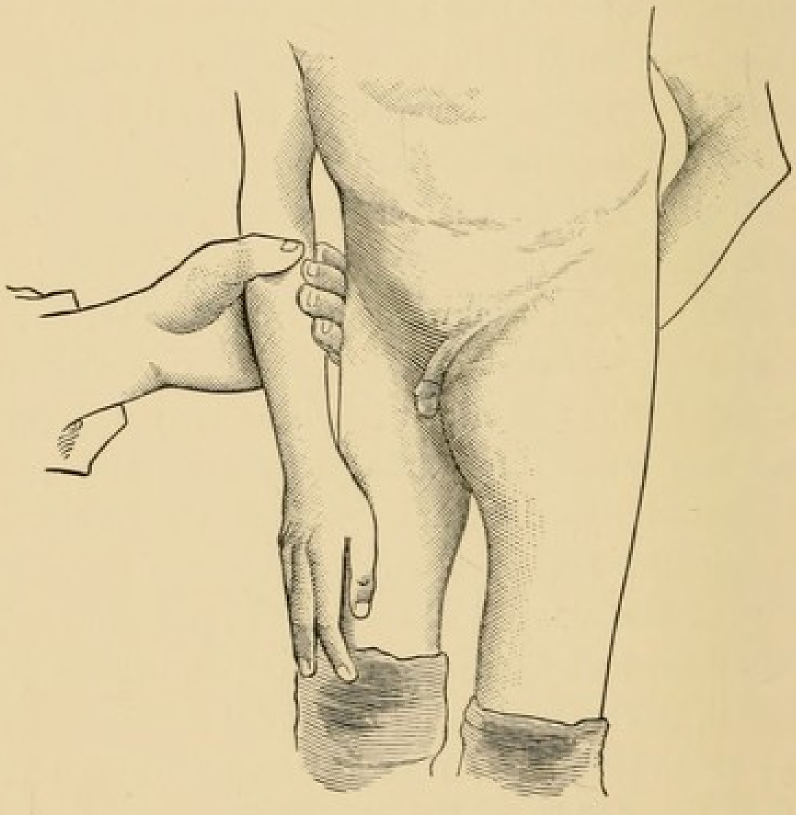

FIG. 50.—Psoas abscess pointing at the upper and inner part of the left thigh, in connection with spinal disease. (After BRADFORD and LOVETT.)

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 very 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 these 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 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. Formerly it was supposed that in an acute curvature the cord might be stretched over the bodies of the vertebræ, and pressed upon in that way, but though it is possible that a spicule of bone may press on the cord, pressure by the merely curved vertebræ does not 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. This pachymeningitis is greatest at the anterior surface, and seldom surrounds and constricts the cord, and, in the first instance, it is generally non-tubercular. As a result, 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, vasomotor 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 spasms, and subsequently contractures, 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 atloaxoid articulations, 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 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 suboccipital 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.

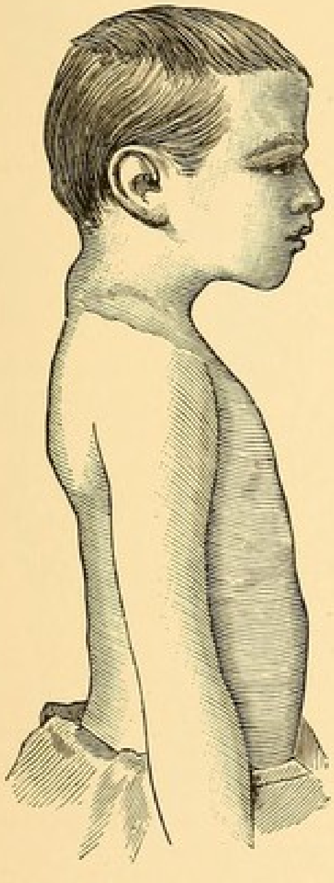

FIG. 51.—Position of the head in disease of the cervical spine. (After BRADFORD and LOVETT.)

At the same time, grave symptoms are apt to occur 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 paralysis; 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. 51.) 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

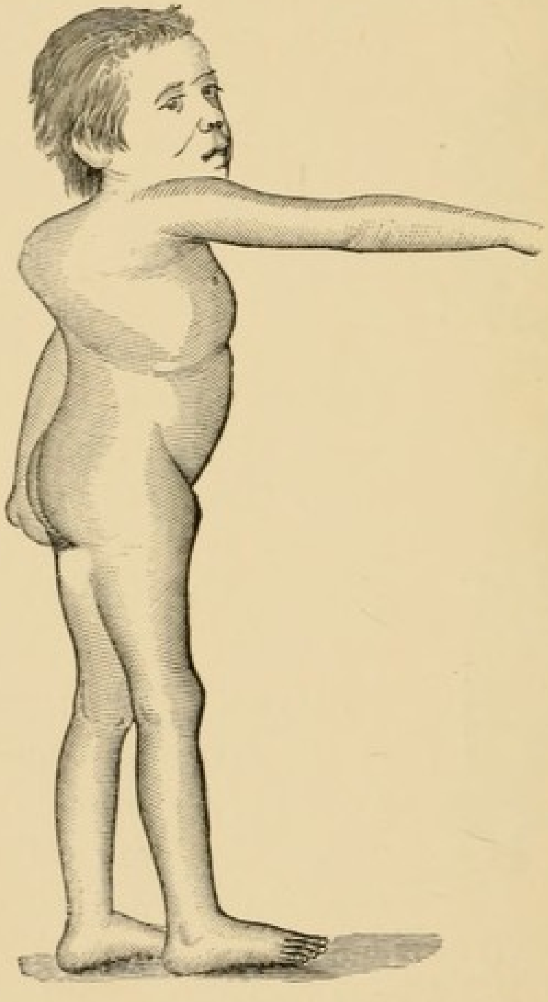

FIG. 52.—Disease in the mid-dorsal region with psoas abscess.

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.

(*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. 52). 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. 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.

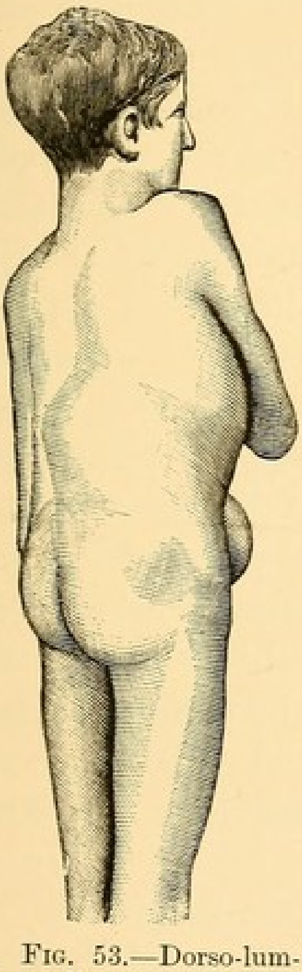

FIG. 53.—Dorso-lumbar disease with iliac abscess.

(*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 tubercular 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 tubercular 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 tubercular 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 lateral 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 from raising the spine. The prone position is 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. The bed should be a hair mattress 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, 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 lbs. 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 lbs. is as much as can be comfortably borne at the head, but in adults a little more 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 abscess kept in bed and at rest for a long time, even for years, without the general health suffering in any way.

The ideal treatment of spinal disease, then, is absolute fixation of the spine in the recumbent posture, with the use of extension to the head and feet, and, if the patient will submit to it and it can be carried out, this treatment 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. As regards the various forms of spinal apparatus, 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

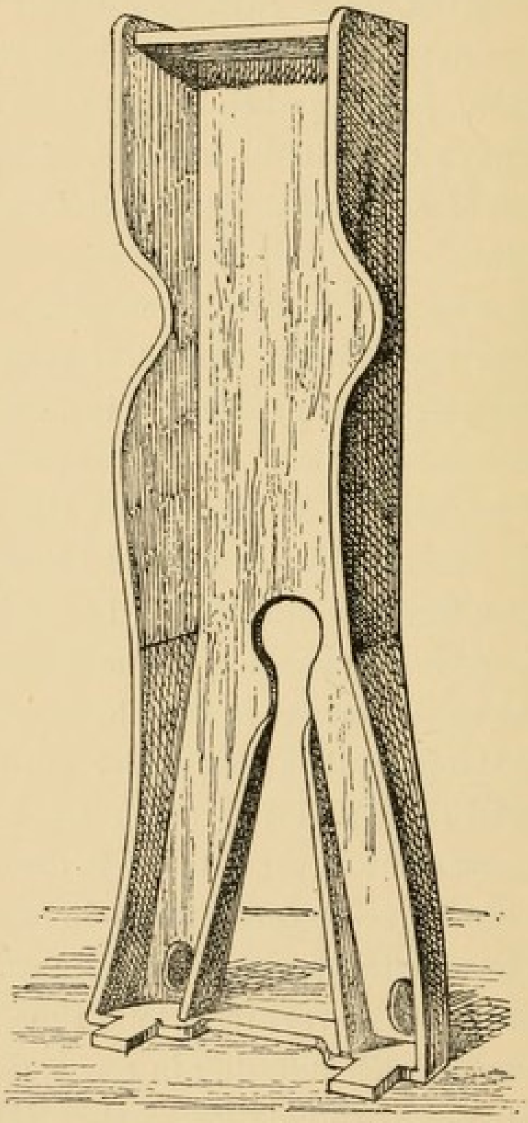

FIG. 54.—Phelps's box for spinal disease.

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. 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 pads so arranged as to prevent undue pressure on the curve. Opposite the buttocks the wood is hollowed out so as to permit 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. 54). In this apparatus the 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 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 for at least two or three years. The whole apparatus with mattresses costs from 15s. to 20s. (Fig. 55).

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

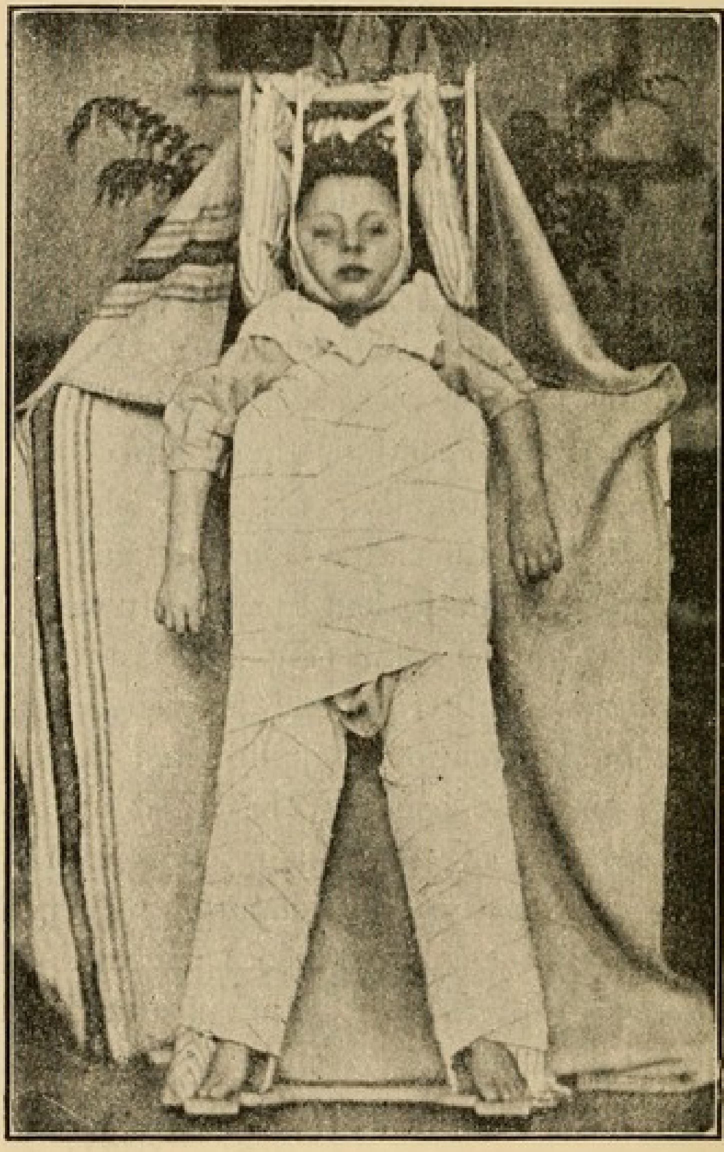

Fig. 55.—Child fixed in Phelps's box.

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 organised and to some extent ossified, and in the adult the pelvis is broad and forms a fairly efficient basis of support. Where the disease is in the lumbar or dorso-lumbar regions, and is not extensive, Sayre's plaster of Paris jacket, put on while the patient is suspended, acts very well, or in cases where a removable apparatus is desired, a poroplastic jacket may prove a fairly efficient substitute.

The idea that these corsets will act by lifting up the thorax from the support on the pelvis is an erroneous one, they really act by preventing the upper part of the spine from falling forwards, and this is much more 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. 56).

I may quote the description of Taylor's brace from Bradford & 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

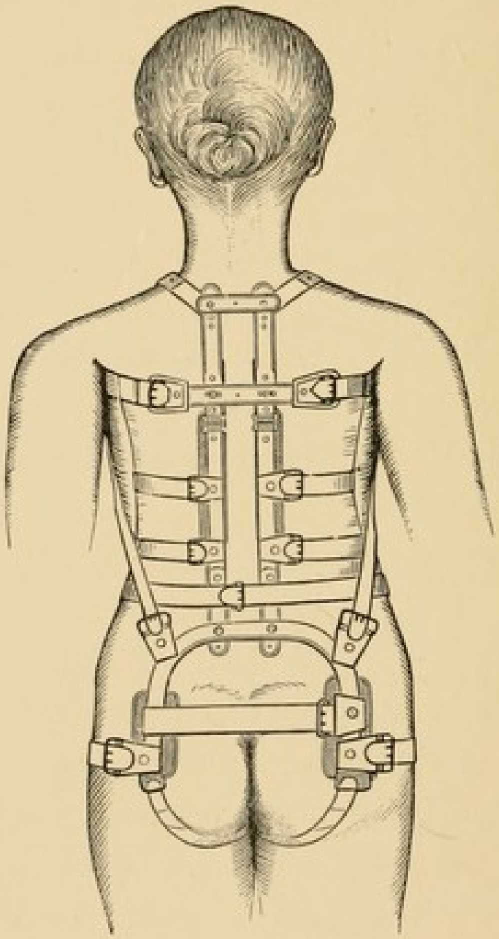

FIG. 56.—Taylor's brace applied. (After BRADFORD and LOVETT.)

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 where 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.

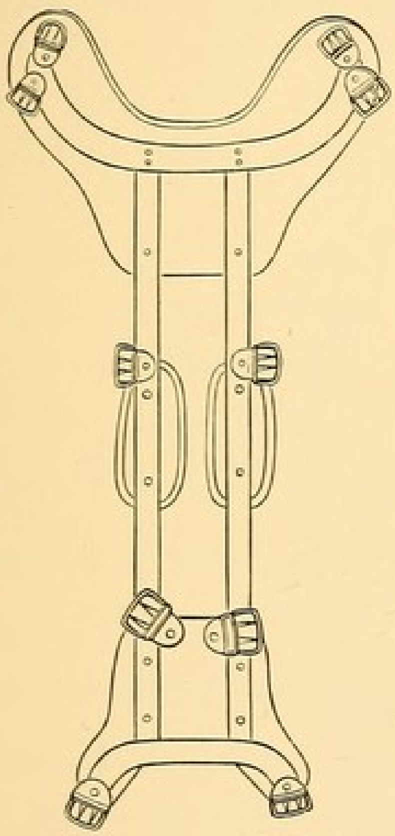

Fig. 57. — Taylor's brace. (After Bradford and Lovett.)

"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. 57).

"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. 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

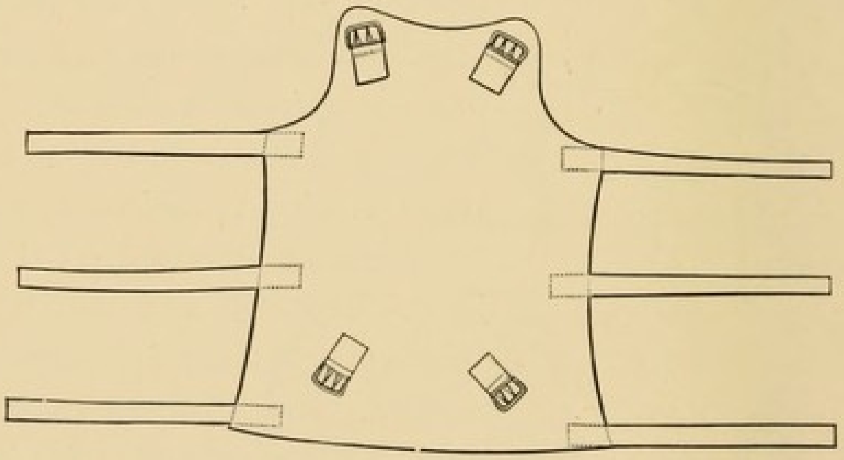

FIG. 58.—Apron for Taylor's brace. (After BRADFORD and LOVETT.)

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. 58).

"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. 59).

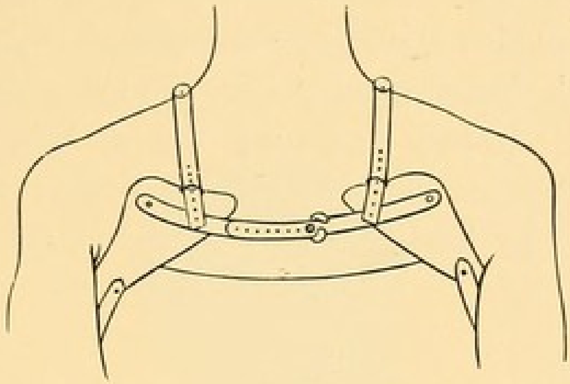

FIG. 59.—Taylor's chest piece. (After BRADFORD and LOVETT.)

"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, 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.

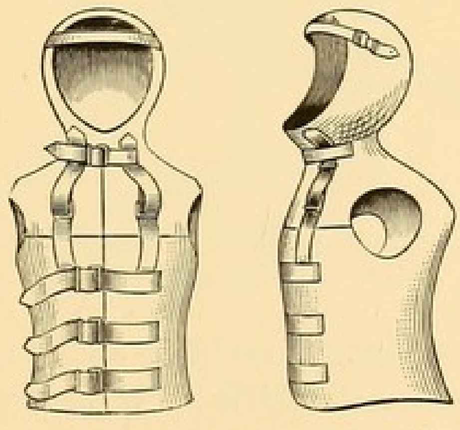

FIG. 60.—Cuirass for cervical or upper dorsal disease. (After BRADFORD and LOVETT.)

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 forms 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. 60). By having a hold of the pelvis flexion of the

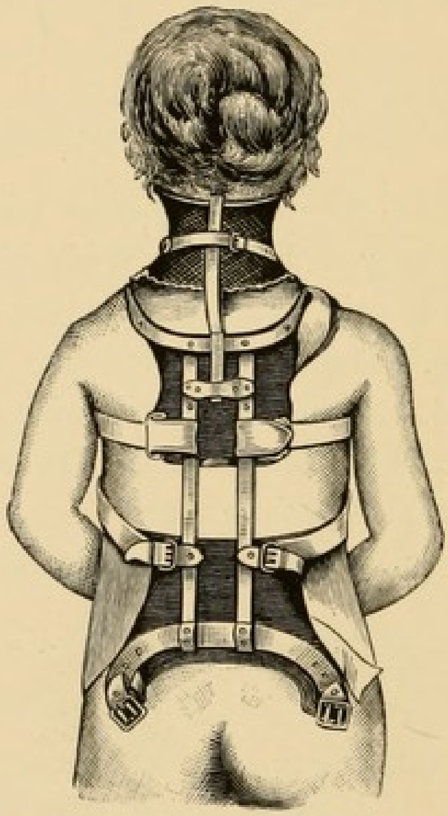

FIG. 61.—Another form of neck support.
(After BRADFORD and LOVETT.)

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 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. 61 and 62). There is a great number of supports of this kind for cervical disease, which need not, however, be detailed here (Fig. 63).

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

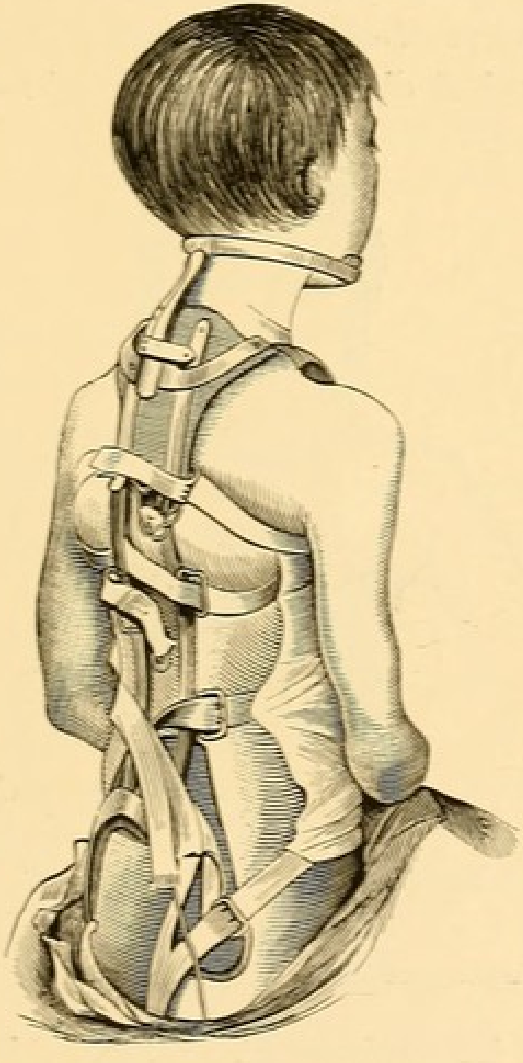

FIG. 62.—Taylor's brace with head support. (After BRADFORD and LOVETT.)

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. 147), and since then I have had several similar cases. On an average, 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

FIG. 63.—Ring support for head. (After BRADFORD and LOVETT.)

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 slit 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 connection with spinal disease. I have already (p. 176 *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. 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 secondly, 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 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 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 connection 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, or 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 no pain at articulation, and no apparent lengthening of the limb), and from 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.

INDEX.

INDEX.

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