EXTRACTS FROM
THREE LECTURES
ON
TUBERCULAR DISEASES OF BONES AND
JOINTS.

Delivered at the Royal College of Surgeons of England.¹

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LECTURE I.

MR. PRESIDENT,—It is with considerable diffidence that I venture to bring forward the subject of tubercular diseases of bones and joints on the present occasion, seeing that excellent lectures on this matter have been recently delivered here by Mr. Barker and Mr. Howard Marsh. These gentlemen have, however, mainly dealt with the treatment of these affections, while I propose only to speak of their morbid anatomy; and thus, while I can hardly help my remarks overlapping theirs to a slight extent, my lectures may be regarded in the main as an expansion and completion of theirs. A thorough knowledge of the exact 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 are coming 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. The main object, therefore, which I shall have in view will be to show the distribution of the disease, and its relation to the surrounding parts; and although a good deal of what I show will no doubt be known to many of those present, yet even well-known facts are interesting when seen from a fresh point of view.

One word as to the specimens shown. The information obtained by the naked-eye examination of fresh or preserved specimens, and the microscopical investigation of small portions of the affected part selected for the purpose is necessarily incomplete and uncertain, especially when, as in this case, the limits of the disease are ill-defined, and more than one morbid process is going on side by side, for what one sees by the naked eye is only the gross changes, while the portions selected for microscopical examination may or may not be those best suited for affording information as to the mode of commencement and progress of the disease. The only satisfactory way of studying the morbid anatomy of these, and, indeed, of most diseases, is by preparing complete sections of the whole of the affected area which shall be suitable both for naked-eye and for microscopical examination, and this principle has been applied pretty extensively, more especially in Edinburgh in the case of diseases of various organs. In the case of bones and joints it is by no means easy to obtain perfect thin sections on account of the various processes which are necessary in their preparation; but, though somewhat ragged, it will, I think, be evident before these lectures are concluded that sections prepared in this way teach much more than can be learned by other methods. While I was working at this subject I very fortunately made the acquaintance of Mr. Andrew Pringle, whose name is well known in the photographic world, and who has lately taken up photomicrography. Mr. Pringle has photographed a large number of these sections for me, and has kindly come here to show these photographs on the screen, and whatever interest there may be in these lectures will be largely due to the opportunity which I have of showing the beautiful work done by Mr. Pringle. I do not intend, for I have not time, to go fully into

the various points in the morbid anatomy of these diseases. I shall only attempt to give a sketch of the matter, and shall mainly confine myself to those points which I am able to illustrate by photographs.

Before entering on the special pathology of tubercular diseases of bones and joints, I must discuss 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; and it is necessary that I should go somewhat in detail into these points, in order that you may understand exactly what I mean when I speak of tubercles and tubercular tissue as being present in a part.

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, entirely erroneous, 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 and 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, namely, 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" (Fig. 2) 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 certain dyes such as those which I have used in this research, namely, Ehrlich's hæmatoxylin, acid rubin and orange, and examined under a low power we generally see that the nodules consist of two parts—a central portion, the larger, faintly stained (with the above dyes of an orange tint), and an external part much narrower and usually more deeply stained. The central portion is the essential part of the tubercle, the external part is merely an adventitious wall. This wall may be either mainly cellular or mainly fibrous. Perhaps in most cases the wall, as in the specimen before us (Fig. 2), is composed of a mass of small, round, deeply stained nuclei, the nuclei of leucocytes which form a barrier round the tubercle. In other cases there is a considerable amount of fibrous tissue in the wall; in some cases, 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 vascular 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, roundish, deeply-stained nuclei, but these cells are few in number as compared with the epithelioid cells, and are frequently entirely absent. The nuclei of the epithelioid cells are large, oval or elongated, distinctly granular, and more faintly stained than those of the external wall. These cells have generally 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 excentrically, 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. The 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 more than one is present, and we also 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 the form of one or more broad protoplasmic bands, in other cases in the form of a number of finer threads. These processes, when present, may either join the protoplasm of the epithelioid cells or

¹ These lectures were illustrated by numerous lantern slides prepared from photomicrographs made by Mr. Andrew Pringle, and as of course only very few of those specimens can be reproduced here, and these much reduced in size, only an abstract of the lectures can be given. I have however, as far as possible, left those portions of the lectures which I publish in the form in which they were delivered. [The publication of the figures will commence in the next number.]

ramify among these cells, often extending as far as the wall. [Specimens were shown illustrating these various points.]

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 especial 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, probably chiefly, diffraction appearances due to bad illumination of the specimens, causing the outlines of the cells, and possibly the small amount of intercellular substance to appear as a reticulum.

I would, therefore, describe a tubercle histologically as a microscopical nodule, generally round or oval in shape, composed of a central portion made up of epithelioid cells, and sometimes giant cells, surrounded by a layer 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, namely, granulation tissue or young fibrous tissue.

In the cellular form we find a mass of cells like that of granulation tissue, among which are numerous epithelioid and frequently giant cells. [In Fig. 3 this condition is present, though it cannot be well reproduced, namely, a mass of granulation cells with epithelioid and giant cells interspersed among them, the whole undergoing caseation at the edge.] 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 certain cases of caries, in caries sicca, strumous dactylitis, etc., and in it 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 type, 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, etc., 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 constantly present, but they also bear a constant relation to the tubercular virus. 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 only few in number they may be found only in the giant cells. In giant cells with marginal nuclei the bacilli frequently form a ring around the margin lying among the nuclei.

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.

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 synovial membrane 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 epithelioid cells, etc. 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 would, however, lead us away from our subject, and I shall therefore not go into the matter, but as I have several specimens which demonstrate remarkably well the vascular origin of tubercles I may show them before leaving this point, it being always understood that this is probably only one out of several sources of origin of these structures. [Specimens were then shown illustrating the various stages from commencing hypertrophy of the endothelium to the presence of a collection of giant and epithelioid cells, in fact, a tubercle, in a dilated portion of a vessel. Also specimens where the development of the epithelioid cells had gone on probably in the deeper layers of the intima, and where the still patent canal of the blood vessel was seen in the interior of the tubercle; and again others showing sclerosis of blood vessels in tubercular disease in connection with, and sometimes in the interior of, tubercles.]

As I said before, it seems to me that most of those tubercles which show a well marked fibrous wall have been developed in connection with blood vessels, and that the fibrous walls are often the remains of the original vessel wall. Even in those cases where no definite fibrous wall is present the point of origin may nevertheless be a capillary blood vessel. That tubercles should commence in connection with the endothelium of blood vessels is not at all surprising when we remember the results of Wyssokowitch's experiments on the fate of non-pathogenic organisms in the blood, which showed that when organisms and their spores were injected into the blood stream they rapidly disappeared from the circulating blood, and one of the most common seats of their deposit was the endothelium of blood vessels.

The life-history of the tubercle is an important element in its diagnosis, and there are two points in its life-history to which I must shortly refer, namely—(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 when retrogressive changes occur. We may divide these changes into three great classes, namely—(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 ending in some degree of calcification.

Simple atrophy of the cells of the tubercles accompanied, no doubt, by more or less fatty degeneration, 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 entirely, and that they do not all become encapsuled or calcified, as seems to be the belief of many writers.

Perhaps the most frequent change which occurs is caseation of the tubercle, and where the tubercles are very numerous, or where 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. [Specimens were shown illustrating various points in connection with caseous degeneration of tubercles, and illustrating the fact that the body of the giant cell is often one of the last structures to disappear.]

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 after many years. [This was shown in a section of the lower end of the humerus from a case of disease of the elbow-joint which had been quiescent for fully ten 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 deposit elsewhere. The tubercular process is also infective from man to man, from man to the lower animals, and from the lower animals to man. Mr. Barker has already mentioned a considerable number of the published cases of infection of wounds in man with tubercular material, 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. We shall see ample evidence of this in the following specimens, and I need not therefore enlarge further on this matter at present.

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 cellular elements 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, etc., 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. Where 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 beyond the area of the parasite, while the constant tendency to multiplication is a characteristic of the tubercular process. I attach no importance to the demonstration

of tubercle bacilli as a means of diagnosing these bone and joint diseases. It would take up too much time to give what I believe to be the explanation of the apparently small numbers of tubercle bacilli in these joint affections; but I consider the above-mentioned histological characteristics 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 tuberculouses, 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, but I cannot take up time in discussing them. I may, however, 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; 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 manner 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."

(To be continued.)

A DISCUSSION

ON

VACCINATION ERUPTIONS.

In the Section of Dermatology at the Annual Meeting of the British Medical Association, held in Birmingham, July, 1890.

I.—MALCOLM MORRIS, F.R.C.S. ED.,

Surgeon to the Skin Department at St. Mary's Hospital.

It is well that a question of such importance as vaccination eruptions should be discussed at the annual meeting of the British Medical Association, and it is particularly fitting that it should take place in this Section, as we have the good fortune to be presided over by one who has done so much to throw light into the dark corners of pathology. That we shall have the benefit of Mr. Hutchinson's great experience will do much to counteract the imperfections of the opening paper.

In order to remove any doubt that may exist as to my own opinion about vaccination, I may say that I am a firm believer in its value as the only real preventive of small-pox, and it is because I hold this view that I think every effort should be made to study the nature of the eruptions that are sometimes associated with vaccinia.

It is only by the knowledge gained from accurate diagnosis that we can ever hope to arrive at a position enabling us to speak authoritatively on the matter. So varied are the phenomena and so complex the questions involved that it is impossible to attempt to do justice to the whole subject in a short introductory paper. I would rather try to bring before you certain well-defined points for discussion, leaving out for the present many interesting collateral questions. The extreme paucity of the literature of this country may be ascribed, on the one hand, to a fear that any full account of unusual appearances may be detrimental to vaccination as a system, and, on the other hand, to the fact that the eruptions are fortunately rare. In answer, I would urge that it is one's duty to record, as far as possible, every deviation from what may be called the normal course.

Without further introduction I pass to the question of the