ON
NECROSIS WITHOUT SUPPURATION:

WITH
A CASE OF INTRA-OSSEOUS NECROSIS OF THE FEMUR
WITHOUT SUPPURATION, FOR WHICH AMPUTATION
AT THE HIP-JOINT WAS PERFORMED.

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(Received January 10th—Read February 27th, 1877.)

IN August, 1872, a man (J. B—), æt. 20, was admitted under my care, into St. Bartholomew's Hospital, at the request of my friend, Mr. Norton, whose patient he had been previously at the Holborn Union Infirmary.

The patient gave the following history:—He was quite well until about ten weeks before his admission into St. Bartholomew's Hospital, when he began to suffer from deep-seated pain, soon followed by slight swelling, in the left thigh. Both pain and swelling gradually increased, the pain being especially severe at night; and, shortly afterwards, being unable to work, he went into the Holborn Union.

For some time no fresh symptom appeared, and the swelling of the thigh, although increasing, assumed no

very definite character. About six weeks, however, after the beginning of his illness, as the patient was walking across the ward his leg suddenly gave way under him, and he fell, and on subsequent examination it was found that the left leg was much shortened, evidently in consequence of a fracture of the femur in its middle third. Some days afterwards I saw the case for the first time with Mr. Norton and Mr. Shepard, and the patient was transferred to St. Bartholomew's Hospital.

At this time there were the following symptoms:—The left lower limb, apparently shorter than its fellow by an inch or two, lay helplessly on its outer side, with the leg slightly flexed. The thigh was much swollen, and on careful manipulation, the swelling was found to be due to a tumour of the femur, hard and incompressible, which occupied the whole of the middle third, and extended also *below* to within a short distance from the knee-joint, and *above* to the trochanters. In its middle third, where the swelling was greatest, the femur looked deformed, and the existence of a fracture at this part was plain, although no distinct crepitus could be detected.

The integuments of the thigh were quite natural, and no abnormal condition of the soft parts between them and the tumour of the bone could be discovered. There was neither redness, nor œdema, nor elasticity as from confined fluid, but only the apparently unquestionable presence of a solid tumour involving nearly the whole femur, which at its thickest part had been fractured, and had thus led to shortening and deformity.

Great pain was caused by all manipulation, and still greater by any attempt to lift the limb.

The patient was exhausted and distressed from pain and sleeplessness, and he was said to have lost much flesh. His temperature was below 100° F. The femoral glands were not enlarged.

The case seemed, without any doubt, to be one of malignant tumour of the femur, which had become the seat of so-called spontaneous fracture, and with this

opinion my colleagues, several of whom kindly examined the case with me in consultation, entirely agreed. We were also unanimous in the belief that the best mode of relieving the patient lay in amputation at the hip-joint.

The patient readily assented, and as nothing appeared on a further general examination to forbid the procedure, I performed the operation by the commonly adopted method of cutting anterior and posterior flaps after transfixion of the limb.

Nothing unusual, or calling for special remark, occurred in the course of the operation. With the help of Lister's abdominal tourniquet there was less difficulty than I had anticipated in restraining the hæmorrhage, and altogether only a moderate amount of blood was lost. Space being allowed for drainage, the flaps, having been washed with a weak carbolic acid lotion, were united by silver sutures, and the wound was dressed in the ordinary way with carbolised oiled lint and cotton-wool.

For the first two days after the operation the patient was somewhat prostrate, but this was sufficiently accounted for by frequent vomiting, doubtless due to the chloroform.

On the fifth day after the operation the wound was suppurating freely. The temperature was 104.4° F. Pulse 120.

On the eighth day after the operation the temperature was 100.2° F., and from this date it gradually fell to the normal point. The wound began soon to heal rapidly, and excepting one part, at which a sinus remained and discharged freely for several weeks, the healing proceeded without interruption, and the patient left the hospital well.

On dissecting the limb, the condition of the integuments and muscles was found to be what had been previously anticipated. There was no inflammatory condition evident, no abscess or sinus, and not a drop of pus. On making, however, a longitudinal section of the femur and of the condensed tissue which formed its immediate covering, a very unexpected appearance presented itself. It was

plain that the disease from which the patient had suffered was necrosis of nearly the whole shaft of the bone. Where the femur had been fractured, the upper and lower fragments formed an obtuse angle. The broken surfaces were covered towards the inner aspect of the limb by fibrous tissue, forming a kind of false joint, but at the outer part the fracture was very irregular, and here the end of the sequestrum, rough and bare, projected from the upper fragment into a corresponding depression in the lower. The fracture was surrounded also by fibrous tissue in which a quantity of new bone had been deposited, so as to form a bossed and somewhat bulky callus. The bond of connection was, however, only feeble, and the callus was less apparent than it would otherwise have been, on account of its continuity with the new bone which had been deposited in and beneath the periosteum throughout the whole length of the shaft (Plate X, fig. 1).¹

The upper half of the femur, at its posterior aspect, had not perished with the rest of the shaft, but new bone had been deposited on this part, or rather, was growing from it and continuous with it.

As may be now seen in the specimen the dead bone is not at all points loosened from its connections. Near the trochanters it is still continuous with the cancellous tissue of the interior, and at the lower end of the bone, near the condyles, the same connection is observable. Between these two points, moreover, the medullary canal is encroached upon, more at the lower than the upper part, by new bone, which has been formed within the sequestrum, and which is continuous with the cancellous bone of the articular extremities and of the immediately adjacent portion of the shaft.

On the outer aspect of the sequestrum, dense and hard new bone has been everywhere laid down by the periosteum, so as to form a moderately thick sheath, which closely envelopes the dead bone; so closely, indeed, that

¹ One half of the preparation is in the Museum of St. Bartholomew's Hospital, and the other in the Museum of the Royal College of Surgeons.

at some points it is difficult to make out any line of separation.

At other parts the space between the new and the dead bone is occupied by a thin but tough membrane, representing, I believe, the innermost layer of the periosteum.

Where the shaft has not perished in its whole thickness, the new bone and the old are continuous, so that, one might say, at these points there is *hypertrophy* instead of *necrosis*.

The periosteal sheath of new bone extends from just above the cartilage of the condyles to the trochanters, and around the whole circumference of the bone, excepting one or two small openings at which the dead bone lies exposed. But these openings look rather as if they were made accidentally after the removal of the limb than like cloacæ formed during life.

The chief interest of this case lies in the absence of suppuration, and the following questions naturally arise with respect to it:—Is the absence of suppuration in this particular instance exceptional? If it be so, what are the causes of the exception? If the freedom from suppuration be not exceptional how can the fact of its being usually unnoticed be accounted for?

The reply to these questions may be best given, I venture to think, in the following manner:

(1.) The case is one in which necrosis was the result of chronic inflammation of the bone, with incipient hypertrophy and sclerosis.

(2.) In such cases the necrosis presents many features which make it differ remarkably from the more ordinary kinds of necrosis, and especially from those in which the death of the bone has been caused by acute subperiosteal effusion, or by conditions which quickly lead to it.

(3.) In cases of necrosis occurring in the course of chronic osteitis, suppuration is not, as a rule, an early symptom.

(4.) The supposed rarity of the existence of necrosis

without suppuration may be due to the fact that opportunities of examining such cases, by section of the bone at an early stage, before suppuration has occurred, must be exceedingly rare, and, as in the present instance, the result of accident.

I will endeavour, as briefly as possible, to illustrate the preceding propositions, and state the grounds on which they rest.

I. *What are the special features which characterise necrosis occurring in the course of chronic osteitis?*

Time will not permit me to consider, in any detail, the pathology of inflammation of bone, but I may remark, in passing, that a careful examination of many specimens has led me to the belief that in the accounts usually given of chronic osteitis of a shaft, accompanied by hypertrophy and sclerosis, too much stress is laid upon the supposed *expansion* of the walls of the bone. Such expansion as exists is, I believe, only a textural expansion of Haversian canals, &c., by more or less absorption of their walls, without any simultaneous increase by any such process of the *girth* of the bone. The *hypertrophied* condition is rather one of overgrowth by the laying on of new bone both without and within, *i. e.* by both the periosteum and endosteum.

In most cases, probably, the hypertrophy thus produced ends as an hypertrophy, the new layers of bone becoming one with the original shaft. In other cases, however, the blood-supply of the shaft is gradually cut off, more or less, in the process of formation of the new layers; a process which may be readily conceived as very likely to starve a structure, such as the compact tissue of the shaft of a bone, which depends altogether for its supplies upon neighbouring tissues, viz. endosteum, periosteum, and the adjacent cancellous structure of the articular extremities. And especially may this be expected at a time at which

the blood-vessels of its own Haversian canals are more or less compressed by the products of inflammation.

The conditions which exist in a typical case of necrosis following inflammatory hypertrophy are thus characterised. (a) The necrosed bone bears evidence of having undergone certain structural changes before death. (b) It is very imperfectly separated from its connections. (c) It is more or less enclosed by new bone which has been produced by both the periosteum and endosteum. (d) The new bone is large, dense, and on its outer surface, stalactitic. (e) The conditions characteristic of complete necrosis, so well marked in one part of the bone, are replaced in other parts by conditions equally characteristic of chronic ostitis with hypertrophy and sclerosis; while, connecting the two, there is an intermediate or neutral territory, in which it is difficult to say whether the term necrosis or chronic ostitis is the more appropriate.

These characters are admirably shown in a specimen of necrosed femur from the Museum of St. Bartholomew's Hospital.¹ I have chosen it as an illustrative example, in preference to the recent specimen just described, on account of its greater age and, therefore, more marked characters; but the disease is the same in both (Plate X, fig. 2).

Perforated at various points by large cloacæ, it is plain that extensive suppuration must have occurred in connection with the necrosis; and, indeed, at first sight, the specimen seems a typical example of the ordinary cases of acute necrosis of the whole shaft of a bone. On further examination, however, it is evident that the specimen is one of necrosis, occurring in the course of chronic ostitis. The sequestrum is that of a bone which, before death, had undergone some of the structural changes characteristic of chronic inflammation. Its section is dense and almost ivory-like, while its outer and, to a less extent, its inner surface is rugged from irregular absorption and deposition of bone. Although of long standing, the sequestrum is in most parts immovable, and for various reasons. In the

¹ A. 95, Catalogue of Museum, St. Bartholomew's Hospital.

first place it is still in direct continuity with that portion of the shaft which has not perished, and there is no indication of even the commencement of a line of demarcation. Indeed, the only distinguishing mark is the appearance of the dead bone, which is whiter and smoother than the apparently living. The sequestrum is also riveted by new cancellous bone, which extends into its medullary canal for some little distance from the cancellous bone of the articular extremities. Here and there, moreover, through a 'break' in the sequestrum, *i. e.*, where the original shaft has not perished, the new bone without and within has become continuous, so as still further to lock the dead bone.

The periosteal sheath of new bone is separated from the necrosed part of the shaft by the usual groove, but as the sequestrum is continuous with the portion of the shaft which has not perished, so its sheath of new bone is continuous with that which is not so much a *sheath* as an *outgrowth* from the latter. In other words, the new periosteal bone (extending from one end of the shaft to the other), the section of the substance of which presents the same appearance in all parts, might be called a sheath at one part, and an outgrowth from the shaft at another. And inasmuch as there is scarcely any other distinction between the living and dead portions of the shaft it would be best, as a mere expression of the fact, to say, "where the new bone is separated by a groove from the original shaft the latter is dead; and where it is continuous with it, the shaft is hypertrophied."

It is worth noting that in this, as in the recent specimen, the upper and back part of the shaft of the bone is sclerosed and much enlarged, but not dead; while, suggesting a possible reason for this, there lies exposed, as it happens, by the section, the canal for a large nutrient artery, the calibre of which has not been interfered with. In both specimens, too, the necrosis is most extensive in the middle of the shaft, extending to the trochanter only along the anterior wall; while, on tracing the disease in

the opposite direction, it is found that, as the condyles are approached, the whole circumference of the bone escapes, and is hypertrophied merely.

On the outside of the specimen are the usual large stalactitic outgrowths of bone which form so characteristic a feature of chronic inflammatory hypertrophy, whether accompanied or not by necrosis within.

The contrast is great between the appearances which characterise this specimen and those which are observable in the more common instances of necrosis of a whole shaft. Take, for comparison, a case of necrosis which has been caused or at least accompanied by acute sub-periosteal effusion,—a case familiar to all. The question at once occurs to the mind, What is it which constitutes the difference? Is the distinction to be found in the *nature* of the disease, or in its *cause*? Or, is it in the *age* at which the disease occurs? for, it must be remembered, the sudden death of the whole shaft of a bone, by or with separation of its periosteum, is rarely or never seen, except in the young. I am disposed to believe that the age at which the two kinds of necrosis, here contrasted, takes place, offers the best solution of the difficulty, although it does not exclude others. A moment's consideration of the different anatomical conditions which exist in young and adult bones, respectively, will suffice to illustrate this. In a young bone there is but slight adhesion of its periosteum, and this is, therefore, readily stripped off by effusion of lymph or pus beneath. The shaft of such a bone, moreover, depends for its blood on two sources only of supply, viz. the periosteal vessels, and the nutrient arteries, both of which, by detachment of the periosteum, may be interfered with, and that completely; the epiphyseal lines of cartilage forming impassable boundaries, so far as anastomosis of blood-vessels is concerned, in a time of disease. Even if, as some suppose, the effusion beneath the periosteum be not the first condition which affects the nutrition of the bone, its occurrence at an early period of

the disease mostly ensures necrosis, when something short of sudden death may have otherwise ensued.

Hence it is, that acute necrosis of a whole shaft is most typically exemplified in the young. The supply of blood is quickly and completely cut off; the bone, of necessity, quickly dies, and the epiphysial lines form natural boundaries at which the dead bone is sharply and easily separated from the living.

At a later period, on the other hand, the anatomical conditions are changed. The union of the articular extremities with the shaft now supersedes the epiphysial line of cartilage, and thus a more complete system of anastomosing blood-vessels, continuous throughout the whole length of the bone, prevents any sudden necrosis, even if, super-added to the original inflammatory change, there occurs some separation of the periosteum by lymph or pus. The much firmer attachment, moreover, of the periosteum offers a greater obstacle to the tracking of fluid beneath it, and thus forestals one chief source of mischief. What wonder, then, if the necrosis be, so to speak, chronic, indistinct, incomplete; if the sequestrum be long in separating, shut up between layers of new-formed bone? The slow extension of the necrosis in these cases is by itself sufficient to account, in great part, for the long delay which occurs in the separation of the sequestrum. For it is plain that no line of demarcation can be formed in the case of mortification of any part, so long as the disease is still extending, and it would be difficult to imagine a case more likely to illustrate delay on this account than one of necrosis from chronic osteitis. Slowly, layer by layer, the new bone is deposited. Very gradually the old bone dies; and still the new bone increases. The original shaft is killed and buried by the same process. But no separation can occur so long as the line of junction of the living and dead creeps onward, and the longer the shedding of the sequestrum is put off, the thicker become the walls which imprison it.

II. *Suppuration is probably not an early symptom in cases of necrosis occurring in the course of chronic otitis.*

That necrosis may occasionally occur without causing suppuration appears to have been long the subject of observation. Mr. Stanley seems to have considered such an event not unusual. In his work on 'Diseases of the Bones,'¹ he remarks, "When the bone attacked by necrosis is of small size, or only a small portion of it has perished, and in a patient who is not of an irritable habit, the inflammation which ensues in the surrounding soft parts is usually so mild that it gives rise to the effusion of fibrin or of serum, without suppuration; the disease then passing through its several stages unaccompanied by any other change than the simple enlargement, and thickening of the parts adjacent to the dead bone. Under such circumstances difficulty is often experienced in determining the nature of the disease, for it may then be doubtful whether the enlargement of the limb has been caused by necrosis, or by chronic inflammation of the bone, or by thickening of the periosteum, such as occurs in scrofulous children, in whom the periosteum of one bone, or of several, often becomes so much thickened as to produce an enlargement of the limb, simulating that which is caused by disease in the bone itself."

In the third volume of the 'Transactions of the Clinical Society,' Sir James Paget also calls attention to cases of necrosis without suppuration. He there narrates a case in which the symptoms were those of periostitis of the middle third of the femur, and in which the source of trouble was found to be a thin, rough sequestrum, about an inch and a quarter long, and a quarter of an inch wide, which lay in a flattened, irregular cavity, from which, on cutting through its outer wall, a little blood-coloured fluid escaped, and was followed by the protrusion of some soft

¹ 'A Treatise on Diseases of the Bones,' 1849, p. 83.

substance like coarse granulations. "The walls of the cavity, of which the outer was formed by the thickened periosteum, and the inner by the hollowed out surface of the femur, felt smooth and velvety, as if covered with granulations like those of ordinary cavities containing sequestra." Sir James Paget remarks, "the central point of interest in this case is, I think, in the fact of necrosis, leading to separation of bone, being unattended with inflammation of any of the textures external to the periosteum, or with more than a scarcely discernible amount of suppuration around the sequestrum. How unlike this is to the ordinary course of necrosis I need not describe." And he adds, that he had seen only one similar case, that of a boy, thirteen years old, in the upper part of whose left humerus was a large ovoid swelling, which had slowly and painfully increased for about a year. An exploratory incision having been made, the periosteum was found greatly thickened, and beneath it were some cavities containing thickened and half-dried pus, and several small sequestra from the wall of the humerus.

Sir James terms the disease, of which these cases are examples, *quiet necrosis*; and the epithet is equally applicable to the cases referred to by Mr. Stanley. The term, however, cannot be applied to a process which leads, with such symptoms as those which have been described, to necrosis of nearly the whole shaft of a femur; and it is I venture to think, to the *cause* of the necrosis, viz. chronic osteitis, rather than to the *quietude* of the diseased process, that we must look for an explanation of the absence of suppuration.

Granting however, it may be said, that the necrosis is the result of chronic inflammation of the bone, suppuration should be established when once a definite sequestrum is present. How can its absence be explained? The reply to this question may be best made, I believe, in the terms of the proposition, "suppuration is not of necessity an early symptom in cases of necrosis following chronic or subacute inflammation attended by hypertrophy and scle-

rosis;" and it may be added, suppuration may never occur at all.

This statement, so contrary to the generally accepted beliefs, does not rest on theoretical grounds alone, or on the recent case here related. As an illustration of its truth I am able to exhibit two very remarkable specimens from the museum of St. Bartholomew's Hospital¹ (Pl. XI, figs. 1, 2).

They are described in the catalogue as having belonged presumably, to the same person. One is the section of a femur, "in which a portion of the whole circumference of the inner layers of its wall, six inches long, has perished, and has been separated from the surrounding bone. New bone has been abundantly formed in and upon the outer layers of the wall, which is separated from the sequestrum. There is not in this new bone any aperture or cloaca, leading into the narrow space around the sequestrum. The tissue of the new bone is compact and heavy, and its surface hard and nearly smooth. It will be observed also, the description in the catalogue continues, "that the medullary tissue is entire within the perished part of the bone, although in this situation its tissue is nearly consolidated."

A. 119. "Section of a tibia, which is presumed to have belonged to the same person as the femur last described, but from the opposite limb. It is diseased in exactly the same manner. A sequestrum of a large portion of the inner layers of its wall is completely enclosed within the thick and hard layer of new bone formed on and united with the remaining portions of the wall. The exterior of this new bone is even smoother than that last described, and there is no aperture leading through it to the cavity containing the sequestrum. The medullary tissue is entire; but partially consolidated."²

¹ A. 118 and A. 119, Catalogue of Museum, St. Bartholomew's Hospital.

² These specimens are referred to by Mr. Stanley (loc. cit.), as the only example he had ever seen, in which *deep-seated* necrosis was unaccompanied by fistulous tracks in the bone and in the surrounding soft parts; but he does not suggest any explanation.

The close likeness which exists between the relations of the dead to the living bone in these specimens and in the two previously exhibited is remarkable; and nobody can doubt for a moment that all are examples of the same kind of disease. There is the same continuity of dead and living bone, the same imprisonment of the sequestrum by new bone without and within, the same evidence of hypertrophy with sclerosis advancing side by side with necrosis, and the evident practical impossibility of removing the sequestrum by any surgical operation short of amputation. No history is attached to the specimens; but, doubtless, the case was diagnosed during life as one of chronic inflammation with hypertrophy of bone. How many of the bones, it may be fairly asked, so diagnosed now, contain sequestra, greater or smaller, buried in them?

I am indebted to Mr. Barwell for drawing my attention to a specimen of necrosis, almost entirely unaccompanied by suppuration, belonging to the Museum of Charing Cross Hospital; and for permission to exhibit it to the Society. The specimen is a femur, the upper part of the shaft of which is occupied by a sequestrum, nearly three inches in length, imbedded in new bone which has been produced by both the periosteum and endosteum. The new bone on the outside is extremely thick and dense. During life, the disease closely simulated a slowly-growing malignant tumour.

The long delay which occurs in the separation of the sequestrum, in cases of necrosis from chronic osteitis, is probably one chief cause of the delayed suppuration.

The fact that dead bone, when not separated from the living, is less likely to excite suppuration than when it exists as a loose sequestrum, was noted by Mr. Stanley in the following passage.¹ "Instances of necrosis in early life have occurred, wherein a small portion of the dead bone, not separated from the living bone, has remained unchanged for many years, and the fistulous passages in

¹ Loc. cit., p. 116.

the soft parts leading to it have become closed." And again, after referring to the fact that, in such cases, a fresh attack of inflammation may ensue, with re-opening of the fistula, he adds, "The complete cicatrization of the soft parts over dead bone, however small its extent, is a rare occurrence, and it probably occurs only in the instances where the separation of the dead from the living bone has failed to take place. When the dead bone is detached from the living bone, it becomes as a foreign body, an irritant to the adjacent parts; purulent fluid is in consequence formed around it, the outlet for which is the fistulous passages in the surrounding soft parts." "But, on the other hand, a small piece of dead bone, retaining its connection with the living bone, may excite so little irritation in the surrounding parts, that no suppuration from them ensues, and, under such circumstances, it is not unlikely that the fistulous passages leading to the dead bone may become closed."

Mr. Stanley implies, here, that fistulous tracks are present at some stage or other of the disease; but the definite manner in which he directs attention to the comparatively small amount of irritation that is excited by unloosened dead bone, may be fairly taken as an additional support to the suggestion here made that, in the long-delayed separation of the dead from the living bone, may be found one great cause of the absence or long-delayed occurrence of suppuration, in cases of necrosis from chronic otitis. But, after all, this is no exception to what is often seen in analogous instances of disease. Senile gangrene, for example, is not at once followed by suppuration. It is only when the dead part begins to be loosened at its line of junction with the living, that the process of suppuration is set up. Say that so many days or weeks are occupied in the complete separation of the skin and other soft parts, suppuration may not be noticeable until a third or a half of this time has elapsed. In the case of necrosis of the shaft of an

adult bone, from chronic osteitis, the separation may occupy many months or years. Is it, therefore, to be wondered at, that the delay in the occurrence of suppuration bears some sort of proportion? Its earlier occurrence would be not less useless than purposeless.

III. The peculiarity of the case which forms the text of this paper is to be looked for, I believe, rather in the rarity with which fracture occurs at an early stage of chronic osteitis with necrosis, than in the nature of the case itself. In other words, in the absence of the fracture, the disease would have been diagnosed as chronic inflammation with hypertrophy of the femur, with, perhaps, just so much suspicion of malignant disease as to lead to its being carefully watched, and, in time, explored, if the swelling increased. Had the pain subsided, and had no suppuration occurred, the patient might never have been operated on; and the existence of necrosis would probably never have been known. And if one considers all the circumstances which would interfere with the examination and preservation of the specimen, in the event of the patient not being operated on, it will not seem remarkable that specimens of necrosis without suppuration should be so rare. On the other hand, if suppuration had occurred, as it almost certainly would as soon as any small fragments of dead bone had become loose, the case would have been merely diagnosed as one of ordinary necrosis; and an operation, perhaps many more than one, would have been performed for its relief; and had the limb been amputated at last, after repeated failure of attempts to take away all the dead bone, or had the patient died from the effects of the disease, or of some other, the case would not have seemed remarkable; and although the bone might have been preserved in a museum, the special interest of the individual specimen to the surgeon would have ceased, as soon as a section of the limb had shown how futile must, of necessity, have been

all endeavours to remove the dead bone by any other method than amputation.

These considerations tempt one to foretell that section of such bones at an early stage of the disease, when the rare opportunity offers itself, will occasionally show the presence of necrosis without suppuration. Section at a later stage, after suppuration has occurred, will show a diseased condition, which, though long known and described, has not been definitely recognised as anything more than exceptionally long-delayed separation of the dead bone; whereas, if the suggestions now made be correct, the condition should be looked upon as *characteristic* of a special kind of necrosis, namely, of that which occurs in the course of chronic inflammation of a bone and its membranes, and more especially if the chronic inflammation take place after a certain *age*, namely, that at which the epiphyses become one with the shaft.

Reading the cases of "quiet necrosis," published by Sir James Paget, in the light of what has been shown by the present case, one may ask whether it is possible that, in these, deep-seated necrosis may have been present, and that the small outlying fragments which were within reach of a surgical operation once formed part of a sequestrum, the remainder of which, not yet separated, lay permanently entombed by new and sclerosed bone.

The imprisonment of a sequestrum by the formation of new bone on both its periosteal and endosteal aspects, for which condition I venture to propose the term *intra-osseous* necrosis, has not received the attention which it deserves either from a pathological or surgical point of view. For, apart from all theory, it is an evident indication of a diseased process which does not occur in the more common kinds of necrosis, in which no endosteal production of new bone takes place; while to the surgeon it is of interest, inasmuch as it may render the removal of a large sequestrum, by any means short of amputation, an impossibility.

The difference between *intra-osseous* necrosis, and the

more common kind of necrosis, in which so much may be done by an easy surgical operation, becomes evident when the two are compared. In one, taking for example a case in which death of the shaft of a bone and of its medulla has been a consequence of subperiosteal suppuration, there is a more or less hard shell of new bone, here and there perforated by cloacæ, and containing, as a loosely held kernel, the more or less rotten and hollow sequestrum. Even if not completely separated from its attachments, the dead shaft is held only by one or both of its extremities. In cases of *intra-osseous* necrosis, on the other hand, there is the hard shell of new bone as before, and within it the sequestrum; but the latter is not loosely contained or held only at its extremities. Within it, as well as without, is new and living bone, continuous, of course, with the living bone of the articular extremities, as well as with any portions of the shaft which have not perished; and through the latter with the periosteal new bone of the exterior. A transverse section best brings to mind the conditions present. Outside is the shell of periosteal new bone; next within is a more or less complete tube of dead bone; while innermost is the section of the solid endosteal rod of new bone, on which the dead bone is placed like a ferule. Even apart from the frequent absence at many points of the slightest line of demarcation between the dead and living bone, the complete removal of a large sequestrum, without destruction of the whole thickness of the bone is, it will be readily granted, impossible.

The bearing of these points on surgical operations, undertaken for the removal of necrosed bone is not, perhaps, often considered. There is no reason, indeed, for their dissuading from any attempt to give relief by operation, as it is impossible to say beforehand how much or how little of the circumference of a bone is affected; but there are, probably, few surgeons who cannot recall to mind cases, in which some such anatomical conditions as those here referred to may have been the cause of the

unexpected failure which attended long-continued endeavours to remove dead bone which had seemed well within reach.

The following are the conclusions to which the foregoing facts and arguments seem to lead :

1. That nearly the whole shaft of a long bone may perish, and that, nevertheless, suppuration, after several weeks, or months, and possibly, even years, may be still absent.

2. That necrosis of a long bone may, in the absence of suppuration, closely simulate malignant disease, even to the extent of undergoing so-called spontaneous fracture; and that the latter event may not, for at least several weeks, be followed by suppuration.

3. That this apparently strange deviation from the course of the symptoms usually accompanying necrosis is probably due to the fact that the death of the bone is the last of a series of changes, of which the earlier consist of chronic inflammation, with hypertrophy and sclerosis.

4. That the symptoms of extensive necrosis, occurring in the course of chronic osteitis, in adults, may be expected to pursue, and do pursue a course which differs, in many respects, from that which is seen in the more common examples of extensive necrosis in the young.

5. That suppuration is not an early event, usually, in cases of necrosis from chronic osteitis.

6. That in such cases of necrosis, the endosteum as well as the periosteum contributes a large quantity of new bone.

7. That it may be well, for distinction's sake, to term this variety of necrosis, in which the sequestrum is enclosed within both periosteal and endosteal new bone, *intra-osseous*.

8. That there exist cases of intra-osseous necrosis, in which complete removal of the dead bone by surgical operation is, from the nature of its connections, a practical impossibility, and for which, therefore, if the sym-

ptoms are sufficiently distressing, amputation is the best remedy.

9. That, in favorable cases, when the disease is not extensive, the surrounding parts may heal, although some dead bone is permanently confined within its new sheath; the separation of the living from the dead being indefinitely postponed.

10. That the peculiarity of the case which forms the text of this paper is to be found rather in the rarity of spontaneous fracture, and of opportunities of examining the bone, in cases of necrosis from chronic osteitis, at an early stage, than in the nature of the case itself.

I have appended two drawings of typical examples of chronic osteitis with hypertrophy and sclerosis, in order that the conditions may be compared with those of the specimens of necrosis. In the *first* (Plate XI, fig. 3), it will be seen that the modelling of the bone is not quite completed, and the line of the original shaft with its periosteal and endosteal outgrowths is still capable of being traced.

At a later stage all distinction between the new and the old bone is lost; and at the same time, of course, all trace of the manner in which the hypertrophy has been effected is lost also (Plate XI, fig. 4).

DESCRIPTION OF PLATES X AND XI.

Necrosis without Suppuration.

PLATE X.

Fig. 1. Section of a femur removed by amputation at the hip-joint. Nearly the whole of the shaft has perished, and before the operation the bone had undergone so-called spontaneous fracture; but at no time, either before or after the operation, could any trace of suppuration be discovered.

Fig. 2. Section of a femur of which nearly the whole shaft has perished. There are several cloacæ leading, through the new bone laid down by the periosteum, into the narrow space by which it is separated from the sequestrum. Where the femur has not perished, it is hypertrophied and sclerosed.

PLATE XI.

Fig. 1. Section of a femur, of which a large portion of the shaft has perished. There is not in the periosteal new bone any cloaca leading into the narrow space around the sequestrum.

Fig. 2. Section of a tibia presumed to have belonged to the same person as the preceding specimen, but from the opposite limb. It is diseased in exactly the same manner, and there is no aperture leading through the new bone into the sequestrum-containing cavity.

Fig. 3. Section of a femur which has undergone hypertrophy and sclerosis, as the results of chronic inflammation. New bone has been laid down by both the periosteum and endosteum. The modelling of the various layers is not yet complete, the line of the original shaft being still plainly visible.

Fig. 4. Section of a tibia also affected by chronic inflammatory hypertrophy and sclerosis; but the modelling process is complete and all trace of the line of the original shaft is lost.