

in great part or in totality by the spongy tissue through which the solution of continuity was made. And the result of this comparative study is to show that all the constituent parts of the bone, spongy tissue, compact tissue, periosteum, contribute to repair fractures of the bone, that even the layers of muscular tissue and the surrounding cellular tissue contribute also to it, and that, finally, the authors erroneously attributed a much too large part to the periosteum in this reparatory function. Furthermore, the same conclusion will be drawn from the study of the consolidation of simple fractures of flat bones and short bones.

In the fourth period, the patients are tormented by the consequences of articular and tendinous synovites, and so much the more so because these fractures being near a joint or synovial grooves, and often even in communication with them, the inflammation has spread to the latter and left behind it the dryness and stiffness which in the joints, characterize plastic chronic arthritis and dry arthritis. These consequences are so much the more marked and rebellious because the patients affected with these lesions of the extremities are almost always advanced in age, for the predisposing cause of fracture with crushing is rarefaction of the cancellous tissue, rarefaction which, in consequence of inexplicable modifications of nutrition, is a very common consequence of age. Now it is also the case that in old people traumatic arthritis and synovitis, although they do not go on to suppuration, are very slow to end and often pass to that condition of incurability which causes dry arthritis. Finally, muscular atrophy occurs after these fractures as well as after those of the shaft.

§ 3. ANATOMICAL PHENOMENA IN FRACTURES OF THE FLAT BONES AND SHORT BONES.

I have not much to say on this subject; nature uses the same resources in the consolidation of these two kinds of bone as in that of long bones. The muscles, the periosteum, and the whole fractured surface furnish the materials, and the same ulterior modifications of these materials cause the formation of the callus. But in the flat bones, and especially in those which have no diploë, or only a very thin one, the periosteum is the chief agent where it has been preserved, and it must not be forgotten that if it has been divided, which very commonly happens, it begins by repairing itself, and the material which it supplies to the callus comes as much from its cicatricial portion as from that which remained intact about the fracture. Further, no matter how thin the bone may be at the place of fracture, it can still furnish the materials needed for repair. I had occasion, in 1871, to trepan for intra-cranial suppuration following gunshot fracture of the right parietal bone, a young man twenty-four years old, who was employed in the museum of natural history, and had been brought to the ambulance of that establishment after the battle of Buzenval, where he had been wounded. Not only did he survive the operation, but a bony growth formed all around the opening and advanced towards the centre, so that this sort of flattened callus

closed entirely the hole made by the crown of the trepan. Larrey has reported similar cases, in which, as in mine, the calluses were formed during suppurative osteitis, but I wish to mention them here in order to show you once more the power and the multiplicity of means which the organism possesses to repair not only solutions of continuity but also losses of substance in the bone.

LECTURE X.

PHENOMENA OF CONSOLIDATION AFTER COMPOUND SUPPURATING FRACTURES.

1st Variety: Consolidation after benign and superficial suppurating osteitis. 2d Variety: Consolidation after deep osteitis or non-putrid suppurative osteomyelitis. 3d Variety: Death before consolidation by putrid osteomyelitis and purulent infection.

GENTLEMEN: Do not lose sight of a first point which is capital in the history of fractures complicated by wounds; they may get well, exactly like simple fractures, but on one condition, which you should always bear in mind when you are called upon to treat such a case, on condition, I repeat, that the bone does not suppurate.

When the broken bone suppurates, and unfortunately all the efforts which you have made and should have made to prevent it do not always succeed, the clinical and anatomical phenomena of consolidation are peculiarly modified, sometimes hindered by this new complication which I shall study especially in the long bones.

Moreover, we have differences depending upon whether the suppurating osteitis occupies the superficies or the entire thickness of the bone, and according to its greater or less intensity. Let me explain these two points.

1. In a first variety, which I call *benign and superficial suppurating osteitis*, the patient has no general symptoms and consequently no fever. The swelling of the limb is moderate, suppuration is established the fourth or the fifth day in the wound itself. The eschars begin to be eliminated, and if you probe the wound gently, you feel the bone denuded superficially. Suppuration becomes a little more abundant after the eighth or ninth day, but the pus is laudable, not fetid, and the apyrexia continues. Things go on in this way for twenty or thirty days; the suppuration continues rather scanty, with no burrowing of the pus, no indication of a deep collection. Mobility of the fragments begins to diminish; in short, except for the superficial suppuration and denudation, the fracture resembles a simple one that has reached this period. But the denudation continues and the fracture goes on to the sixtieth, sixty-fifth day; about the seventieth

day we find it consolidated. Increase of volume can be felt above and below, showing that the osteitis on both sides of the fracture has taken on the condensing form with which we are acquainted. But the fistula persists and the suppuration which it supplies only ends twenty, thirty, or forty days later, after elimination of a splinter or mortified piece comprising a more or less considerable portion of the thickness of the bone. To use the ordinary terms, there has been superficial necrosis, and, after expulsion of the necrosed part, the callus and cicatrix have been completed. The osteitis, instead of remaining plastic over the whole fracture, became suppurative and necrotic in one place, hence the anatomical phenomena which have taken place. In the deep parts of the bone, that is to say, between the fragments, in the medullary canal, and at that portion of the circumference of the bone which is opposite that with which the wound communicates, the osteitis has been plastic, that is, non-suppurative, and the callus has been formed, as in ordinary cases, by effusion and ultimate transformation of the lymph. Adjoining the wound the periosteum has been destroyed by absorption or by mortification; part of the bone has necrosed. Suppuration has taken place about the necrosis without extending to the interfragmentary space. After expulsion of the sequestrum, the suppurating granulations have covered the surface of the bone, and it is in them that have taken place the ulterior transformations, that is, into fibrocartilage, and then into bone, which have brought about both the reproduction of the periosteum at this point, and the reproduction, sometimes excessive, of the subjacent layer of bone. Here then you see a new element intervene in the formation of the callus, an element which is itself a product of the consecutive inflammation; the granulations, which whilst they suppurate on the surface, ossify below and are transformed into a bone cicatrix, just as they are transformed upon the skin and subjacent tissues, when there is suppuration, into inodular fibrous tissue. The intervention of this new element shows you once more how many assistants the periosteum needs in order that the callus may form under all the conditions where its production becomes necessary.

2. In a second variety, suppuration invades the surface and the depths of the bone, that is to say, the interfragmentary space, the medullary canal, and that portion of the circumference which is furthest from the wound. The osteitis, in a word, has become a general suppurative one, and is no longer partially suppurative as in the other variety. This is the form which we call suppurative osteomyelitis, so as to indicate also the participation of the marrow.

At first the clinical phenomena vary according to the intensity of this osteomyelitis. If this is moderate, if the osteitis is subacute, the primitive or traumatic fever is not very violent; the pulse does not go beyond 100, 110, nor the temperature in the axilla above 101° to 102°; you do not see the subicteric tint, the delirium, the dryness of the tongue, the tympanism of the abdomen, which announces the dangerous form of traumatic fever. Suppuration begins on the fifth or sixth day in the wound; the pus burrows in the neighbouring

tissues. Through the wound and the new openings made by the suppuration, the probe, and sometimes the finger, show that the bone is denuded to a considerable extent above and below the fracture, both about the wound and on the opposite side. The probe penetrates deeply between the fragments and brings out pus. If in order to dress it, you are obliged to move the limb, you see at each movement the liquid escape from the deep parts; furthermore, the suppuration is very abundant. These are so many indications of the presence of suppuration in the depths of the bone, and consequently in the medullary canal.

The case goes on thus for weeks and months unless complications, particularly erysipelas or purulent infection, should intervene. Suppuration continues to be abundant, from time to time slivers of bone are eliminated, the fragments remain movable, repair does not go on, and yet the tumefaction of the bone above and below the fracture indicates that there the osteitis has become condensing, a circumstance which generally augurs well, because, in cases of this kind, the osteitis is reparatory at the same time that it is condensing, that is, the nusus which increases the size of the bone above and below the fracture tends also to repair it.

Finally after a length of time which varies from three to six months, a large callus exists at the seat of the original lesion of the bone. There are still superficial slivers of bone, others, surrounded by new bone, are invaginated; more or less numerous fistulae lead to these sequestra. In short, the suppurating osteitis has at the same time been hypertrophying and necrotic, as is generally the case in acute suppurating osteitis of youth, and finally, the fracture is really replaced by necrosis consecutive to this osteitis.

How is this callus produced? Very probably by the two mechanisms which we already know; in spite of the intensity and abundance of the suppuration there are perhaps here and there a few points where it has not taken place, and where the plastic exudation has been deposited either by the muscles or by the portions of bone furthest removed from the wound. But in addition, at those points where suppuration takes place without necrosis and elimination, the callus is formed by the granulations themselves, as Sabatier formerly pointed out, and as well by those of the medullary canal and compact tissue as by those of the periosteum. Another proof in support of the opinion that the periosteum is far from being the only agent in the formation of the callus.

3. In a third variety, the osteomyelitis becomes as intense as possible; it is hyperacute, gives rise to traumatic fever of the most dangerous kind, and is followed, if life is prolonged, by putrefaction of the marrow and periosteum which becomes the point of departure of that other fever which we call purulent infection. But I do not wish to treat to day of putrid osteomyelitis. I only wish to point it out to you, placing it beside the other forms of suppurating osteitis and the mode of consolidation after their appearance.