

would be much more intense than usual, and it is allowable to think that this greater intensity would be due to the worse character of the septicæmia, for the putrid gases which form under the skin, and there produce the consecutive emphysema, might be reabsorbed and become the cause of a more serious poisoning than that of the ordinary traumatic fever. However that may be, in such a case, when gangrene has commenced with emphysema, death is imminent unless the putrefying part is removed in time. That is why I urged the patient more strongly than I did yesterday to submit to amputation.

Fortunately the gangrene and emphysema have not extended to the upper part of the leg, and we can amputate at what is called the place of election, and still be beyond the limits of the trouble.

(Amputation was performed. The patient did not succumb to the traumatic fever, but he was carried off by purulent infection fifteen days after the operation.)

## LECTURE XV.

### BI-MALLEOLAR AND SUPRA-MALLEOLAR FRACTURES OF THE LEG.

I. Bi-malleolar fracture—Obscurity of the mechanism—Two cases, one without displacement, the other with the displacement described by Dupuytren—Different indications for the two patients—Simple retention for the first—Retention with adduction of the foot for the second. II. Supra-malleolar fracture—Displacement difficult to correct—Possible eschar in cases of this kind—Explanation by more crushing behind than in front—Principal indication is to avoid an eschar.

GENTLEMEN: I. *Bi-malleolar fracture*.—We have at this moment in the wards two patients affected with simultaneous fracture of the lower extremity of the fibula and the internal malleolus.

I give this variety of fracture the name of *bi-malleolar*, although I recognize that sometimes in the fibula the solution of continuity occurs a little above the part which, strictly speaking, constitutes the external malleolus.

In both cases the fracture was caused by a misstep in which the foot was subjected to a certain degree of torsion. I wish I could tell you if the foot, at the moment of the accident, turned about its vertical axis from within outwards, so that the outer facet of the astragalus pushed the external malleolus backwards and outwards, while strong traction was exerted upon the internal malleolus by means of the lateral ligament, and that we might, following M. Maisonneuve,<sup>1</sup>

<sup>1</sup> Maisonneuve, Fractures du Péroné (Archives Gén. de Médecine, 3d série, tome vii. p. 165).

explain the fracture of the fibula by divulsion, and that of the internal malleolus by traction. Nor can I tell you if at the time of the accident the foot turned about its antero-posterior rather than its vertical axis, nor if it took, to use Malgaigne's expressions,<sup>1</sup> the position of adduction, or that of abduction. For the patient could give me no precise information as to the way in which his foot turned.

Reading the works of the two authors just mentioned, and Dupuytren's<sup>2</sup> much earlier one on this subject, one would believe from the manner in which they speak of the mechanism of fractures of this kind, that they were able constantly and very easily to confirm by their patients the theories which they developed upon it. But it is not so. The patients can almost never say how the foot turned, and can give the surgeon no information upon this point which can clear up his diagnosis and prognosis.

I admit willingly that we can study upon the cadaver certain points of the mechanism of fractures of the fibula, and especially that which relates to the effects of torsion of the foot. But we can never know if, in an accident, everything has taken place as in our experiments, for two reasons: first, because the patients, as I told you, do not know what has taken place; and, second, because in the living body we have, added to the torsion of the foot, energetic muscular contractions, and the weight of the body upon the lower part of the leg and the foot while they are in a vicious direction. These difficulties render the results of experiments upon the cadaver inapplicable to the clinic, and cast, it must be frankly admitted, great obscurity upon the mechanism of fractures. But on this point, as on many others, I like better to tell you that we do not know, than to give you false and incomplete explanations.

In one of our two patients the double fracture is accompanied by no deviation of the foot, and no other deformity than that which results from the swelling. The diagnosis, nevertheless, is incontestable. Not only have we found that sharp pain on pressure above the external malleolus and at the base of the internal one, which is one of the probable signs, but we were able to feel crepitation by the three principal manœuvres recommended for that purpose:—

1st. For the external malleolus, pressing with one finger upon the point of this malleolus while the other hand holds the lower part of the leg firmly; for the internal malleolus, seizing it between two fingers, and moving it backwards and forwards.

2d. Raising the leg, holding it firmly with one hand, seizing the foot with the other, the palm of which embraces the sole, while the thumb and middle finger are placed by the ankles, and moving it alternately outwards and inwards, sometimes without rotation, that is, carrying it bodily sideways, sometimes with rotation about its antero-posterior axis.

3d. Fixing the leg upon the bed, without raising it, with one hand, the fingers of which are placed over the ankle, and moving the point

<sup>1</sup> Malgaigne, Traité des Fractures et des Luxations, tome i. p. 808.

<sup>2</sup> Dupuytren, Leçons Orales de Clinique Chirurgicale, tome i.



of the foot outwards with the other, thus giving it a movement of rotation about the vertical axis of the astragalus.

In the other patient, on the contrary, you saw most notable deformity. When the two limbs are compared without raising them we see that the right foot (the injured side) is distinctly carried outwards, that its external border is slightly raised, and its internal border lowered, in consequence of the rotation about the antero-posterior axis which coincided with the abduction. Two finger-breadths above the external malleolus is a depression which Dupuytren compared to an axe-cut. The internal malleolus projects below the skin, which is very tense and seems threatened with rupture. But this projection is a little above the point of the malleolus, and is formed by the irregular surface of the upper fragment of a fracture which passes near the central part of this eminence.

You saw that I reduced the deformity by fixing the leg with one hand, and carrying the foot inwards with a double movement of bodily transportation and rotation about its antero-posterior axis. I showed you that during this manœuvre the point of the internal malleolus, forming the lower fragment, returned to its place, and that after the reduction, the skin was much less tense and no longer threatened with gangrene or perforation.

The prognosis in these two patients is very different.

In the former we have to fear neither trouble on the part of the skin, nor consecutive suppuration. We are sure that the patient will recover without deformity. The only ultimate troubles will be those of tibio-tarsal arthritis and synovitis of the neighbouring tendons. These troubles, of which I often speak (see p. 70), are inherent to all fractures near articulations, and of course to these which communicate with the joints, as these two must inevitably do. These arthritides and synovites differ in being accompanied by lesions, sometimes temporary, sometimes of very long duration, or even incurable, which limit the movements, render them painful, and make it difficult to walk. These lesions are a thickening of the synovial membranes, and consequently a rigidity; or, if you prefer, a loss or a notable diminution of their extensibility, artificial union by means of false membranes, between the articular surfaces and the parietal synovial between the tendons and their sheaths. In order that the articular movements and the gliding of the tendons may resume their physiological conditions, it is necessary that these lesions should disappear. That never occurs in less than from four to six months, and often much later. The length of time that is necessary depends especially upon the age. Especially during youth, and until about the age of forty years, the synovial membranes lose quite promptly these consecutive inflammatory lesions. After forty, and especially after fifty years of age they disappear much less rapidly, particularly if the subjects are rheumatic or gouty. It is then that you see the patients, especially the women, walk for years slowly and painfully with the help of a cane. In this respect the condition of our first patient is favourable. He is thirty years old, and is not rheumatic; we may then hope that he will feel the consequences of his articular fracture

for only five or six months. I do not mean that he will be confined to his bed during all this time; on the contrary, fractures of this kind, like those of all the small bones, like those of all the extremities of long bones, consolidate rapidly, and it is not necessary to keep the limb immovable for more than thirty days. After that immobility is no longer of any use to the fracture, and it may have disadvantages for the articulation already inflamed by proximity, and especially for the small articulations of the foot. In this respect, I make a distinction, as I have already shown you, and as I shall again show you hereafter, between the joint or joints which are near the fracture, and those which are more or less removed from it. The first present the lesions and symptoms of arthritis; but as these lesions are the result either of the propagation of the inflammatory process from the fracture to the synovial membrane, or of the traumatism in which the articulation has participated, we cannot tell to what extent the immobility has contributed, and in this respect M. Teissier (de Lyon)<sup>1</sup> invoked a number of facts which are not demonstrative, when he cited examples of arthritis of the knee with neighbouring fracture of the femur. The second, on the contrary, those which are more or less distant from the seat of the fracture, and which we may suppose not to have participated in the effects of the traumatism, may alter in consequence of prolonged immobility, and they alter the more as the articulations are smaller and tighter, such as those of the hand and foot. There would then be reason to fear that by keeping the foot immovable too long, we might produce in the small articulations of the tarsus and metatarsus the lesion pointed out by Teissier and Bonnet de Lyon,<sup>2</sup> which are followed by more or less painful prolonged rigidity.

To return to our first patient. I say then that he will have an inevitable tibio-tarsal arthritis; but that as he is young and not rheumatic this arthritis will remain subacute, and will not pass to the state of curable but prolonged chronic arthritis, nor to that of incurable dry arthritis, and as I shall not leave him very long in the immovable apparatus, he will also escape those arthritides caused by immobility and the consecutive stiffness which we see especially in the small articulations.

As for our second patient, if we should do nothing or if we should not treat him properly, the prognosis would become very serious. First, if we should not make the reduction an eschar might easily form over the upper fragment of the internal malleolus and cause its suppuration and that of the articulation itself. If suppuration did not occur consolidation would take place with the foot in its present position. That would be a deformity, and at the same time an infirmity, for the patient would walk upon the inner border of the foot and not upon the sole. The internal lateral ligament and the inner portion of the synovial membrane would be constantly strained, causing re-

<sup>1</sup> Teissier, Mémoire sur les Effets de l'Immobilité des Articulations (Gaz. Médicale, 1841).

<sup>2</sup> Bonnet, Traité des Maladies des Articulations, tome i. p. 67.



peated sprains and incessant tibio-tarsal arthritis, which would compel the patient to walk very little and to rest himself frequently.

*Treatment.*—That of the first patient will be very simple. In a few days we shall wrap his foot and the lower part of the leg in a silicated apparatus which will be removed about the 25th or 30th day, counting from the accident. After having taken it off we shall permit the patient to walk with crutches; we shall advise him to move his foot while lying in bed, and we shall ourselves communicate some movements to it every morning, in order to restore suppleness to the articulations and tendons. We shall apply prolonged frictions, either with the naked hand and grease, or with a flannel, and finally we shall give him some sulphur baths.

For the second one we have to make and maintain reduction. You saw that reduction was quite easy, but that the foot, abandoned to itself, returned promptly to its vicious position. It is then necessary to apply an apparatus which will hold the foot firmly in place. Dupuytren understood this indication perfectly, and met it with an apparatus which was as perfect as was possible at a time when they did not use immovable bandages. This apparatus, which I have applied temporarily upon this patient because there was too much swelling to allow of the immediate application of an immovable one, and which I am glad to show you, because you may be obliged to use it yourselves sometimes, is composed:—

1st. Of a very long bag filled with chaff and folded at the middle, which is placed, thus folded, upon the inner side of the leg, taking care that it does not descend as low as the internal malleolus and that it leaves it free; for you understand that from the moment we fear an eschar at this point we must abstain from compression.

2d. Of a wooden splint long enough to cover the bag and extend beyond the sole of the foot, so as to leave a gap between itself and the foot.

3d. Of two bands, one of which is rolled about the upper and middle portion of the leg and fastens the bag and splint there, and the other, as soon as the foot has been brought inward by the manoeuvre of reduction which I indicated a little while ago, forms a figure of 8 about the lower part of the leg and the foot, holding the latter close to the splint.

This dressing meets the indication very well if it is sufficiently tight over the foot and is renewed almost every day, for it gets loose very easily. You saw that after the apparatus had been applied I placed the limb upon a large and rather high cushion of chaff, resting the limb upon its outer side, as Dupuytren advised in cases of this kind, and as, before him, Pott advised for all fractures of the leg. This position has no advantage when the limb is in the Scultet bandage, but it is much more convenient when it is set with an inner splint. A hoop to keep off the weight of the bedclothes completes the dressing. Of course if the bands are too tight and the patient suffers, or if the inner border of the foot is pressed so tightly against the splint as to give pain, it would be necessary to loosen the bandage or to renew it before the end of the twenty-four hours. There is, however,

no reason to fear gangrene by constriction, for the fractured region is not entirely comprised in the apparatus, since on the inner side the band passes over the splint and not over the foot itself.

If after forty-eight or seventy-two hours, I find that the inflammatory swelling does not increase, I shall apply an immovable apparatus. I should wait longer if there were any small wounds, phlyctenæ, or scratches which I wished to see cured before thus inclosing the limb. This delay would be no disadvantage if the Dupuytren apparatus were renewed every day, and if it certainly maintained the reduction.

It has happened to me sometimes, and some day you may meet with cases in which you will be obliged to do the same thing, to apply an immovable bandage on the first or second day. Once it was because the patient had violent alcoholic delirium, and disarranged his apparatus and reproduced the displacement of the foot by his movements. On two other occasions it was because, notwithstanding the care with which I placed the splint and bag, the displacement of the foot reappeared in a few hours, and the skin over the internal malleolus was so pressed upon as to render perforation or eschar imminent.

The application of an immovable apparatus having been decided upon, to which should we give the preference? Unhesitatingly to the plaster apparatus without the addition of gelatine. Why? Because it dries most rapidly, and if the foot is well drawn inwards and the reduction maintained during its application, I am sure that when the operation is terminated the bandage will be dry and will keep the parts as I placed them.

If by chance, in a case of this kind, you do not have proper plaster at your disposal, apply a bandage of starch, dextrine, or silicate of potash; but take care to keep the foot turned in during its application, and add to the inner side of the leg two thick linen cushions, one below the knee, the other above the internal malleolus, place over them a long inner splint like that of Dupuytren's apparatus, and fasten the leg and foot in the same way until all is dry.

The immovable apparatus should not remain more than 30 days in place. After that time the consecutive treatment is the same as that described in the preceding case.

II. *Supra-malleolar fracture.*—The patient in No. 26 is a man 61 years old, a little weakened by age, who, while descending a staircase in the dark, thought he had reached the bottom when he was still three steps from it. He fell, having, he says, his left foot and leg caught under his buttocks. You saw that the deformity resembles that of the preceding patient in this, that the foot is turned outward, that its outer border is raised, that there is the "axe-cut" depression above the external malleolus, and abnormal projection of the internal malleolus with a depression below. The foot is drawn backwards as well as outwards so that the skin is pressed upon and endangered by a very large bony prominence formed by the upper fragment of the tibia. For it is easy to see, by taking the leg in one hand and the foot in the other, and trying to restore their normal shape, that the principal line of the fracture is above the line of the malleoli, and passes through the inferior extremity of the tibia a few lines above the articulation,



and through the adjoining part of the fibula. It is then one of those fractures which, on account of their position, Malgaigne<sup>1</sup> named *supra-malleolar*. You noticed that, after having made an almost complete reduction, I saw the displacement immediately reappear, and that after having placed the limb in a wire trough I saw, notwithstanding the anterior splint, the foot again turn outwards and backwards. I then placed two graduated compresses along the anterior and inner portion of the tibia, after having first applied a layer of cotton; then, adding the bag and anterior splint, and tightening the straps over them, I managed to maintain, if not the whole, at least a very great part of the reduction. We are here then in the presence of a supra malleolar fracture with complex displacement, difficult to correct.

It is not always so in supra-malleolar fractures; I have seen some, and Malgaigne also gives examples, in which there was little or no displacement, and in which reduction was easily maintained. On the other hand, the present case is not uncommon. Malgaigne quotes two similar ones from Dupuytren's work in which the splints, the only apparatus used at that time, did not prevent the displacement from obstinately reappearing, and the upper fragment of the tibia from causing a large eschar followed by suppuration and serious accidents. The patients recovered with a deformity and an infirmity. I myself had at the Hôpital de la Pitié in 1866 a man 66 years old, in whom a similar fracture was followed, in spite of all my care, by an eschar, suppuration of the articulation and bone, and finally by purulent infection and death.

To what is the difficulty of retention and consequently this gravity due? The authors have not explained it, but this is the explanation which I reached by autopsical examination of my last patient and a study of one or two specimens in the Musée Dupuytren. The fracture is undoubtedly produced, or, if you prefer, completed by the mechanism of crushing, that which takes place in most of the fractures of the extremities of long bones, and which has been well studied, especially for fractures of the lower end of the radius and upper end of the femur. At the moment of the accident the upper and lower fragments are pressed against each other by the weight of the body and by contraction of the muscles. This reciprocal pressure has caused the crushing of the cancellous tissue, a crushing favoured by its greater fragility which is the consequence of age, and which appears much sooner in some subjects than in others.

Remember that this patient is sixty-one years old, and that the one at La Pitié was sixty-six. The crushing is not regular, it is greatest at those points where there was most pressure, and those points are the ones where the muscular action was most energetic. The action of the peronei, the gastrocnemius, and soleus predominated, and was undoubtedly favoured by the abduction and extension of the foot at the moment of the accident. In consequence of this predominating action the sinking and crushing of the cancellous tissue were greater

<sup>1</sup> Malgaigne, *loc. cit.*, p. 818.

on the outer side and behind than in the other directions. When we replace the foot in its natural position, it can maintain it only if the fractured surfaces are interlocked at some points, but if this condition is lacking, and an empty space exists there where the crushing has been greatest, it is plain that the effect of the tonicity of the muscles is to draw the foot in the direction indicated by the irregular form of the fragments.

If, in other patients, the deformity is less, or if retention is easier, it is because the crushing has not been so great, the cancellous tissue not having yet acquired great fragility, or because it has taken place more evenly, the foot not having turned outwards at the time of the accident.

However that may be, we must not expect in this patient recovery without deformity. Whatever we may do, there will remain a deviation of the foot outwards and a projection forwards of the upper fragment of the tibia. The interfragmentary callus which will be produced, as in all fractures of the cancellous tissue, will partly fill the gaps, but will not efface them entirely. It will be the less able to do so because these crushings of the spongy tissue are followed by a process of absorption which removes part of the bone. Great as may be the power of repair, it is not sufficiently so, especially in a subject advanced in age, to reproduce all that has been lost, and so much the less so because the surfaces left by the loss of substance are constantly drawn towards one another by the tonicity of the muscles.

That which we desire most of all, and that towards which we shall direct all our efforts, is to prevent the formation of an eschar which would transform our fracture into a suppurating osteo-arthritis. The indication to be met is that of preventing the upper fragment from pressing upon the skin, since we cannot meet that of entirely correcting the deformity. How is this end to be reached? By repeated reductions, and by compression all along the upper fragment, the limb being kept in a metallic trough. I would not apply the plaster apparatus very early in this case, for I fear the displacement might be reproduced below it, and that the dreaded eschar might be caused. I prefer the trough, which lets me see what is going on.

If after a few days I saw the skin endangered by the incessant reproduction of the displacement forward of the upper fragment, I might perhaps use Malgaigne's point. At the end of his article upon supra-malleolar fractures, this surgeon expresses great confidence in his process. "As for apparatuses," he says, "the inefficacy of splints and of bands is shown by the preceding observations, and I do not know any which, under such circumstances, can take the place of my screw apparatus." I should have preferred to this affirmation the exhibition of one or two cases in which the screw had succeeded. This kind of fracture presents special anatomical conditions which might well make it fail. Still, I repeat, if we cannot keep the fragments well enough in place to prevent an eschar we shall make use of it. Would it not be better to give the preference to the section of the tendo Achillis, and to hope that, as after this section the foot and lower fragment would no longer be drawn upwards and backwards,



the upper fragment would no longer project so much forwards? I ask the question, but I do not yet possess any fact upon which I could support the use of this little operation.

(The patient recovered without eschar and without suppuration, by the aid of the trough and compression distributed all along the upper fragment. There remained an abduction and a deviation backwards of the foot, with marked false ankylosis of the tibio-tarsal articulation.)

## LECTURE XVI.

### CONSECUTIVE AND LATE PHENOMENA OF SIMPLE FRACTURES OF THE LEG.

I. Fracture of the leg eight years before—Complete restoration of shape and function—Slight persistent muscular atrophy—Considerations upon this atrophy. II. Another fracture dating from eighteen months—Deformity due to the persistence of the projection of the upper fragment. III. Old fracture with hyperostosis of the tibia. IV. Consolidation since a year ago—Persistence of neuralgic pains (osteo-neuralgia). V. Fracture with persistence of tibio-tarsal arthritis. VI. Recovery with outward rotation of the upper fragment.

GENTLEMEN: Chance has permitted us during the week to see here five patients who had been treated for simple fractures of the leg, either by myself or by other surgeons. This is an opportunity to call your attention once more to the remote consequences of these fractures, consequences of which I have often spoken to you without having any examples to show you.

I. The first is a young man of 25 years, admitted for a wound of the left arm, who had his right leg broken in the lower third at the age of seventeen years (eight years ago). You saw that the conformation of the bones was excellent, that there was no pain along them, that all the articulations of the foot had their normal suppleness and motions, and that his walk was free, and without limping. Here is, then, an excellent recovery with restoration of shape and of functions. It is due to the fact that the fracture was without displacement, or that, if the displacement existed, it was easy to reduce and keep reduced, and it has appeared early because the subject was young, for at this period of life, when the constitution is not scrofulous, the tendinous and articular synovial membranes quickly recover the suppleness and extensibility which are destroyed in cases of fracture by the neighbouring synovites and the lesions caused by the immobility. I showed you only that the muscles in front and behind were smaller than those of the opposite side. We recognized it: 1st, with our eyes, when the patient was lying down and when he was standing;

2d, with the hands, by comparing the two calves. There is, then, in this patient, a little atrophy of all the muscles of the leg.

Do not wonder at it; this atrophy is very common after fractures of the leg.

It was twenty years ago that I discovered it for the first time, and showed it to the students at the Hôpital Cochin. I also told you that Dr. Lejeune,<sup>1</sup> by my advice, chose this atrophy for the subject of his inaugural thesis. Since then, I have noticed it very often, and have produced it artificially in animals, especially in guinea-pigs whose thighs or legs I had broken. It would be difficult for me to say what parts of the muscles this atrophy specially affects. Is it the muscular fibre itself, or is it the interfibrillary connective tissue? In the studies which I made upon guinea-pigs, not having had occasion to make them upon men, it seemed to me that both parts were diminished. Having weighed, immediately after death, the principal muscles of the thigh, and found a difference between their weight and that of the corresponding muscles of the opposite side, I macerated both in ether, taking care to renew the liquid often; at the end of seven months the muscles were freed of almost all their fat, those of the fractured side had lost as much of their weight as had those of the other, and there remained the same difference between the almost exclusively muscular parts which remained. Thence I concluded that the diminution of weight was made in both the constituent parts of the muscles, but more especially in their contractile part. I should, however, say that it was impossible for me to thoroughly appreciate the new anatomical condition of this contractile part; with the naked eye I saw that it was less red and less vascular than on the unaffected side, and M. Lejeune remarked the same fact. On microscopical examination, I found the usual longitudinal and transverse striæ. Upon some of the fibres of the guinea-pig, it seemed to me that the transverse striæ were a little less apparent or masked by fatty granulations, but it was not so evident that I could affirm the chief lesion of the muscular fibre to be a granulo-fatty transformation. It is probable, but thus far I have not been able to determine it rigorously with the aid of the microscope, that this capital lesion is a diminution of the volume of the fibrillæ, and that the general atrophy of the muscle is the result of the atrophy of each one of its fibrillæ, which, however, have lost neither their normal structure nor their function of contractility.

Notice, gentlemen, that although the diminution of volume is appreciable by the eye through the skin, the contractile power seems to be as well developed as that of the opposite side. Examination with the dynamometer would perhaps be necessary to form a precise opinion upon this subject. I have never made it, because I did not think it would lead to any important practical results. What you ought to know is, that after fractures in general, and those of the leg in particular, the muscles diminish in size, without diminution of their functions, so far as the patients can tell. You should know this fact

<sup>1</sup> Lejeune, see page 71.