

make sure that no displacement has occurred, and, for the one which has the phlyctenæ, to renew the cerate dressing which is applied to them.

In fifteen or twenty days, when the inflammatory period is ended and there is no more swelling, and when the second phase of the affection has begun, during which we have fibro-cartilaginous transformation and the beginning of calcareous deposits in the soft, sanguinolent, and glutinous substance which forms outside the bone and inside the medullary canal during the first period, you will undoubtedly see me change the apparatus: I shall envelop the limb in a layer of cotton, and wrap about it first a dry band and then another soaked in dextrine or silicate of potash. This band will be left in place for twenty or thirty days. When I wish to remove it, I shall place the limb in warm water for half an hour, and then, the bandage being thus softened, take it off carefully, while the leg is held by two assistants, so that no shock may be communicated to it in case consolidation should not be sufficiently advanced.

The bandage removed, I shall see if any mobility remains; it is probable that I shall find none. The rule is that it does not last until the forty-fifth day in fracture of the leg in adults. Does that mean that the callus is complete and perfect at that period? By no means, it only means that it is solid enough to resist the lateral impulsion which one hand gives the lower fragment while the other one holds the upper one immovable. But a few anatomical studies which I have had occasion to make upon fractures at this period in man, and the analogy with that which we find in the bones of animals subjected to experiment, oblige me to admit that, notwithstanding the disappearance of abnormal mobility, the callus is still in part fibro-cartilaginous, and is not so exclusively bony as it will become. These same studies have also taught us that it is only the peripheral periosteal callus which has become solid and partly ossified; but that the interfragmentary callus, so well demonstrated by M. Lambron,¹ is still soft and without admixture of calcareous molecules and bone corpuscles.

Finally, clinical experience has taught us that if the patients now begin to walk, the callus may bend, yield, and an iterative fracture be produced. In a word, the callus will be so solid on the forty-fifth day in both patients that mobility will no longer be felt; but not sufficiently solid to allow us, without danger, to subject it to the trials of walking or even standing. Therefore we shall advise them to remain a fortnight longer in bed, and not to begin to walk with crutches until the sixtieth day. By that time the peripheral callus will have completed its ossification, and the interfragmentary one will have commenced and will be able to continue and complete its own notwithstanding the movements and exercise of the patients. As its ossification advances, the volume of the exterior callus will diminish.

But let us return a moment to the treatment which I have begun and which I propose to continue in both patients. I want you to understand that I might employ many others and obtain an equally

¹ Lambron, *Etudes sur les Formations du Cal*, Paris, 1842.

good result. You will find in your text-books the description of a certain number of apparatuses for fractures of the leg, and you may even, by consulting a masterly thesis written by Malgaigne,¹ make yourselves acquainted with all the inventions bearing upon this point which have been produced since the days of Hippocrates. They are very numerous; and indeed any one of them might do for our present patients. For when we find ourselves in presence of a fracture with a displacement which it is easy to reduce and keep reduced, all apparatuses are good if they are sufficiently restrictive and if the patient will keep as quiet as possible. You will then be able, in your practice, to employ, instead of this wire trough, one made of tin, gutta-percha, or wood. Above all, you will be able to use the system of short separate bands, called Scultet's apparatus. Its advantage is that it can be constructed everywhere out of materials which are almost always at hand, and which, if necessary, can be replaced by others quite as easily found. Before applying it, it is to be prepared in the following way:—

Arrange upon a table three or four cords parallel to one another, or, better, three or four bands of stout duck or elastic webbing furnished with buckles. Over these place a large napkin or towel; upon this towel you place small bands, three inches in width, whose length is double the circumference of the limb; each band overlaps three-quarters of the breadth of the preceding one. They are to be placed perpendicularly to the axis of the limb, beginning at what is to be the upper end of the apparatus and continuing until you have obtained a length equal to that of the injured limb. Upon these bands, and beginning at the same end, you place doubled compresses five inches wide, each of which covers half the breadth of the preceding one. A splint, as long as the limb, is then placed along each side, and the towel, bands, and compresses rolled over them until they meet in the centre. Thus arranged, the apparatus can be easily transported.

To apply it, the assistant, who makes the extension, raises the foot, drawing it towards himself, while the surgeon, seizing the leg with his left hand (if it is the right leg) above the fracture and with his right hand below, maintains the reduction. Another assistant places the bandage under the limb, and, unrolling the splints, spreads out the apparatus. The limb is then placed carefully in the centre, and, while the assistants keep up extension and counter-extension, the compresses and bands are freely wet with a mixture of two parts of water and one part of camphorated alcohol. The surgeon then takes the lowest compress by one end, while an assistant holds the other, rolls it smoothly over and engages its end under the limb on the opposite side; he then brings over the other end and tucks it under on his own side. He does the same for each compress, one after the other, and then applies the bands in the same way. He then rolls up the outer splint in the towel and places a chaff-bag, an inch thick, between it and the leg; an assistant does the same on the opposite side, and the apparatus is completed by means of an anterior bag upon which is a shorter splint.

¹ Malgaigne, *Sur les Appareils contentifs des Fractures en général* (concours de professorat, Paris, 1841), and Gaujet, *Arsenal de la Chirurgie contemporaine*, Paris, 1867, tome I.

The assistant then holds the three splints in place while the surgeon ties or buckles the straps. He takes care that the heel does not press upon the bed, so as to avoid those intolerable pains which are sometimes caused by continuous pressure of the calcaneum. If this pain occurs the surgeon places a small square cushion under the lower part of the leg so as to raise the heel from the bed. A hoop or cradle protects the leg from the weight of the bedclothes.

Sometimes the point of the foot has a tendency to incline to the right or left. I then fix it in a good position by means of a long compress wrapped about it and fastened on each side to the bed. The foot is in a good position when a line drawn from the patella to the great toe is parallel to the axis of the leg.

I advise you to familiarize yourselves with the construction and application of Scultet's apparatus; for in private practice you will often employ it. But, when you make use of it, do not forget one principal precaution, that of not making it too tight at first. It has been often discussed whether it is better, for fractures in general, to reduce them and apply at once the restrictive apparatus, or to wait until the inflammatory period is ended. That is a question which should not be examined generally; its answer varies according to the regions.

As for fractures of the leg, it is incontestable that the patients feel better and suffer less when the limb is kept in a good position. I advise you then to apply the first day the restrictive apparatus which you may select. But do not forget that the limb will swell, on account of the distant infiltration of the blood which continues to be poured out by the fractured surfaces, and of the serosity exuded during the inflammatory process. Consequently it must not be tightly applied at first, for a slight constriction might be turned into a strangulation by this inevitable increase of volume. Of course, in a limb so well supplied with muscles and whose arteries are so well protected, gangrene is not to be feared, at least in an adult, but the constriction might cause new phlyctenæ, and, above all, it would have the disadvantage of causing the patient to suffer, of preventing sleep. Now, our duty is to avoid causing useless suffering, and, moreover, suffering affects the health.

I told you that to have a regular and prompt consolidation it was necessary that the general health should be troubled as little as possible. With troughs and straps we can easily avoid too much constriction, and if by chance it should be too great, any one can loosen the straps without disarranging the apparatus. With Scultet's apparatus this is not so; when the constriction is painful, it is necessary to await the arrival of the surgeon, and consequently long suffering is needlessly inflicted upon the patient. You will avoid this by not tightening at first, and by renewing the application every day so as to proportion the compression to the increase or diminution of volume.

I have sometimes used Malgaigne's box, or Jules Roux's *planchette polydactyle*.¹ The latter is very convenient, especially if you take care

¹ A trough pierced with holes through which pegs are passed to press upon the fragments and keep them in position.—TRANS.

to pad it well with cotton or with a sheet, and if the holes through which the pins are to pass, are numerous enough to furnish, on each side of the foot and leg, sufficient support for the limb.

These apparatuses have the advantage of allowing the surgeon to easily uncover the fractured limb to see what is going on, treat the phlyctenæ, arrange the degree of constriction according to the change in size, and make, if necessary, a new reduction. Among these apparatuses, I may even establish a distinction between those which leave the anterior part of the limb uncovered, and those which allow the fractured point to be seen only after they have been entirely, or in part, removed.

The first, which I also call *open apparatuses*, are the troughs, when they are not closed by means of the anterior splint and strips, Roux's *planchette polydactyle*, the simple cushion-trough which I have sometimes used, and which consists of a large square cushion, filled with chaff, upon which the leg is placed, and then its sides are turned up and fastened with straps, taking care to leave an open space in front through which the leg can be seen and felt. I might add, as forming part of this category, Maisonneuve's plaster splints. They are made of two pieces of linen, folded in eight thicknesses, and long enough for one of them to pass along the back of the leg and sole of the foot to the ends of the toes, and for the other to encircle the sole of the foot like a stirrup, and pass up each side of the leg as far as the knee. These pieces of linen, dipped in plaster, and folded so as to be two and a half inches wide, are applied to the leg, and kept in place by a roller bandage until they become dry, when the bandage is removed, and three strips of diachylon substituted, one about the foot, the other two about the leg, leaving a part of the anterior face of the leg, and particularly that which corresponds to the fracture, uncovered. This apparatus is very restrictive, but after having used it for more than a year I have given it up, for two reasons: first, because upon patients with a fine and delicate skin, especially women, the diachylon causes an erythema and unpleasant itchings; and secondly, because I have twice seen an eschar produced on the heel, on the most prominent part of the calcaneum.

The second, the *enveloping apparatuses*, are all those which hide the fractured limb from the sight of the surgeon, and allow him to examine it only by removing them in whole or in part. The Scultet apparatus and the roller bandage are types of this variety. The first is much to be preferred, because the limb can be uncovered without raising it, and consequently without giving it any movements which might be painful or might disarrange the position of the fragments or the work of consolidation. The trough, with straps, bag, and anterior splint, belongs to the same category. If I have given it the preference, it is simply because, without spending too much time, I can unbuckle it, remove the splint and the bag, examine the limb, and put everything in place again. But I repeat that if you are willing to give it a little more time, the indication is met as well with the Scultet or any other apparatus, as with that which I now use upon our two patients.

I have already told you that in about three weeks I shall change the apparatus, and substitute an immovable roller bandage, made with a very concentrated solution of silicate of potash. Why this change? It is certainly not that the consolidation may take place more regularly or rapidly. You know what are the anatomico-physiological phenomena which accompany the formation of the callus; you are acquainted with the first period, that which is characterized by the effusion of blood and plastic lymph about and between the fragments, that which almost always, passing beyond the simple needs of repair, gives us, clinically, the inflammatory phase. You know the second period, that which begins between the eighth and thirteenth days, and during which the plastic matter, and perhaps the blood, are transformed into a cellulo-fibrous substance about the fragments and the periosteum. Finally, you know the third period which, beginning from the twelfth to the fifteenth day, and continuing until the end of consolidation, is characterized by the deposit of phosphate of lime and the formation of bone corpuscles in the fibro-cartilaginous substance. Well, these phenomena go on independently of our apparatuses; we apply the latter that the former may follow one another while the limb is fixed in a good position, and that the callus may be as little of a deformity as possible. If we should put on no apparatus, the consolidation would, none the less, take place, provided that the limb was kept nearly immovable, but it would be irregular.

If then we have recourse afterwards to an immovable bandage, it is not to accelerate nor to regulate the callus; in this respect the trough, continued until the forty-fifth day, the Scultet's apparatus, if we had used it, would give exactly the same results. We have no other intention in thus modifying the treatment than to make the patient a little more comfortable. You have often heard me ask patients with broken legs a day or two after the application of an immovable apparatus if they felt more or less comfortable than with the one that had been first applied, and you have heard almost all of them reply that they felt easier because it was lighter, and because the limb, especially the foot, being better immobilized, they can turn and move a little in the bed without causing any pain. It is then because the immovable apparatus is more convenient and more agreeable to the patients that we use it. As for any preference for the silicate of potash, it is not absolute, and nothing would prevent us from using dextrine, simple plaster, or plaster mixed with gelatine, or starch upon linen or paper. It is quite indifferent. The important thing is to know how to well utilize these different substances.

A few years ago I used a good deal, and even now sometimes use plaster or dextrine, which I applied in the following way:—

With the plaster we first make a clear paste by mixing it with water, and then roll a dry band about the limb, previously covered with a thick layer of cotton, while the leg is held by three assistants, two of whom make extension and counter-extension, and the third supports it at the point of fracture. I then roll a band of coarse tarlatan about the limb, beginning at the foot, soaking it in and covering it, as I advance, with the clear plaster paste placed in a basin under the leg. I

apply the plaster thus in three superposed layers of tarlatan so as to have a sufficient thickness.

I much prefer this method to that of first applying the plaster to an ordinary band and then rolling it about the limb.

Dextrine is applied as follows: it is not easy to dissolve this substance rapidly in water, and it would require too much time to make a homogeneous glue. In order to obtain it immediately we first mix the dextrine with alcohol, which does not dissolve it, but which gives it the appearance of a fine moist sand, then we slowly add hot water. As the water has a great affinity for the alcohol, it penetrates into all the interstices and dissolves the dextrine at once. The alcohol has the additional advantage of making the solution dry more rapidly.

When the solution is brought to the consistency of a thick syrup, a bandage is unrolled and rolled up again in it so as to be thoroughly impregnated with it. The bands thus prepared may be kept for some time.

The limb is covered with a layer of cotton kept in place by a dry band over which the dextrinated one is applied. When this application is ended, a little of the solution is spread over the outside to fasten the edges down. Bottles of hot water are placed about the leg to hasten the drying, and yet, notwithstanding that, it does not become perfectly solid in less than forty-eight hours.

That is the disadvantage of dextrine: plaster dries too quickly, dextrine too slowly. We possess now an intermediate substance, of which I have spoken—the silicate of potash. The prepared solution is kept for sale. It is obtained by heating to red heat a mixture of one part of powdered quartz with four parts of carbonate of potash. The substance thus obtained is dissolved in water, and evaporated to the consistency of a thick syrup.

It is applied exactly like dextrine, and has the advantage of drying much more rapidly, but the impure article which we sometimes receive dries quite as slowly. At present I use the silicate because it is good, but you would see me return to the dextrine in case I found that the silicate furnished by the administration did not dry rapidly enough.

You might also use plaster with the addition of gelatine, in the proportion of two parts in a thousand of water, as recommended by Prof. Richet. The mixture, which is quite convenient, has, like the silicate of potash, the advantage of drying less rapidly than ordinary plaster, and more rapidly than dextrine.

When you wrap the band soaked in a solidifying mixture about the limb, it is necessary: 1st. To have the limb supported above and below the fracture by two aids, who will make extension and counter-extension; 2d. To make sure that displacement is not produced, an accident which is not probable, since we have reached a period in which the consolidation is sufficiently advanced to prevent the fragments from separating with so much ease; 3d. To see that the foot is so placed that a line drawn from the centre of the inner border of the first metatarsal bone to the inner border of the patella, is parallel to the axis of the leg; 4th. To surround the limb with a layer of

cotton, so as to protect it from too much pressure upon certain points; 5th. To tighten it only moderately; the effects of too great constriction would undoubtedly not be so bad as during the first period of the fracture, but yet this excess of constriction might cause pain and oblige the surgeon to remove the apparatus the next day or the day after. Of course it ought to be examined after it has become dry, to see if it threatens to cause excoriation or gangrene of the skin at any point, and to prevent this complication, either by putting some more cotton between that part of the skin and the apparatus, or by cutting away the offending part. These precautions are especially necessary in persons, such as women and children, whose skin is thin and easily irritated or broken.

LECTURE XII.

FRACTURES OF THE LEG—CONTINUED.

Fractures of the leg in the lower third, continued—"V" fractures with displacement which is reducible, but difficult to maintain reduced, and fractures with irreducible displacement (3d and 4th clinical varieties)—Fractures with incomplete perforation of the skin (5th clinical variety).

GENTLEMEN: I. At No. 26, Ward Sainte-Vierge, is a man 35 years old, of habitual good health, who was brought to us ten days ago with fracture of the lower third of the right leg, caused by a fall down a staircase, but which still seems to have been indirect.

I shall not occupy your time with the question of diagnosis. As in the other cases of which I have had occasion to speak, the diagnosis was easy; inability to walk, pain, swelling during the first few days, mobility, crepitation, left us no doubt of the existence of a fracture of the two bones.

I showed you, from the first, that there was an angular displacement, for the leg described a curve the concavity of which was directed upwards, and a rotatory displacement, for the foot rested on its outer portion, and had turned outwards with the lower fragment. I told you that we had easily corrected these two displacements. But in addition we had the most common variety of transverse displacement, that in which the upper fragment projects in front. You were able to feel the first day, when as yet there was no swelling, that this projection of the upper fragment, instead of terminating in a sharp point corresponding to the crest of the tibia, as is the case in oblique fractures, had its point placed upon the antero-internal face, and at the extremity of two lines of equal length, so that the edge of the upper fragment had the form of a projecting V.

I reduced this displacement, as I did the other two, the first day by

the classical manœuvre of reduction, then placed the limb in a wire trough, and completed the dressing with the bag, the anterior splint, and the straps with which you are already acquainted. But when I examined the leg the following morning, I found, that, although the angular and rotatory displacements were not reproduced, the transverse one had reappeared, and that the point of the projecting V exerted quite a strong pressure upon the under surface of the skin. I reduced it again, and then, replacing the limb in the trough without completing the apparatus, I observed what took place. We saw the upper fragment resume almost immediately its vicious position and project under the skin. Again reducing it, I tried to maintain the reduction by means of a layer of cotton and two longitudinal graduated compresses, which I placed along the whole length of the upper fragment from two finger-breadths above the point of the V, so as not to make compression over the point itself. My intention was to distribute a moderate compression all along the upper fragment. Above the graduated compress I placed the bag and anterior splint, which I bound down with three straps about the upper fragment, and one about the lower one. The foot was also fastened to the sole of the trough with a band.

The next morning, by slipping my finger underneath, I felt that the point did not again project, and thence inferred that the displacement had not been reproduced.

But the following morning it was not the same. The projection had again become very notable. I again reduced it, and renewed the compression all along the upper fragment by means of a triple graduated compress and a layer of cotton.

The apparatus has now been five days in place, and the displacement has not reappeared; I therefore hope that it will remain reduced. Of course, if it should reappear after a few days, I should again reduce it, and try to make a more efficacious compression along the upper fragment.

Two peculiarities here require attention: 1st, the V-shape of the upper fragment; 2d, the difficulty of maintaining the reduction.

1st. The V shape of the upper fragment has not in itself a very great importance. But it has the advantage of indicating some anatomo-pathological details of a certain clinical value, which without it we could not suspect.

I have made several autopsies of fractures of this kind while they were quite recent, and found that when the upper fragment showed this projecting V in front, its posterior surface was very irregularly divided, and showed also two lines of fracture forming a re-entrant V with its point directed upwards, that at the same time the inferior fragment presented in front a hollow V corresponding to the projecting one of the upper fragment, and on the posterior surface a point fitting into the re-entrant V of this latter. Hence an irregularity in the main line of fracture, which cannot be included in the anatomo-pathological divisions, heretofore admitted, of transverse and oblique fractures, and which was better described by Gerdy under the name of *toothed or pointed fractures*. It is a curious and inexplicable thing,