CHAPTER XXXIII.

FRACTURES OF THE TIBIA AND FIBULA.

Causes.—A majority of these fractures are the results of direct blows or of crushing accidents, such as the kick of a horse, the passage of a loaded vehicle across the limb, the fall of heavy stones or timber, etc.

In an analysis of two hundred and seventeen cases, where I could ascertain the cause, I have found the bones broken in the upper third from a direct cause seven times, and from an indirect cause three times. In the middle third fifty-two have been referred to a direct cause, and ten to an indirect; and in the lower third fifty to a direct cause, and thirty-two to an indirect. An observation which does not sustain the remark of Malgaigne, based upon his analysis of sixty-seven cases, that fractures of the upper third are produced by direct causes alone, those of the middle third much more frequently by indirect causes, and that those of the lower third are especially due to indirect causes.

Of the indirect causes, falls upon the feet from a considerable height—as from a scaffolding, or from a top of a building—are by far the most common. Eight times I have found the bones broken by muscular action alone, as in the following example:

Mrs. W., of Buffalo, aged about twenty-five years, and weighing at this time nearly two hundred pounds, was descending her door-steps with an infant in her arms, when, the steps being covered with ice, she slipped and fell, breaking her right leg just above the ankle. Mrs. W. says she felt and heard the bones snap before she touched the steps. Of this she is certain.

I found the tibia broken obliquely, the fragments being quite movable, but not much, if at all, displaced. The limb was dressed with a carefully moulded and well-padded gutta-percha splint, and then laid in a pillow upon the bed. Mrs. W. experienced unusual pain from the fracture for several days, for the relief of which we were compelled at times to permit her to inhale chloroform. She was of a nervous temperament, and had frequently resorted to chloroform before to relieve neuralgic pains. The limb became very much swollen, and remained so for a week or two. No extension was ever employed.

Within the usual time the bones united in perfect apposition, and in about four months she was able to walk without any halt.

Pathological Anatomy.—We have seen that fractures of both bones through some part of the lower third are most frequent. Thus, of two hundred and seventeen fractures, twenty-two belonged to the upper third, seven to the middle, and one hundred and twenty-five to the lower. In some cases the two bones were broken in different divisions. It is often difficult, and sometimes quite impossible, to determine precisely where the fibula is broken; but the analysis is sufficently correct to illustrate

the much greater frequency of fractures of the lower third, and also the fact that the two bones generally break nearly on the same level; usually the point of fracture in the tibia is between two and three inches above the joint.

In an examination of twenty museum specimens, I have found both bones broken at the same point, or within two or three inches of the same point, sixteen times, and at extreme points four times; and in these last examples the tibia has always been broken in the lower third, while the fibula has been broken in the upper third.

In twenty of the fractures mentioned as belonging to the lower third only the malleolus of the tibia was broken, while the fibula was broken two or three inches above its lower end. Some of these were complicated with dislocation of the angle.

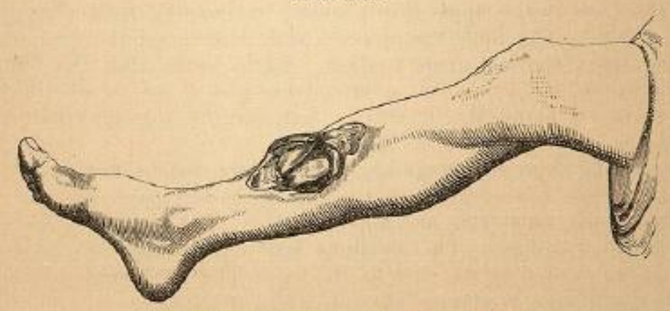
I have seldom seen a transverse fracture of the tibia, except in its lower or upper extremity, in the expanded portions of the bone; and even in those examples which we are accustomed to call transverse, because they are sufficiently so to prevent any sliding or overlapping of the fragments, there has existed, generally, a marked inclination of the line of fracture in one direction or another.

The examples of fracture produced by muscular action have, without an exception, occurred in adults. Five of them were in the lower third of the leg, and three in the middle third. I think they were all of them nearly transverse, since they never became much, if at all, displaced.

Most of the fractures of the tibia produced by falls upon the feet are very oblique, and the direction of the fracture is generally downwards, forwards, and inwards; but I have found almost every conceivable variation from this general rule.

The fracture in the fibula is even more constantly oblique than the fracture in the tibia; but this is a point of very little practical consequence, and one which we can seldom determine positively, unless one of the fractured ends protrudes through the flesh.

FIG. 232.



Compound and comminuted fracture of the leg.

Compound and comminuted fractures are more frequent here than in any other of the bones of the body. My tables, which have rejected all fractures demanding immediate amputation, most of which are compound,

do not for this reason give a just idea of their proportion to simple fractures, yet even in these tables, of two hundred and seventeen fractures, seventy-four were compound, and also, frequently, more or less comminuted. Of eighty cases reported by W. W. Morland, of Boston, from the Massachusetts General Hospital, and in which the character of the accident is recorded, thirty-nine were compound.[1]

Symptoms.—The symptoms indicating a fracture of both bones of the leg are the same which are usually present in other fractures, namely, mobility, crepitus, shortening of the limb, distortion, swelling, etc. Generally, the lower end of the upper fragment projects in front, and can be seen or felt; but in some instances the swelling follows so rapidly that it is impossible to feel distinctly the point of fracture, and its existence can only be determined by the crepitus, mobility, and shortening of the limb, or, perhaps, by the marked deformity or deviation from the natural axis.

The shortening, where it exists at all, varies at the first from a line or two to one inch. Generally, it is about half an inch.

Dr. E. D. Merriam, of Conneaut, has reported to me a fracture of both bones of the leg, which occurred in his own person; the tibia being broken transversely near its upper end, and that portion of the fibula being also broken off to which the biceps is attached. The small fragment of the fibula became tilted outwards, and in this position it has remained permanently. I have spoken of this form of fracture more fully in connection with fractures of the upper end of the fibula.

Prognosis.—The average period of perfect union in twenty-nine cases, including those in which union was delayed by extraordinary causes beyond the usual time, was forty days. The general average, under ordinary circumstances, may be stated at about thirty days.

Union has been noted as delayed a few weeks beyond the usual time in at least twelve cases of simple fracture. Cases of complete non-union are less frequent here than in the femur or humerus, the union taking place spontaneously often after the lapse of several months. I shall refer to this subject again when speaking of the treatment.

F. C. T., of Erie Co., N. Y., æt. 35, had an oblique, simple fracture of both bones, in the upper third, caused by jumping from a buggy, in June, 1852. The limb was dressed with lateral splints, compresses, and bandages, and laid upon a pillow. Eight weeks after the fracture had occurred, the gentlemen in attendance wished me to see the limb with them. I found Mr. T. still in bed, and the fragments not at all united.

Mr. T. had enjoyed average health heretofore, but he was never very robust. When I was called to see him he looked pale; his skin was cold and moist, pulse 120, and appetite poor. The broken leg and foot were greatly swollen. The swelling was œdematous. Considerable excoriations existed on the back of the leg. The fragments were quite movable, and were overlapped three-quarters of an inch.

We agreed that the patient ought, as soon as possible, to be got out of bed, so as to enable him to recover his strength, which had sadly declined. To this end, a gutta-percha splint was made to fit accurately

[1] Trans. of Mass. Med. Soc. for 1840; Fractures, by A. L. Pierson.

the whole length of the leg; and, having attached a large number of tapes, it was secured upon the limb. Several times each day it was to be removed, and the limb bathed with brandy and water. Gradually, also, the limb was to be brought down to the floor, and the patient be made to sit up, and, as soon as possible, he was to walk with crutches, or to ride.

Nov. 4, 1852, Mr. T. visited me at my house. The directions had been followed implicitly. About two weeks after my visit he rode out, and in about nine weeks, or seventeen weeks from the time of the fracture, the bones were found united. His health and strength were quite restored, and the limb was no longer œdematous. It was found to be straight, or with only a slight projection of the upper fragment in front of the lower, and shortened three-quarters of an inch.

In most oblique fractures of the shafts of these bones, union takes place with some shortening, the average being, even in simple fractures, about half an inch, but in some cases I have found the shortening one or even two inches. With judicious management, however, in simple fractures, this amount of shortening seldom or never occurs.

Inasmuch, however, as among the claims lately instituted for the plaster of Paris dressing, it has been affirmed by at least one surgeon that it is competent to prevent in all cases shortening after fractures of the bones of the leg, as well as of the thigh (see chapter on General Prognosis), it may be necessary to refer the question at once to the test of experience, and thus dispose of it before considering the subject of treatment.

Flori Albert, æt. 24, fell, April 11, 1876, breaking his left leg three inches above the ankle, and was admitted to my service at Bellevue on the same day. My house surgeon, Dr. Thomas, while the limb was extended to its utmost, applied the plaster of Paris dressings from the toes to the knee. The dressings were removed, in my presence, at the end of six weeks, when the bones were found united with a shortening of one inch.

Timothy Mahoney, æt. 30, fell and broke his left leg by a twist of his foot, February 21, 1873. Admitted to Bellevue, ward 16. Fracture simple, oblique, and in lower third. Plaster of Paris was applied at once, while extension was made to the utmost. The splint was renewed once during the treatment, and on the 19th of April, the splint being removed, I found the limb united, and shortened three-quarters of an inch.

These two cases will serve to illustrate what has been my experience at Bellevue and elsewhere with the plaster of Paris as a means of extension. Of fifteen cases of oblique fractures of the shaft in my record, the average shortening is nearly three-quarters of an inch, and all are shortened. It is not the practice generally at Bellevue to give an anæsthetic in applying plaster to the leg, nor is it mentioned as having been used in more than one of the cases contained in Dr. Van Wagenen's tables, referred to in the chapter on General Prognosis. But, to determine the value of this method in a case of simple oblique fracture of both bones, I first measured the limb carefully before it was dressed, and found it shortened half an inch. The patient was then placed under the influence of an anæsthetic, and forcible extension made with pulleys

until the limb was of the same length as the other. In this position it was retained until the plaster was applied, from the toes to above the knee, and had hardened. At the end of about six weeks the dressings were removed, and the limb was found to be shortened half an inch precisely the same as before the extension was employed.

It is certain that this form of dressing makes no permanent extension within a range of three-quarters of an inch, and that, therefore, for all practical purposes, as a means of preventing shortening, it is useless.

Generally, when a shortening has occurred, I have found the upper fragment in front of the lower, and oftener a little more upon the inner than upon the outer side.

A deviation from the natural axis of the limb has been noticed by me in a good many instances. Several times the lower part of the limb has fallen backwards; or, in consequence of its having rested too much upon the heel, it has inclined forwards; and in other cases it has inclined inwards or outwards.

Ulcers upon the back of the heel, seen by me many times, as a result of undue pressure upon this part, have, however, been presented but seldom in cases of simple fractures.

It is not very unusual to find, also, over the exact point of fracture, and after the lapse of several months, or even years, an ulcer, or sinus, which is due sometimes to the presence of a small fragment of bone which has remained in the wound from the time of the accident, or to a thin scale which has subsequently exfoliated. In other cases it is due to the prominence of the salient angle when the lower part of the limb inclines considerably backwards; and in still other cases, no doubt, to the general dyscrasy of the system, and to the same causes which produce chronic ulcers in the lower extremities where only the skin has been originally injured. I have reported elsewhere examples of this complication existing after five months, two and three years,[1] and in the remarkable case which I shall now briefly relate an ulcer existed at the end of twenty-three years.

Thurstone Carpenter, when four years old, received an injury, breaking both bones of one of his legs near its middle. The fracture was compound. It was dressed and treated by an excellent surgeon, then residing in Buffalo, but long since dead.

Twenty-three years after the accident, Mr. Carpenter called upon me on account of a paralysis of his lower extremities, which had recently occurred. He stated that from the time of the fracture until within about one year an open ulcer had existed over the seat of fracture, and that soon after it had closed over completely he began to lose the use of his limbs. During the time it was open, small scales of bone have frequently been thrown off. The limb is half an inch shorter than the other, but straight.

A gentleman residing in Quincy, Chautauqua, Co., N. Y., had his tibia and fibula broken near the ankle-joint in the year 1844, by the passage of a carriage-wheel across his limb. The skin was a good deal lacerated. The wounds, however, healed kindly, and the broken bones

[1] Trans. Amer. Med. Assoc. Report on Deformities after Fracture.

united in the usual time without any apparent deformity; but the limb continued swollen and painful, until finally suppuration took place. After twelve years of great suffering, I amputated the leg near its middle, from which time he made a speedy recovery. I found the lower end of the tibia inflamed, softened, and expanded, and containing in its interior about three ounces of pus, but no sequestrum.

Anchylosis of the knee- or ankle-joint may follow as a result of the accident or of improper treatment; and at one or both of these joints I have found more or less anchylosis at the end of nine months, one year, six years, twenty-five, thirty, and forty years. Generally, however, it disappears in a few weeks, and seldom remains to any considerable extent in the knee-joint after the dressings have been removed two or three weeks; but an Irishman called upon me in 1853, whose leg had been broken about three inches below the knee-joint six years before. It was a simple fracture. A surgeon in Ireland had treated the case. I found the limb shortened one inch and a half, the fragments being overlapped and displaced backwards at the point of fracture. The knee was also partly anchylosed. I could not learn what the treatment had been.

In other cases, where no permanent anchylosis has followed, the ankle-joint has been occasionally painful, and subject to swellings, after the lapse of many years.

In Muhlenberg's tables, already referred to in previous chapters, there are recorded 94 cases of delayed union or of non-union of these two bones at the same time; also 84 similar cases where the tibia alone was ununited, and 2 in which the fibula alone was ununited: making a total of 180 cases.

After all that has been said as to the occasionally serious nature of the consequences of these accidents, as shown in the shortening of the limbs, in their deviations from their natural axes, in the stiff ankles, ulcers, and abscesses, it must be still admitted that in another point of view these results are not extraordinary, and may hereafter continue to be fairly anticipated in a certain proportion of cases, even under the best management; since it must be understood that more fractures of the leg are attended with serious complications than of any other limb; and that while many produce death rapidly from the severity of the shock, and very many are condemned at once to amputation, a large number of those which are saved have been in that condition which has rendered the application of bandages or splints impossible for many days. Indeed, not a few of these crooked limbs may still be presented as real triumphs of the art of surgery, inasmuch as by consummate skill alone have they been saved.

Treatment.—It is wholly impossible in a class of fractures which present so great a variety in regard to form, seat, and complications, to establish any universal system of practice; nevertheless it is possible to declare certain general principles in reference to a few well-recognized classes or varieties: and I shall deem it especially important to record my disapproval of certain plans of treatment which have from time to time been suggested and adopted.

It is seldom that I have found it necessary or useful to apply any bandages directly to the skin, whatever form of apparatus has been em-

ployed; but in certain cases of compound fractures, where primary dressings have been applied which needed support and protection, a bandage has been of service. The roller, unless the patient is a child, whose limb can be easily lifted and managed, is always objectionable; but the many-tailed bandage, made of narrow strips of cloth, laid upon each other, as we have already described in our general remarks upon bandages, etc., is occasionally useful.

Having made these preliminary dressings, we flex the leg to a right angle with the thigh, and by the hands make extension and counter-extension as much as the patient will bear, or as much as may be necessary to restore the fragments to place, in case this restoration is found to be practicable. If the fracture is compound, and the point of bone protrudes through the skin, it is often difficult to replace it. That is, we are unable to overcome the action of the muscles sufficiently to make the limb of its natural length, and for this reason, mainly, we are unable to get the point of bone beneath the skin. If we cannot then "set" the bone, or bring the ends into apposition, and this will be the fact pretty often, we still have no apology generally for leaving the bone outside of the skin. First, an attempt must be made to accomplish this reduction by pulling aside the skin with the fingers, or with a blunt hook. This simple procedure has often succeeded with me in a moment, when others have been trying in vain to accomplish the same end by pulling upon the limb. If this fails, then the skin should be cut sufficiently to allow the bone to retire, or if the point is sharp, and especially if it is stripped of its periosteum, it may be sawn or cut off. Resecting thus the end of an oblique fragment does not generally affect in any degree the length of the limb, or interfere with a prompt and perfect cure, but, on the contrary, it often is advantageous in every point of view. In certain exceptional cases we may find it advantageous to employ an anæsthetic to aid us in the reduction.

We are now prepared to apply the splints. Before, however, considering the character and form of the splints to be applied, it seems proper to call attention again to the danger of ligation of the limb from the tightness of the bandages, and especially from the use of a bandage or roller placed beneath the splints and directly against the skin.

The large size and irregular form of the bones of the leg, the small amount of muscular tissue covering them, especially near the articulations, the severity of the injuries to which they are liable, with their remoteness from the centre of circulation—these circumstances altogether, render them exceedingly exposed to injury from the too great or unequal pressure of splints or of bandages; and it has often occurred to myself, as it has to Dr. Norris, whose remarks upon this point I have already quoted, to find the skin vesicated, or even ulcerated and sloughing, when the patients are first admitted to the hospital; a condition which, in nine cases out of ten, is due to the maladjustment of the splints, or to the tightness of the bandages.

If bandages are used under the splints, and next to the skin, they must be applied very moderately tight, and loosened or cut as the swelling augments; and, from the first day of treatment to the last, the surgeon must be careful to loosen or tighten the dressings when the swelling

increases or subsides, just as the prudent boatman trims his sails to the rising and falling breeze.

Dr. Krackowizer presented to the New York Pathological Society, June 10, 1863, a leg which he had amputated for gangrene occasioned by tight bandages. A boy, five years old, sustained an injury of the ankle-joint, which his medical attendant pronounced a fracture of the fibula, and for which he applied only a tight bandage. The child suffered a good deal after the bandage was applied, and the following morning the toes were blue, but the doctor paid no attention to this circumstance. The pain subsided on the third day, and on the fourth the bandages were removed, and the limb found to be gangrenous.

The specimen showed that the fibula was not broken, but that there was a fissure or crack in the lower part of the shaft of the tibia.[1]

The following case, which has been communicated to me by Dr. Fuller, of Wyoming, N. Y., with permission to make such use of it as I saw fit, is sufficiently pertinent and deserves a public record:

A man, æt. 71, fell from a tree, striking upon his foot, August 27, 1855, producing a backward dislocation of both the tibia and fibula upon the astragalus, and also a fracture of both bones of the leg a few inches above the ankle.

An empiric took charge of this unfortunate man, and immediately applied lateral splints and a firm roller from the toes to the knee. Notwithstanding the remonstrances and prayers of the patient to have the bandage loosened, it was kept on until the ninth day, when the doctor cut the bandage upon the top of the foot, and it was found vesicated. Ignorant, however, as to the cause of this vesication, and of the danger which it threatened, he omitted to loosen the remainder of the bandages, and the limb was left in this condition until the twenty-third day, when Dr. Fuller being called, and having removed all the dressings, found the integuments covering the whole foot dead and dried down to the bones. The dislocation had not been reduced. Soon after this the limb became œdematous, and on the 27th of October the leg was amputated by Dr. Barrett, of Le Roy, from which time the patient recovered rapidly.

The fragments being adjusted, two lateral splints of leather, long enough to extend from near the knee-joint to the metatarso-phalangeal articulations, and wide enough nearly to encircle the limb, are moulded to the limb on each side, and secured in place by successive turns of the roller. When the skin is delicate or tender, these should be underlaid with a thin sheet of cotton wadding or of sheet lint. A soft woollen cloth may answer the purpose equally well. A rack is then placed over the limb, such as will be seen figured for the suspension of the limb when dressed with plaster of Paris, and from this the leg is suspended. The objects to be attained by the suspension are threefold: first, to avoid the danger of pressure upon the heel, and consequent ulceration; second, to prevent that driving down of the upper fragment upon the lower which constantly ensues when the foot rests upon the bed, or in a box which is immovable; third, to obviate movement of the fragments upon each other when the patient sits up or lies down in bed. This movement, I

[1] Krackowizer, Amer. Med. Times, Nov. 7, 1863.

observe, is peculiar. It is not simply a motion of the fragments upon each other, as upon a pivot at the point of fracture, which motion seldom interferes materially with consolidation, but it is a rising and falling of the upper fragment, or a motion to and fro of the fragments, and also a riding motion; either of which latter movements necessarily delays or defeats bony union. It is because these motions are generally permitted to occur in the usual modes of dressing these fractures, more than for any other reasons, that union is so often delayed in the case of these bones. In my own practice, when this plan of suspension is enforced, delay seldom occurs, but nothing is more common than for me to meet with it when other surgeons have had charge of the limb, and the suspension has been omitted.

In suspending the limb, it is only necessary that the leg should float clear of the bed; and I think it worth while to say that when lateral splints only are used, broad oval pieces of leather or of some other firm material should receive the limb in suspension, rather than narrow pieces of bandage, which soon become cords, and press unequally. To the sides of these oval pieces bands are attached, and their ends tied over the top of the rack. One must be placed under the knee and one under the ankle.

If the fracture is above the middle of the leg, complete quietude of the fragments can only be obtained by carrying the splints and the bandages above the knee.

I have already, in my remarks on the treatment of fractures in general, declared my acceptance of the so-called "immovable apparatus" in the treatment of certain fractures of the leg below the knee, and especially of the plaster of Paris dressings. In hospital practice, where these dressings can be applied by experts, and where the limb can be watched daily and hourly, most or all of the dangers incident to this form of dressing may be avoided; but even here I have occasionally seen, from a little too much delay in opening the dressings, serious trouble ensue. Its most devoted advocates, Seutin, Velpeau, and others, have never denied the necessity of caution in its use. To-day I hear of a surgeon in a neighboring State who has been prosecuted for damages in consequence of the death of the limb, caused, as is alleged, by this form of dressing. On the other hand, when applied judiciously, even immediately after the receipt of the injury, and when carefully watched and opened freely on the first notice of danger, it has, in my wards, and in the hands of my excellent house surgeons, often served its purpose more completely than any other apparatus or splints I have ever seen employed. It has steadied and supported all parts of the limb more completely, and permitted it to be handled more freely, than anything else could do. In simple fractures patients have been permitted to walk about upon crutches after the third or fourth day, and generally no harm has resulted. In one case, however, I believe this liberty caused a serious delay in the union; and in another an abscess resulted, which would have been avoided if he had remained in bed.

But it is in the management of compound fractures of the leg that I have of late seen the greatest advantage in this mode of dressing; and it was in precisely these cases that I formerly believed the immovable

apparatus most objectionable. I do not wish, however, to retract anything I have heretofore said as to its dangers in most cases of recent fractures of the leg, or as to its ability to make permanent extension in all cases, whether the fracture is simple or compound.

The following careful description of the proper mode of applying plaster of Paris bandages in fractures of the leg, has been prepared at my request by Dr. S. B. St. John, late House Surgeon to Bellevue Hospital. His large experience and his habits of accurate observation render his statements peculiarly trustworthy.

"The materials necessary are, blanket, or cotton-wadding, blanket being preferable, and plaster of Paris bandages, which are prepared by rubbing dry plaster into the meshes of a bandage of coarse texture, and rolling it up so as to make it convenient of application. (These may be kept ready for use in tin cans.) The bones having been placed in position, the leg is placed upon the blanket, which is cut and folded neatly around it, and secured by a few pins. The blanket should extend from the base of the toes to the knee, or in case of fracture above the middle, or of compound fracture at any point, a few inches above the knee. The plaster bandages should then be immersed in hot water, to which a little salt has been added to hasten the setting, and while in the water they may be gently kneaded to insure moistening of every part. In about three minutes, or when bubbles of air cease to rise from them, they will be ready for use, and should be taken out as they are wanted, and gently squeezed to get rid of superfluous water. They are then to be applied after the fashion of an ordinary bandage, over the blanket, with just sufficient firmness to insure a complete fit. If, at any revolution of the bandage, the plaster is seen to be dry, it should be moistened by dipping the hand in water and rubbing it over the dry surface. Extra turns of the bandage should be taken at the places where it is necessary to secure extra strength to the splint. Three or four bandages (six yards long) are usually sufficient to make a firm splint. This splint will usually be sufficiently pliable just after its application to allow of rectification of any faulty position which may have occurred during its application. It should then be kept in shape by the pressure of the hands until it hardens, which will be in from ten to thirty minutes, according to the freshness of the plaster and texture of the bandages used. If, for any reason, it is desirable to cut the splint so as to admit of its removal, or to cut a fenestra through which to observe any part, this may best be done before the plaster becomes perfectly dry, say in from two to five hours after its application, depending upon the quality and freshness of the plaster. It will then cut like hard cheese, and a stout sharp knife should be used. In splitting a splint anteriorly, it is convenient at the same time to take out a piece about an inch wide, by making two parallel cuts one inch apart, one on either side of the median line, extending nearly through to the blanket, and then by raising the strip at the upper edge, and cutting on either side alternately, the section may be completed, and the central slip removed without danger of cutting through the blanket and wounding the patient. The blanket may then be cut with scissors and the splint sprung off to examine the limb, if necessary. When replaced, a bandage should be applied over it. If it should be necessary to cut

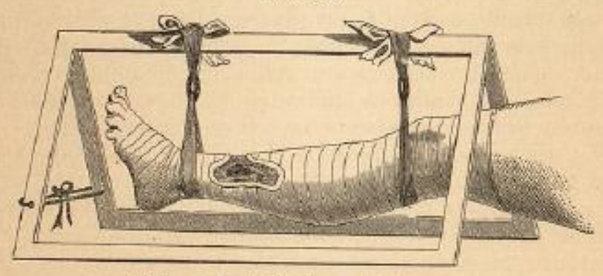
a splint which has already become dry, and cuts with great difficulty, it may be softened with hot water, applied by a sponge in the track of the proposed section for ten or fifteen minutes.

"If it is necessary to cut such a large fenestra that only a small strip of the splint would be left connecting its upper and lower portions, it is better to adopt a different plan of application. For this it is necessary to have a solution of plaster of Paris in water of the consistency of cream. A piece of blanket is then cut long enough to reach from the toes to the top of the proposed splint, and about fifteen inches wide. This is to be thoroughly soaked in the solution, and folded several times so as to be about two or three inches wide when folded. This is to be applied along that part of the limb which it is not necessary to keep under observation (if convenient, along its posterior aspect), and it is then to be secured in position by circular turns of the plaster bandage above and below the portion to be left exposed. Whenever a plaster apparatus extends above the knee, and it is proposed to sling the leg from a cradle, the leg should be flexed slightly upon the thigh, so that it may be swung horizontally. Any portion of a plaster splint exposed to the moisture of discharges or of water used in dressing should be carefully protected by oil silk and cotton-wadding.

"In cases where not much swelling is anticipated, blanket is preferable to cotton-wadding, as an elastic medium between the splint and skin, because it is of more even thickness and retains its place better when the splint is removed, but cotton answers better when much swelling is anticipated, as being more elastic."

The accompanying illustration (Fig. 233) has also been made for me by

Fig. 233.



Plaster of Paris dressing, and suspension.

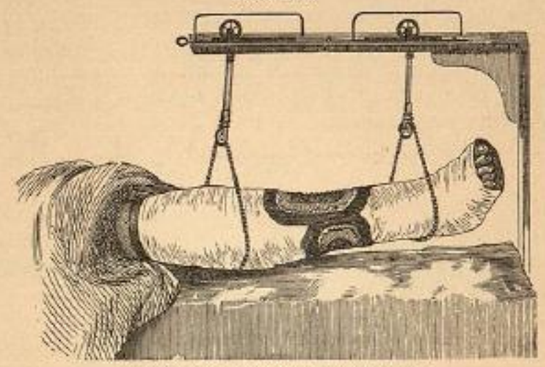
Dr. St. John, and furnishes a faithful picture of one of the many similar cases which have been under treatment by this method at Bellevue Hospital.

Dr. George A. Van Wagenen, while acting as house surgeon at Bellevue, devised a most ingenious, simple, and effective apparatus for suspending the limb, which will be found illustrated in the accompanying woodcut (Fig. 234).

"It consists of an elbow ┐ of wood projecting over the foot of the bed, from which the leg is suspended by two pieces of rubber tubing; one above the ankle, the other just below the knee. The tubes have

common grooved iron pulleys or wheels at each end; those above, rolling on a large iron wire to allow motion toward the head or foot of the bed; those below, at right angles to the others, holding the rings of rope in which the leg rotates; this last being far the most important, allowing the patient *to turn on either side*. Motion on these rollers is accomplished with so *little resistance* that there is *no pain*.

Fig. 234.



Van Wagenen's suspension apparatus.

"The upright of the elbow to go at the foot of the bed should be long enough to rest on the floor, or any convenient part of the bedstead, and project about two feet above the level of the mattress,—the horizontal piece long enough to reach nearly to the knee; pine ¾ by 2 inches is heavy enough. The angle made by these pieces is braced, and a strap of hoop-iron outside makes it very strong. In the horizontal piece two slots are cut wide enough to allow the iron pulleys to pass through, and of sufficient length to allow the patient to draw himself up and down in bed. A ⅛ inch iron wire passes the whole length of this piece above the slots, steadied by small staples, so that it may be withdrawn. On this the upper pulleys run. The wire shields ┌─┐ above these slots are to prevent the bedclothes from resting upon the rollers.

"The pulleys or wheels are fastened in the rubber tubes by making a few turns of copper wire around the iron screw of the pulley. This is pushed into the tube and bound outside with fine wire.

"Rings of rope large enough to pass over the foot are then put through the lower pulleys. If these rings open, or the foot is slipped out of them, the leg is taken down without any of the apparatus about it, and the large wire may be withdrawn and the leg lowered, with the pulleys and rings still attached."[1]

There are a few cases in which a very much better position of the fragments can be secured by placing the patient under the influence of an anæsthetic, and by applying the dressings during complete anæsthesia. But the surgeon needs to be warned of two things in this connection: first, that just as much harm can be done to the soft parts by violent

[1] Van Wagenen, Med. Record, April 1, 1873.

wrenching and pushing when the patient is insensible as when he is fully conscious; second, that while the patient is passing under the influence of an anæsthetic he is liable to violent muscular spasms, which may do serious injury.

Dr. Banga, of Chicago, prefers stilts to suspension, as a means of support for his plaster splint. His method is a modification of a plan adopted by Ries, of Basle; but it does not seem to me to possess any advantages over suspension.[1]

What is known as the Bavarian method of using plaster of Paris has been adopted by some American surgeons, which consists essentially in leaving the splint open in front and behind, or in leaving it connected posteriorly only by a strip of cloth, which serves as a hinge. This plan has been especially recommended by Prof. James L. Little, of this city, by Prof. W. W. Dawson, of Cincinnati, and by Dr. G. Wackerhagen,[2]

Fig. 235.

G. Wackerhagen's method.

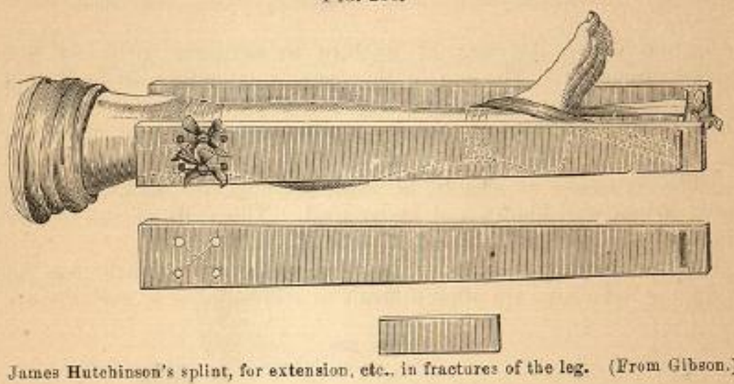
of Brooklyn, N. Y. By this method all danger of strangulation is avoided. As between this plan and the use of sole leather, which can be made to fit as accurately, or nearly so, as plaster of Paris, it is, therefore, a question of convenience rather than of practical utility.

In such few cases as demand or warrant a resort to permanent extension and counter-extension, a double-inclined plane furnishes a convenient mode for its accomplishment; but it is only occasionally that, in fractures of the leg, permanent extension and counter-extension can be employed; an assertion which, however much it may surprise the inexperienced, observation will prove to be true. If the fracture is near the middle of the leg, quite remote from the points upon which the ap-

[1] Banga, Chicago Med. Journ. and Examiner, June, 1877.
[2] Wackerhagen, Hosp. Gazette, May 24, 1879.

pliances for extension, etc., are to be made fast, and the inflammation is moderate, something may be done in this way; but when the point of fracture approaches the ankle-joint, as it actually does in a great majority of cases, a gaiter, made of any material whatever, if it has sufficient firmness to overcome completely the action of the muscles, will inevitably cause congestion and swelling, accompanied sooner or later with great pain and with ulcerations, and simply because the extension is made directly upon parts already tender and inflamed from the accident itself; and when we add to this complete and violent ligation of the limb near the seat of fracture, a similar ligation of the limb just below the knee, for the purpose of making counter-extension, as was done in what is known among American surgeons as "Hutchinson's splint,"[1] we are prepared

Fig. 236.



James Hutchinson's splint, for extension, etc., in fractures of the leg. (From Gibson.)

to understand how the worst consequences may ensue. I have once seen, when this abominable apparatus had been used, a complete ring of ulceration below the knee, and another as complete around the foot and ankle. The limb was twice girdled, and yet the surgeon thought he was performing a duty for the omission of which he would scarcely have been regarded as excusable.

Jarvis's adjuster, a still more mischievous, inasmuch as it is a more powerful instrument, operating in a similar manner, has been productive of like consequences; but Jarvis's adjuster is liable to the additional objection that by its great weight it drags off the limb, turning the toes outwards, an objection which no care or diligence can generally overcome.

I could wish that neither of these appliances would ever again be impressed into the service of broken legs.

Neill, of Philadelphia, and others have sought to overcome some of the difficulties in the way of making extension in fractures of the legs, by substituting adhesive plaster for the usual extending or counter-extending bands.

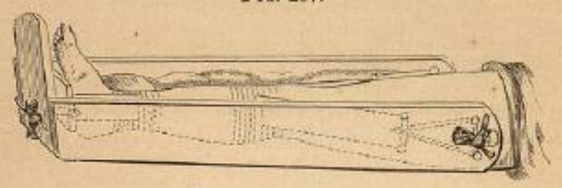
Says Dr. Neill: "For simple fractures of both bones of the leg,

[1] Elements of Surgery, by John Syng Dorsey, vol. i. p. 181. Philadelphia, 1813.

attended with shortening and deformity not easily overcome, the limb should be placed in a long fracture-box with sides extending as high as the middle of the thigh, and a pillow should be used for compresses.

"The counter-extension is made by strips of adhesive plaster, one inch and a half in breadth, secured on each side of the leg below the

Fig. 237.



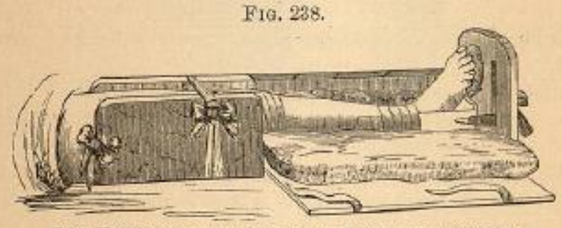
John Neill's apparatus for fractures of the leg requiring extension and counter-extension.

knee, and above the seat of fracture by narrower strips of plaster applied circularly. The end of the counter-extending strips may then be secured to holes in the upper end of the sides of the fracture-box, by which the *line of the counter-extension is rendered nearly parallel with the limb.*

"The extension is also to be made by adhesive strips, in a mode which is now well known and understood. The ends of the extending bands may be fastened to the foot-board of the box."[1]

Dr. Neill further remarks: "In compound fractures of the leg, shortening and deformity are often difficult to overcome, as is well known to

Fig. 238.



John Neill's apparatus for compound fractures of the leg.

experienced surgeons. In such cases we may wish to dress the wounded soft parts, and, at the same time, maintain a certain amount of extension and counter-extension.

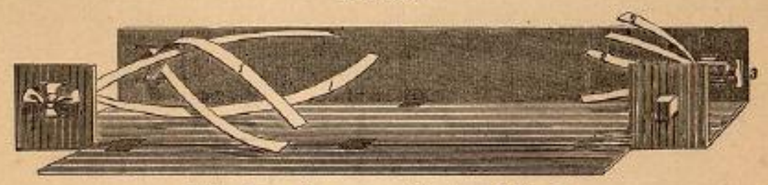
"This can be readily accomplished by having the sides of the fracture-box sawed in two parts at the knee, so that the sides of the box above the knee, from the upper ends of which the counter-extension is made, need not be disturbed during the dressing, while that portion of the side of the box corresponding to the leg may be opened at pleasure, without diminishing the tension of the extending or counter-extending bands."

In compound fractures of the leg, Dr. Gilbert recommends a modification of the common fracture-box. In this apparatus the foot-board is

[1] Philadelphia Med. Exam., vol. xi. p. 580, 1855.

omitted, and a block for the reception of the frame of the tourniquet is substituted. Each side of the box consists of three separate segments. Of these the upper and lower are permanently screwed to the bottom board, and the central one is attached by hinges. By this arrangement there is full access to the wound, which may be dressed from day to day

Fig. 239



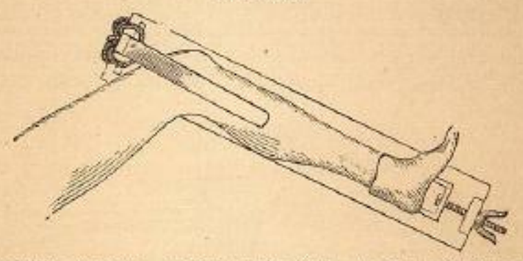
Gilbert's box for compound fracture of the leg.

1. The four counter-extending adhesive strips, as if encircling the knee and upper part of leg. 2. The two extending adhesive strips crossing at the bottom of the foot, ready to be applied to the foot. 3. Tourniquet.

without disturbing the extension and counter-extension, maintained by the permanently attached upper and lower segments.

The following woodcuts are intended to illustrate an apparatus invented by R. O. Crandall, for the purpose of making permanent extension. The

Fig. 240.



Section of Crandall's apparatus, applied to the limb; showing adhesive plaster counter-extending bands and gaiter for extension, etc.

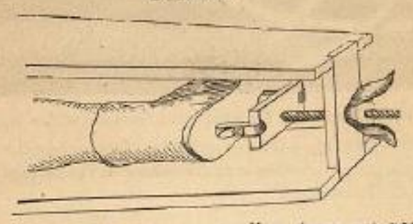
extension is represented as being made by a gaiter, but Dr. Crandall leaves it to the choice of the surgeon whether he shall employ the gaiter or adhesive strips.[1]

Without intending to deny to these contrivances for permanent extension much ingenuity and some little practical value, I am far from conceding that they will be found capable of overcoming the action of the muscles where the ends of the fragments do not support each other. Their mode of action is such that they can scarcely do more than to steady the limb, and if they operate upon the fragments at all in the direction of their axes, it must be only in the most inconsiderable degree. The adhesive plasters are substituted for the circular knee-bands and the

[1] Crandall, Phil. Med. Journ., vol. iv. p. 193, Jan. 1856; also Transac. of Med. Assoc. of Southern and Central New York, 1855, pp. 81, 82.

gaiters, with a view to avoid ligation; but in order to do this they must not encircle the limb, but only be laid parallel to its long axis. The leg of an adult, or that portion to which the adhesive plasters can be applied, supposing the fracture to be exactly at the centre, may be sixteen inches, that is, eight inches for extension and eight for counter-extension; but when we employ the same means for extension in fractures of the thigh, we find it necessary to apply the strips over the whole of these sixteen inches, the entire length of the leg, or they will not hold. It will be

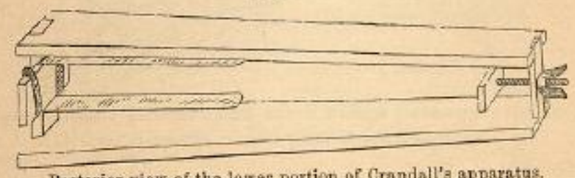
Fig. 241.



Crandall's apparatus complete. The counter-extending straps are passed over a block of wood, supported above the knee, to prevent their pressure upon the sides of the knee.

apparent also that we cannot use even the eight inches which we have, for the purpose of argument, allowed these gentlemen in fractures of the leg. There must be at least a space of eight inches between the ends of the two opposing strips in order that they may operate at all upon the fragments; indeed, I do not believe that even then their influence would reach beyond the skin to which they were directly applied; but if a space of eight inches is left, only four remain for the strips at either

Fig. 242.



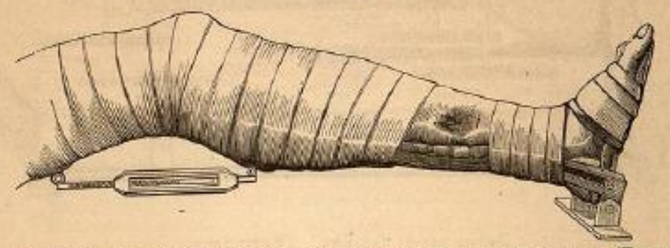
Posterior view of the lower portion of Crandall's apparatus.

end; and this is an amount of surface wholly insufficient for our purpose. What, then, shall we do when the fracture is near one of the extremities of the bone? These gentlemen seem to have forgotten, moreover, that the whole leg is tender, and that the skin easily vesicates. In short, they have not seen the many points of difference between the application of these means in fractures of the thigh and leg, and which, while they allow us to accomplish all that we could desire with the one, are of little or no use in the other. We shall then always come to the same conclusion: whatever means we may employ to make permanent extension in fractures of the leg, we must either fail to accomplish all that we desire, or incur the hazards incident to complete and firm ligation of the limb; and if the preference is given to any form of apparatus to accomplish

these ends, it must be to some form of the double-inclined plane, by which we may at least avoid ligation in the upper part of the limb, the counter-extension being made against the under surface of the thigh while it is resting upon the thigh-piece; or to one of the long straight thigh-splints, which will enable us to make the counter-extension from the thigh and perineum.

If a double-inclined plane is used, I prefer either a plain apparatus, such as we have already described as in use for fractures of the thigh, con-

Fig. 243.

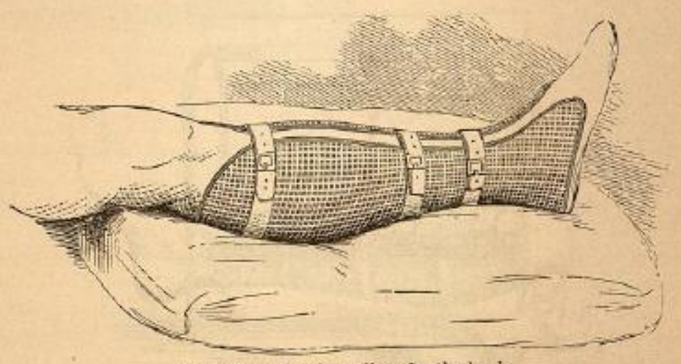


Liston's double-inclined plane, applied to the leg in case of compound fracture. (From Miller.)

structed of boards, joined together by hinges opposite the knee, and with an upright foot-board, upon which a carefully arranged and thick cushion has been placed; or the more elegant double-inclined plane of Liston.

In using Liston's apparatus, it must not be inferred that the knee is always to be bent. The apparatus is designed to be used occasionally

Fig. 244.



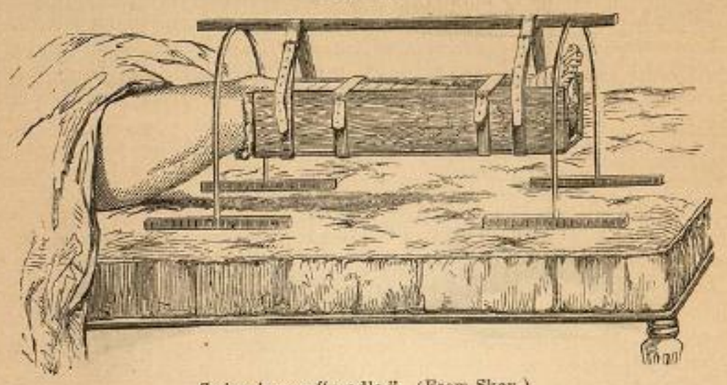
Louis Bauer's wire splints for the leg.[1]

as a straight splint; and there will be found many cases of fractures of the legs in which the straight position will be most suitable: this is especially true of such fractures as, occurring just below the knee-joint, have the line of fracture directed obliquely downwards and forwards. But there are many compound fractures which demand the same extended

[1] Bauer, Buffalo Medical Journal, April, 1857, vol. xii.

position; and in nearly all cases where this form of apparatus is used as a double-inclined plane, the lower end of the splint should be elevated so that the heel shall not be much below the level of the knee.

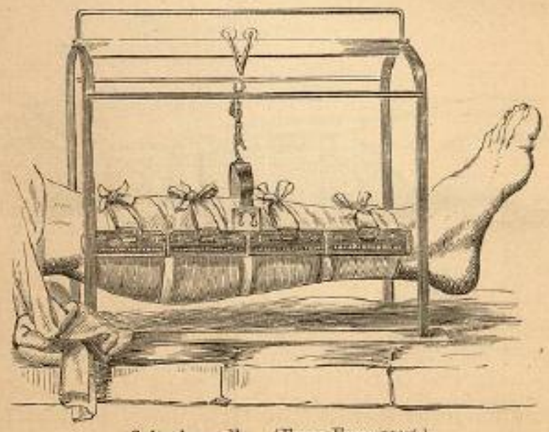
Fig. 245.



Swing box or "cradle." (From Skey.)

Bauer's wire splints, used also for side-splints, when they are formed to fit the limb accurately, possess some advantages which must recommend them to the attention of surgeons; but neither these splints nor any other, however accurately fitted, ought to be applied directly to the naked skin. They require always the interposition of a well-padded lining.

Fig. 246.



Salter's cradle. (From Fergusson.)

Boxes are rarely useful except in certain compound fractures. They are heavy and awkward machines, which prevent the patient from moving readily in bed; or which, being fixed, if he does move, allow the upper fragment only to descend, or to move upon the lower as a fixed point.

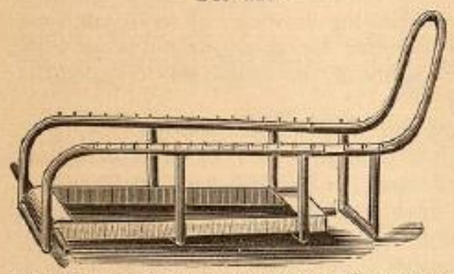
If used at all, they ought generally to be suspended, or made to move on a suspended railway. But however they are arranged, the limb is a great part of the time concealed from sight, and the surgeon is prevented from making use of such means to rectify deviations in the line of the bone as he would probably have otherwise employed.

The swing invented by James Salter, of London, is constructed so as to allow not only a lateral motion, but also a more complete motion in the direction of the axis of the limb, by which the danger of pushing the fragments upon each other is obviated. This is accomplished by the rolling of two pulley-wheels upon a horizontal bar. The case in which the leg rests may be made of metal or of wood, and the frame of iron, for the sake of lightness and strength.

Dr. Hodgen, of St. Louis, suspends the box over a pulley placed transversely, so that by drawing the rope to the right or to the left, the box may be turned upon either side.

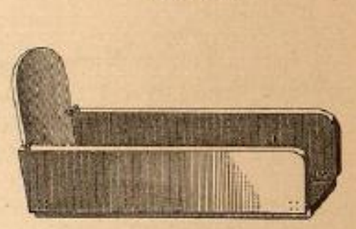
The suspension apparatus devised by Dr. John W. Trader, of Sedalia, Missouri, for the treatment of compound fractures of the leg, when it is desired to employ irrigation, I have found very useful in my wards at

Fig. 247.



John W. Trader's suspension apparatus for compound fractures.

Fig. 248.



Fracture-box, with movable sides.

Bellevue. The limb is suspended by transverse strips of cloth, over a tray, from which the water is conducted by nozzles. I have found it convenient to attach India-rubber tubing to these nozzles, through which the water may be conveyed to a pail placed beside the bed. We have used it satisfactorily, also, for other cases than fractures.

Fracture-boxes, employed in the treatment of compound fractures of the leg, are, in this country, sometimes filled with bran; the bran being closely packed upon all sides so as to support the limb uniformly and gently. This method of treating compound fractures of the leg was first suggested by J. Rhea Barton, of Philadelphia,[1] and has been much used in the Pennsylvania Hospital; and more lately it has been introduced into the Bellevue and New York City Hospitals. It possesses the advantage of affording a perfect protection against flies in the summer season, and of absorbing the matter as it escapes.

In using the "bran-box," the sides are first brought up into position and made fast. A piece of muslin cloth, one yard in length by half a

[1] Barton, Amer. Journ. of Med. Sci., vol. xvi. p. 31, and vol. xix. p. 515.

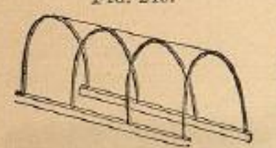
yard in breadth, is then laid upon the box, and into this the bran is poured, until it is about one-fourth full. The bran is then distributed so as to fit the back of the leg, and the limb is placed in position. After which, additional bran is packed on either side of the limb, until it is nearly or quite enveloped; the wounds being first covered by pieces of lint smeared with simple cerate. Finally, the upper portion of the muslin sack is fastened around the limb just above the knee, to prevent the escape of the bran.

Whenever any portion of it becomes soiled by blood or pus, it may be dipped out with a spoon, and its place supplied with fresh bran. The support which it gives to the limb is also uniform without being at any time excessive; and Dr. Coates states that the escape of blood in rapid hæmorrhages has been known to increase the bulk of the bran sufficiently to arrest the bleeding by its accumulated pressure.

Dr. L. D. Mason, of Brooklyn, N. Y., has carbolized the bran, by stirring in a small quantity of carbolic acid.[1]

In whatever position the leg is placed, and with many of the forms of apparatus which I have enumerated, it will be found necessary to protect the limb from the weight of the bedclothes by some contrivance similar to that figured in the accompanying drawing; or by a rack, such as is represented for suspending the leg when leather splints or the immovable apparatus is employed.

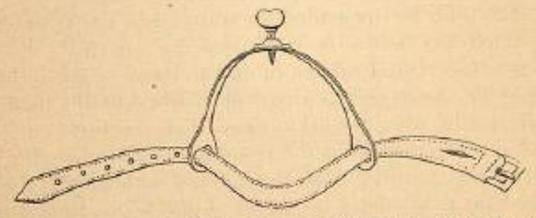
Fig. 249.



Wire rack for fracture of leg.

Malgaigne, who declares that every surgeon knows how impossible it is, in an immense majority of cases, to overcome the projection of the superior fragment when the limb is placed in the extended position (over a double-inclined plane), and who affirms that neither Pott's position, nor Dupuytren's modification of it, will do much if any better, nor, indeed, that Laugier's plan of cutting the tendo Achillis possesses in this respect any real advantage, concludes at last to resort to a new and really ingenious method, the value of which, also, he claims to have already fully demonstrated. His apparatus consists simply of a steel band of sufficient size to encircle three-fourths of the limb, at the two extremities of which are two horizontal mortises through which a band is passed, and

Fig. 250.



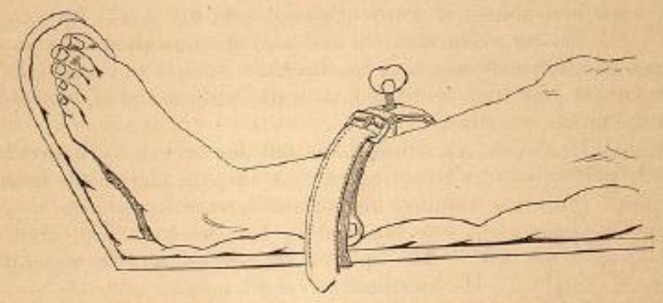
Malgaigne's apparatus for oblique fractures of the leg. (From Malgaigne.)

[1] Mason, N. Y. Med. Journ., Sept. 1876, p. 253.

which may be buckled upon itself behind. The centre of the metallic arch, in front, is penetrated with a firm metallic screw, terminating in a very sharp point, and which is moved by a flat thumb-piece.

The limb being laid over a doubled-inclined plane, and the pads being carefully adjusted, as we have already directed when speaking of other forms of apparatus, and the limb properly extended, the apparatus of Malgaigne is placed over the limb, with the sharp point of the screw resting upon the upper fragment, a few lines above the point of fracture; and at the same moment that this point is pressed firmly down to the bone, the fragments being held together by an assistant, the strap is buckled as tightly as possible under the splint. A few turns of the

Fig. 251.



Malgaigne's apparatus applied. (From Malgaigne.)

screw will now make its point penetrate more deeply into the bone, and insure the most complete apposition of the broken extremities. "This is accomplished," says Malgaigne, "with very little pain to the patient;" and, as will be seen, the steel arch effectually prevents any ligation of the limb. I cannot say that the plan receives my unqualified approval; yet I have employed it to advantage in some cases of old ununited fractures.

Treatment of Delayed or Non-union.—It has already been remarked that pretty frequently in this fracture union is delayed considerably beyond the usual period of six or eight weeks, but that in a large majority of these cases of delayed union consolidation is finally accomplished without any surgical operation. This is most often effected by permitting the patient to rise and go about on crutches, the fragments being supported by some light but firm splint, which will permit also the limb to be opened daily and washed or rubbed gently, so as to restore its circulation. In some few cases, after the lapse of several months, if this method has not succeeded, the bones have been known to unite firmly in a year or two, without side-splints, and even when the patient has been bearing his weight upon the limb. But such a result is rare, and is scarcely to be expected. If, indeed, the union is not effected within four or five months with the splints and crutches, it is better to resort at once to perforation between the fragments, as has been directed in the general chapter on Delayed or Non-union of the Bones.

A few illustrative examples will serve, perhaps, to enforce these statements.

John Connor, æt. 28, was admitted to Bellevue Hospital, Oct. 31, 1869, with a simple fracture of his leg below its middle. The limb was placed in a fracture-box, but not suspended, where it remained six weeks. A starch bandage was then applied, and continued two months. About the middle of February the fragments were perforated, and the starch bandage again applied. March 3d, the patient having come under my care, I substituted leather splints for the starch, and directed him to go about on crutches. April 2d, finding that union had not taken place, I perforated the fragments thoroughly, applied the splints, and allowed him again to use his crutches. A few months later I was informed that bony union had taken place.

Mary Welsh, æt. 28, was admitted to Bellevue with a simple fracture of the leg near the upper end of the lower third. Within one week it was inclosed in a plaster of Paris dressing. At five weeks there was no union. The plaster splint was renewed, and she was allowed to go about on crutches. No bony union at ten weeks. Splints and bandages were then removed, and she continued to walk with crutches, and in one month the union was firm.

Cornelius Hasbrook, æt. 36, had his left leg broken by a direct blow June 16, 1877—fracture comminuted. A surgeon placed the limb in a "bran box" until the swelling had subsided, and then applied a plaster of Paris dressing, whch was removed in four weeks. The fibula had united, but not the tibia. The splint was kept on, and he was allowed to go upon crutches. He consulted me eight months after the accident. I found the limb much wasted, and no bony union of the tibia. He was advised to lay aside his crutches and to remove the splints, and to walk about. This advice was followed by his surgeon, Dr. Herrich, of Passaic, except that he was permitted occasionally to use crutches. In about four months the union was firm, the limb being a little bent outwards at the seat of fracture, and shortened three-quarters of an inch.

The following is the only case I can recall in which I have found these bones ununited at the end of a period so long as four years:

A gentleman, æt. 33, from Bergen, N. Y., was struck by a billet of wood on the 3d of August, 1856, breaking his left leg just below the knee. The fracture of the tibia was transverse. His surgeon dressed the limb on a double-inclined plane. Four years later he consulted me, when I found the bones still ununited, although he was in perfect health, and had been constantly using the limb. I advised perforation, but he did not consent, and I have never heard from him since.

In Dr. Muhlenberg's tables of delayed union and ununited fractures, in a total of 94 examples involving both bones, 71 were finally cured, 3 were relieved, 19 failed, and 1 died. It might be more proper to say 71 were cured, and 23 failed.

Of these, 10 were cured by friction, 26 by mechanical appliances and immobilization, 4 by seton, 20 by resection, and 10 by drilling. 1 died after resection.[1]

Resection and Refracture of Crooked Legs.—In some cases of extreme deformity of the legs consequent upon badly united fractures, *resection* of the bones has been practised with more or less success.

[1] Muhlenberg, Agnew's Surg., vol. i. p. 866.

A case of resection is reported by Charles Parry, of Indianapolis, Ind. A young man, æt. 15, having broken his leg near its middle, the fragments united, from some cause, nearly at right angles with each other. Some years afterwards, on the 15th day of January, 1838, Dr. Parry operated, by removing a wedge-shaped portion from both the tibia and fibula. The recovery was tedious, but satisfactory.[1]

Mr. Key, of London, made an operation of this kind upon a gentleman who had suffered a fracture of the right tibia from a musket-ball. The limb was nearly useless, since he could only bring his toes to the ground. Mr. Key operated in October, 1838, and when the report of the case was made, five months subsequently, the patient was doing well.[2]

In September, 1840, Dr. Mütter, of Philadelphia, made a similar operation upon a patient, whose leg was shortened three inches and a half, and very much deformed; by which operation, when the recovery was complete, the shortening was considerably reduced.[3]

Gurlt[4] in a record of 25 resections for badly united fractures of these bones, reports 19 as cured, 2 deaths, 1 amputation, and 2 failures.

More often cases are presented of badly united fractures of the leg, which seem to justify a resort to *refracture;* and, while this procedure is attended with little or no danger to life, after neither resection nor refracture can we always make sure of a reunion. If, moreover, the surgeon expects, by a refracture, to lengthen a limb much, where it is merely overlapped and shortened, he is, I am certain, destined to disappointment, at least in all cases where sufficient time has elapsed for the bones to have become firmly united. I have myself several times refractured bones; and I have several times met with cases of old fractures newly broken; and I have constantly observed that I could never, in the end, make them but very little if any longer than they were before the refracture. The muscles had contracted and shortened, and their contraction could not be overcome. In the case reported by Mütter, he believed that he stretched the muscles two inches. With all deference for the skill and honesty of this gentleman, I think that he was mistaken.

If, however, the object of the refracture is to straighten the limb, then no doubt it may be sometimes accomplished; and in some degree also by the straightening of the limb the shortening may be overcome; but in my opinion, such procedures ought to be reserved for extraordinary circumstances, unless the refracture can be made soon after the union has taken place. In those cases in which I have refractured the tibia and fibula after a recent union, the bones have reunited promptly.

An instructive case of refracture is reported by Dr. Horner, of Philadelphia, in the *Medical Examiner*. The limb had been broken eight weeks, and was quite crooked, but was not very firmly united, and Dr.

[1] Parry, Amer. Journ. Med. Sci., August, 1839, p. 334.

[2] Key, Amer. Journ. Med. Sci., Aug. 1839, p. 339; from Guy's Hospital Reports, April, 1839.

[3] Mütter, Amer. Journ. Med. Sci., April, 1842. p. 359. Three similar cases may also be found in the Oct. No. for 1841, and the April No. for 1842 of the same journal, in which the operation was made by Portal, of Palermo. Malgaigne mentions two other examples.

[4] Poinsot, op. cit., p. 602.

Horner, having refractured it, was able at once to restore it to a nearly straight line.[1]

Mary McCormick, æt. 5, 342 E. Twenty-third Street, broke her left leg near the upper end of the lower third. A doctor was called who did not recognize the fracture. Probably it was a green-stick fracture, and no splints were applied. Six months later she was taken to another excellent surgeon in this city, who found it greatly bent at the seat of fracture, and he refractured it. The child remained a long time in bed with splints, and when I was consulted in 1868, about eighteen months after the refracture, no bony union had taken place.

T. B. Johns, of Terre Haute, Indiana, had his right leg broken near its middle. Under the care of Prof. John E. Link, of the same place, it united. In Nov. 1876, ten years after the first accident, he was thrown from a horse, and it was refractured at the same point, after which the tibia refused to unite. Six months later he consulted me, and I advised perforation at the seat of fracture. I am imformed that Dr. Pancoast, of Philadelphia, subsequently brought about union by perforation, but that extensive suppuration ensued, and that the cure was not accomplished in less than six months.

In the case of Blair, related in connection with fractures of the tibia, and which was finally treated successfully by me by perforation, the fragments united after the original accident, and were refractured at the end of six weeks by an attempt to overcome an anchylosis at the knee-joint. They refused thereafter to unite until placed under my charge.

CHAPTER XXXIV.

FRACTURES OF THE TARSAL BONES.

Causes.—The astragalus is generally broken by a fall from a height, the patient having struck upon the bottom of the foot. Monahan, in an analysis of ten cases, found it had been broken by a fall upon the foot nine times,[2] and only once by a crushing accident.

Dr. F. J. Shepherd,[3] of the McGill University, Montreal, has called attention to a fracture of the "little process of the astragalus external to the groove for the tendon of the flexor longus hallucis muscle," to which is attached the posterior fasciculus of the external lateral ligament of the ankle-joint. He has met with four examples in the dissecting-room. All of them without a history. The first was a man about 25 years old; right foot; and it had united to the main portion by fibrous tissue. The second was also in a young man; right foot; with neither fibrous

[1] Horner, New York Journ Med., May, 1851, p. 432.
[2] Fracture of the astragalus, with analysis of the recorded cases of this injury. An inaugural thesis, presented to the faculty of the Buffalo Med. Col., March, 1858, by Bernard Monahan, M.D.
[3] Shepherd, Journ. Anat. and Physiology, vol. xvi. p. 79.

nor bony union. It remained attached to the posterior fasciculus of the external lateral ligament, but it was displaced slightly outwards, and was quite movable. In the third case the process had been broken off; right leg; and it had become reunited by bone The fourth case was found in a woman aged about 69, whose bones had undergone fatty degeneration. The fragment had united by fibrous tissue.

Dr. Shepherd was unable to produce this lesion upon the cadaver; but he calls attention to the fact that this process is much more prominent in some persons than in others; and furthermore, since in none of these cases was there a noticeable deformity of the foot, it would naturally be overlooked, or be regarded as a mere sprain.

The calcaneum is also occasionally broken by violent lateral pressure, but much more often by a fall upon the foot, or rather upon the heel.

Abel, of Stettin,[1] has called attention to a fracture of the little apophysis of the calcaneum (lesser process, or sustentaculum tali; the tubercle situated above the groove for the tendon of the peroneus longus, and called by Henle, the "trochlear apophysis"), the apophysis being broken by a fall upon the foot when in the position of varus. Biddle[2] has seen the same lesion, caused in the same manner in a man 39 years old, and which he ascribed to the action of the peroneo-calcanean ligament (middle fasciculus of the external lateral ligament). After the lesion the foot becomes everted, and flattened as in valgus, and the length of the heel is apparently shortened by a slight displacement of the calcaneum forwards.

In some instances both heel-bones have been broken at the same moment.

Malgaigne has collected eight cases of fracture of this bone by muscular action, as in jumping upon the toes, the posterior portion of the bone being thus violently acted upon by the tendo Achillis. South, in his Notes to Chelius, has mentioned two other cases, one of which was seen by Lawrence, and has been reported in the second volume of the *Lancet*. This person had received the injury by jumping off a stage-coach. The fragment was found to be drawn upwards slightly, but not so far as to prevent crepitus when the muscles on the back of the leg were relaxed. The other example mentioned by South is a cabinet specimen contained in the museum of St. Bartholomew's Hospital. The fracture had taken place just below the attachment of the tendo Achillis, but the upper fragment was not displaced.[3] Mr. Cooper mentions two other cases, both produced by violent efforts on the part of the patients to sustain themselves when falling. In one of these the fragment was immediately drawn up three inches.[4] Burggraëve,[5] Coote,[6] Anningson,[7] and Poinsot[8] have met with the same accident from a similar cause.

The other bones of the tarsus are generally broken by crushing acci-

[1] Abel, Arch. für Klin. Chir., 1878, Bd. xxii. Hft 2.
[2] Bidder, Cent. für Chir., 1881, p. 733 (Poinsot).
[3] South, Notes to Chelius's Surgery. vol p. 639, Amer. ed.
[4] B. Cooper's ed. of Sir Astley, Amer. ed., p. 311.
[5] Burggraëve, Bull. Acad. Roy. de Méd. de Belgique, t. 6, p. 886, 1868.
[6] Coote, *Thetanest*, 1867, t. 1, p. 270 (Poinsot).
[7] Anningson, Brit. Med. Journ., 1878, vol. i. p. 128.
[8] Poinsot, op cit., p. 695.