

O. S. Budlong, æt. 55, of Utica, had a fracture of the left femur four inches above the knee, caused by a direct blow, Nov. 10, 1875. His surgeon is confident the bone was comminuted. Splints were applied after extension had been made under ether.

I found the limb, Sept. 18, 1876, shortened two and a half inches, and not united. At my request, an artificial support was applied by Dr. Hudson, and he returned home. A letter received Oct. 3, 1877, says "the bone has not united, but the apparatus has been of the greatest comfort to him, as it enables him to walk." May 15, 1878, it had not yet united.

CHAPTER XXX.

FRACTURES OF THE PATELLA.

IN 1880, I made a careful study of 127 cases of fracture of the patella. Of these, 71 were either treated by me, or they were seen by me in consultation in the course of the treatment, or came subsequently under my notice. Of nearly all of these I made careful notes at the time. The remainder of the 127 cases (56) are copied from the Bellevue Hospital records, including all that had been recorded up to the date of the completion of the study; excluding only those which had been treated by myself, and were included, therefore, in the class of cases first mentioned. The cases, reported at length, as copied from the records, have been published, with the conclusions drawn from them, and are now embodied in a single volume for the instruction of the profession.¹

In this chapter I shall make free use of the observations and statements contained in that volume, without, however, attempting to describe in detail the cases, but presenting here only a summary of them.

Total number of cases.—127.

Sex.—Males, 99; females, 28.

Age.—Ten years and under, one case. This is the case (52) of a lad five years old, in whom, from a direct blow, a small piece of the margin of the patella was broken off.

From ten years, including twenty, six cases; of which 1 (113) was 16 years old—a boy—the fracture being oblique and caused by a direct blow; 1 (case 19) was 19 years old—the fracture was transverse, and was caused apparently by a direct blow. In this case the ligament subsequently gave way completely on the outside, and a new patella formed in the very much elongated ligament on the inner side. The remaining four cases were at the age of 20 years: all were transverse; two are known to have been caused by muscular action—one by direct force, and in one the cause is not stated.

Before the twentieth year of life, then, there were only three fractures, and these were all supposed to be caused by direct blows. Up to this

¹ Fracture of the Patella. A Study of 127 Cases, by Frank H. Hamilton, M.D. New York, Chas. L. Birmingham & Co., Med. Publishers, 1880.

period, muscular action seems to take little or no part in the production of these fractures.

From twenty years, including thirty, 48 cases. From thirty years, including forty, 33 cases. From forty years, including fifty, 22 cases. From fifty years, including sixty, 8 cases. From sixty years, including seventy, 4 cases. From seventy years, including eighty, 1 case. In this one case, the patient, a woman, was 80 years old.

In all the six cases included in the last two decades—that is, from sixty years, including eighty, four are known to have been caused by direct blows, and the remaining case, Bridget Callaghan, 80 years old, fell fifteen feet, and it is fair to presume that the fracture was caused by a direct blow.

It would seem, then, that after the sixtieth year, muscular action alone seldom causes these fractures, the largest number of cases having occurred between the twentieth and fortieth years of life; the total in these periods being 103, out of 122 whose ages are known, or, if we include the three at the twentieth year, 106 out of 122 cases.

Right or Left Limb.—Of 134 in which this fact is recorded, ninety-three were in the left limb, and forty-one in the right.

Character of the Fracture.—Of the whole number, all were simple, except eleven; and of these, nine were comminuted, and two were both compound and comminuted. Of the comminuted fractures, cases 61 and 94 were accompanied with fractures of the thigh also—one died of shock on the fourth day, and one died after amputation, rendered necessary by gangrene.

Direction of the Fracture.—The fractures were transverse in 106 cases—not including two which were transverse and vertical (comminuted)—of these 106 cases, twenty-two are recorded as below the middle of the patella, sixteen at the middle, and seven above the middle.

Cause of the Fracture.—Twenty-five are known to have been the result of muscular force alone; and fifty-eight are recorded as having received blows upon, or as having fallen upon the patella, and have been placed in the list of those caused by direct blows. In forty-three cases nothing is said as to the cause.

Of the transverse fractures, it will be noticed that a majority of those occurring below the middle are ascribed to muscular action—that is, twelve out of twenty in which the cause is given. Of four oblique fractures, three are known to have been from direct force; and all of the comminuted fractures, except case 127, were from direct blows, as were also the two compound fractures.

Active Synovitis and Bursitis.—I infer that active synovitis ensued in at least thirty-four cases, and probably in many others. Inflammation of the bursa of the patella is mentioned once. Probably in most cases the bursa is torn open as the patella ascends, and communicates freely with the joint, so that bursitis could not be recognized as a distinct phenomenon.

Blood in the Joint, etc.—In case 90, a compound fracture, the presence of blood in the joint was actually demonstrated. Probably it was present in many other cases, but the fact could not be proven. Pretty

extensive subcutaneous *ecchymoses* on the sides of the knee and in the ham were very frequently observed.

Treatment.—It will be impossible to summarize the treatment. Nearly all of the recognized plans of treatment were adopted, but in a majority of cases the same plan of treatment was not continued from the beginning to the close; and it would be difficult in most cases to say to which particular method the result must be ascribed. Of the specific forms of apparatus, there are mentioned Lausdale's, Wyeth's, Turner's, Mott's, Malgaigne's hooks, Sir Astley Cooper's, both of my own methods, plaster of Paris, and other forms of immovable dressings, the "lock strap," "wooden fingers," pulley and weight, crescentic pads, and figure-of-8 bandages, also elastic bands, rollers, etc. Most of the patients have been kept in the recumbent posture, with the foot elevated; but some have been allowed to walk about on crutches, especially when either of the forms of immovable apparatus has been employed.

Results.—We now approach one of the most important parts of our subject, and, fortunately, the records are sufficiently accurate and full here to enable us to make valuable conclusions.

It is stated distinctly in 84 cases that the union was fibrous. The bond of union did not permit the fragments to be moved upon each other soon after the treatment was concluded, and therefore may be constituted of bone, in case 11, and I believe in three or four other cases.

In cases 22, 23, and 64 no union ever occurred.

The length of the bond of union is given as $\frac{1}{4}$ of an inch in 16 cases; $\frac{1}{2}$ in 33 cases; $\frac{3}{4}$ in 13 cases; 1 inch in 3 cases; $1\frac{1}{2}$ in 2 cases; 2 in 3 cases; $3\frac{1}{2}$ in 1 case; 4 in 1 case, and 5 in 1 case. The last four cases, or those in which the separation exceeds $1\frac{1}{2}$ inches, are respectively cases 22, 23, 54, and 111.

The above records, it will be understood, do not include cases of rupture subsequent to union, but only the results of the first treatment. I shall refer to the results after refracture or rupture of the bond of union hereafter.

It is not to be supposed that these estimates of the length of the bond of union are absolutely accurate. Probably the length of the ligament was generally a little more than is stated, but the records are sufficiently accurate for our purposes. All but 8 are united with a ligament of one inch or less in length, and the largest number have a ligament of only half an inch.

Anchylosis—more or less complete—has existed in nearly all of the cases when the limb was first removed from the apparatus; being most complete, as a rule, in those cases in which the joint has been kept the longest in the dressings, without the use of passive motion.

In no case recorded has force been resorted to to overcome this anchylosis; but it has gradually disappeared under passive and active use of the limb within a year or two.

Rupture of the New Ligament.—The new ligament has given way more or less completely in 27 cases. Possibly we may have included in this number one or two which were never held well in position, such as cases 9 and 32, in which the inner portion of the ligament alone is elongated. This unilateral elongation occurred three times on the inner side

and once on the outer. Of the entire number, 5 were gradual, the elongation commencing soon after the patients began to walk; and 18 occurred within ten weeks after the receipt of the original injury, generally on the seventh or eighth week, when the patient in his first attempt to walk has slipped, and the limb has been suddenly bent. After the eighth week there are, 4 cases at 3 months, 3 at 5 months, and 1 at 2 years and 4 months (case 18). Case 21 is put down as refractured after 4 years; but the history of the case is doubtful.

I think, in the light of this experience, it may be said that after the fifth month there is usually no more danger to the injured limb than to the sound one.

Other Displacements of Fragments.—The lower fragment was found slightly tilted forwards in case 31; and the lower fragment overlapped the upper a little in case 9. The upper fragment was tilted over by the elongation of the inner portion of the ligament in 3 cases; and in the opposite direction by the giving away of the outer portion in 1 case. In case 19 a new patella was formed in the much-elongated ligament.

Repetition of the Fracture in the Opposite Leg.—Cases 6, 45, 68, 85, and 124 belong to this class. Perhaps also 59; or it may have been a case of refracture. These latter accidents have evidently resulted from the fact that the sound limb has been compelled to receive alone the resistance in efforts to prevent a fall.

Hypertrophy of Fragments.—This has been especially noticed in 9 cases; namely, twice in the upper fragment alone, once in the lower, and six times in both. It is probable that its occurrence is much more frequent than this record implies.

Period of Time which elapsed before the Functions of the Limb were sufficiently restored to resume Labor.—Of the primary accidents, that is, of those in which there was no subsequent rupture of the union, I have been permitted to examine 23 cases, at periods of time ranging from four months to twenty-nine years. Only four of these are said to have acquired perfect, or nearly perfect, use of the limb in a less period than two years, although in general they have resumed work within about one year. The cause of this inability to labor has almost invariably been the lack of the necessary freedom of motion in the knee-joint—a partial anchylosis.

It is remarkable, however, that in case 23, a British soldier, there being no union and a separation of the fragments to the extent of five inches, he was able to walk well at the end of twenty-nine years, when I saw him. Case 22 was seen after four years with a separation of four inches, and case 54 was seen after seven years, and both walked badly.

Results in Cases of Refracture or Rupture of the Bond of Union—27 Cases.—Of 15 cases in which the ligament gave way within a period of three months from the time of the original accident, that is, soon after the union had been effected, 12 have terminated very satisfactorily. Under a renewal of the treatment the fragments have united with a short ligament. Case 56, refractured twice, and cases 40 and 47 were not so fortunate.

I do not think that in any case where the refracture occurred later than this was a permanent reunion effected.

Having given this brief analysis of these cases, I shall proceed to consider the subject of fractures of the patella in a more general way.

Etiology of Fractures of the Patella.—Twenty-five of the cases reported by me are known to have been the result of muscular force alone; the fractures having occurred without a fall or while the patient was standing, and in some cases when the knee was not bent, the fracture being announced by a distinctly felt snap. I believe, however, that muscular action was more or less efficient in causing the fracture, in all the simple transverse fractures, and in at least one of the comminuted fractures; that is to say, in 107 of the 127 cases.

My reasons for this opinion are: the great power of those four strong muscles which unite to form the tendon of the quadriceps—the fact that ninety-nine occurred in males—that only three occurred in persons under twenty years of age, and only five after the sixtieth year—the largest number being between the twentieth and thirtieth years of life—the remarkable uniformity in the direction of the fracture; and finally because I am unable to cause a transverse fracture on the cadaver by a direct blow. I might have added also the fact, as attested by museum specimens, that the fracture is very uniformly from before backwards and downwards, as would be the case if it were caused by a cross-strain, the active force being attached to the upper fragment. That the bone breaks most often in the lower third is probably due to the fact that when the knee is slightly bent—and this is the position of the limb in which the fracture generally occurs—the centre of the patella rests upon the condyle of the femur, leaving the upper and lower portions unsupported, when, the lower portion, being the weakest of the two, gives way under the cross-strain.

A patella having given away, transversely, to muscular action, those fibres of the quadriceps which are inserted into the sides of the patella still continuing to act, may break the bone vertically, or cause them to separate laterally. No doubt this is what happened in case 127.

The source of error in estimating the value of muscular action in the production of this fracture has been, that in the majority of cases the

FIG. 206.



Simple transverse fracture.

FIG. 207.



Comminuted fracture.

patients have actually fallen upon their knees, and all such cases have been set down as caused by direct force; but in a fall on the knee upon a plane surface, when the leg is flexed to a right angle with the body, the patella does not touch the plane; it is only the tubercle of the tibia which touches, and the contact with the plane has had nothing to do with the fracture, except as causing, by the concussion, a more active con-

traction of the muscles already rendered tense by the position and by the effort to prevent the fall. If a man falls headlong, with his knee slightly bent, the patella may strike the floor, and in this way, and by other methods, the patella may receive a direct blow; but even then, if the fracture is transverse, it is probable that the blow induced the fracture by causing a sudden spasmodic action of the muscles, for, as I have said before, we cannot imitate the fracture by a direct blow on the patella of the cadaver.

Camper, Velpeau, Malgaigne, Tillaux, Agnew, and others have observed the frequency with which this cause has operated in the production of transverse fractures of the patella. Agnew speaks of a fracture of the patella as being frequently produced by the act of mounting a horse.

Anatomy, Pathology, and Semeiology.—I have already stated that the fracture is almost uniformly transverse, occasionally oblique, and in a few cases the line of fracture is slightly curved; very seldom is the line of fracture vertical. The fracture occurs most often in the lower third, and least often in the upper third. In the transverse fractures the direction of the fractures is from before backwards and downwards.

In a large majority of cases the lesion is limited to the bone, its periosteal coverings and the thin and scattered fibres of the tendon of the quadriceps which traverse the front of the bone to become continuous with the ligamentum patellæ. Perhaps a few of the fibres of the aponeurosis on either side of the patella give away also, but the lesion of this aponeurosis is ordinarily not extensive. For this reason the upper fragment seldom separates from the lower more than one inch, and in most cases only about half an inch. It is only when great and extraordinary muscular force has caused the fracture, that the aponeurosis is sufficiently torn to permit the upper fragment to ascend two inches or more; and we may always estimate the extent of this latter lesion by the extent to which the upper fragment is drawn up. This was sufficiently illustrated in a dissection which my Senior Assistant House Surgeon, Dr. Girdner, kindly prepared for me. He exposed the patella and the quadriceps with its broad lateral aponeurosis, which passes down, spreading out, to be inserted finally into the sides of the tibia and fibula at their upper extremities. He then divided the patella transversely with a chisel, leaving the aponeurosis untouched, and we observed now that by no amount of pressure upwards short of that which would cause a laceration of the aponeurosis, could the upper fragment be made to ascend more than half or three-quarters of an inch. By cutting the aponeurosis on

FIG. 208.



Transverse fracture of the patella.

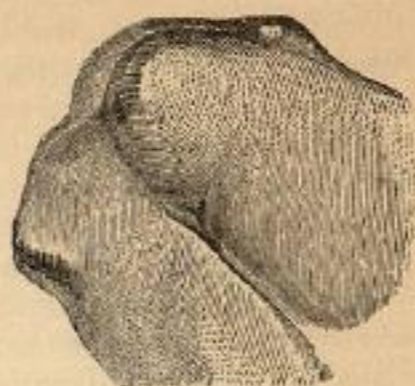
either side, the fragment could be pushed up further, but the cutting had to be very extensive before it could be pushed up three inches, as has happened in some of the recent cases which have come under my observation. Such extensive separation, therefore, implies necessarily extensive laceration of the aponeurosis.

FIG. 209.



Separation of the fragments in moderate flexion when the whole aponeurosis and tendon is torn.

FIG. 210.



Fragments separated by forced flexion of the knee.

There is another anatomical lesion, the existence of which it may be proper to assume in the majority of cases, although we have not the means of demonstrating its occurrence. The posterior wall of the bursa in front of the knee is probably lacerated, and the joint surfaces, or articular synovial capsule is made to communicate freely with the cavity of the bursa.

This bursa is usually present in adult life, and is especially well developed in males. Its posterior wall is composed of a thin synovial membrane, which is in direct contact with the front of the patella and its immediate investments; so that a separation of the fragments to the extent of half an inch could scarcely occur without laying open the bursa. The exception must be found in those cases in which the bursa is not at all, or is only imperfectly developed, or the fracture has taken place at a point which does not exactly correspond to the under surface of the bursa.

I have once or twice observed, a few days after the fracture, a fulness in front of the patella so defined as to seem to indicate that the bursa had not been torn, but that it had inflamed and become filled with serum; but I imagine that this appearance might be presented sometimes when a communication with the joint had been established, and the bursa had become filled, its anterior wall being simply pressed forwards by the fluids of the joint.

There remains then, usually, in front of the joint nothing but the skin and a thin layer of areolar tissue, or probably the skin alone, which if it were not at this point very redundant and elastic would often be torn,

rendering the fracture compound. In no case under my notice has the skin been torn as an original accident, however much the fragments may have separated; but in one case, not recorded in the preceding report, but which was at the time under the care of Dr. Erskine Mason, the skin was torn in a subsequent accident—a rupture of the new ligament—the fragments being separated very widely. Suppuration of the joint ensued, and it became necessary to amputate at the knee-joint by Cardan's method. After which he made a good recovery.

It has been found possible sometimes for the patient, immediately after the accident, to continue standing, or even to walk by exercising great care, but in most cases the patients have at once fallen to the ground and been unable to rise.

Very speedily, often within a few minutes after the injury is received, the joint appears swollen. This early swelling must be in part attributed to the effusion of blood into the joint from the broken patella and adjacent tissue. The presence of blood in the joint was demonstrated in case 90, and there can be no reason to doubt that it is often, perhaps always, present in the joint in some amount, after the fracture, where it probably undergoes a pretty rapid disintegration and is mostly absorbed.

There is quite often, also, at an early date, considerable discoloration of the skin on the sides and back of the knee, caused by the infiltration of the blood into the subcutaneous areolar tissues.

A synovitis and bursitis (when the bursa is torn) are inevitable also; the amount of inflammation being more or less in different cases, but being, in most cases sufficient to fill the joint with serum and probably some lymph, within the space of a few hours, or days at most. This effusion, caused by the synovial inflammation, generally begins to disappear within a week or ten days, and cannot usually be detected after the second week; but meanwhile, pretty often, a more or less extensive cellulitis ensues, involving the front and sides of the knee and extending some distance up and down the limb. Usually this is moderate, but it has occasionally, and especially when injudicious pressure has been employed, resulted in suppuration of the areolar tissue.

Mode of Union and Prognosis.—The frequency with which, according to my observations, the bond of union has given way at some subsequent period, renders it necessary that I should speak of the character of the union and the prognosis relating to primary accidents, and the character of the union and the prognosis relating to secondary accidents, separately.

Character of the Union and Prognosis in Primary Accidents.—In my published cases the bond of union is known to have been fibrous in 84, and in no case is it known to have been bony; but quite often it has been thought, when the patient was first dismissed, that the union was bony, and in almost every case a much later examination has shown that it was fibrous. When the dressings are first removed there is often such a degree of hardness of the tissues between the fragments as to lead one to suppose that the fragments have united by bone, and they are so fixed that they cannot be made to move separately, but which deceptive appearance is removed in the course of a few weeks or months. I do not know positively that in any case the union was by bone. If I were to

state my convictions, I would say that probably none of the tabulated transverse fractures were united by bone; and that only a small proportion of the vertical and comminuted fractures were thus united. I do not deny the possibility of union by bone. A few cases, verified by the autopsy, have been reported from time to time, but I have never seen but one case verified by dissection, and to this I shall refer again hereafter.

Bony union was for a long time considered impossible. Pibrac challenged all surgeons of his time to show him a patella thus united. Dupuytren, who thought he had obtained a union of this kind, offered for the patella of his patient its weight in gold. According to Velpeau, however, Wilson and C. Bell had seen a case of bony union; Lallemand had demonstrated its possibility, and there was a specimen of it in the Hunter museum.¹

The length of the fibrous bond, in primary cases, is usually about half an inch, and ranges from one-quarter of an inch to five inches: but of the whole number recorded by me, there are only four in which the new ligament is more than one and a half inches in length. These latter are, therefore, exceptional cases; and were rendered so by the greater violence inflicted, and the more extensive rupture of the aponeurosis and muscle, or by injudicious treatment.

I will relate the cases, in order that we may appreciate where the responsibility generally lies, when fragments unite with so much separation:

I found Samuel Hanna, æt. 38, in my ward at Bellevue, June 1, 1875, admitted on account of an abscess which had formed without any appreciable cause in the areolar tissue, just above the left knee. He had an old fracture of the patella in the same limb, the fragments being separated nearly four inches. He was unable to extend the limb by muscular action, there being apparently no bond of union between the fragments.

He gave the following account of the injury: The accident occurred in December, 1871, about three years and five months before. He was immediately taken to Bellevue Hospital. On the fourth day the limb was laid upon an inclined plane. On about the seventh day a plaster-of-Paris splint was applied, from the foot to the hip. He was permitted to go about on crutches. When the splint was removed the fragments were separated two inches. He has had no treatment for the fracture since.

John Sharkie, æt. 24, a soldier in the British service, was struck in the right knee while he was sitting with his leg bent under him. He was immediately put under charge of the surgeon of the 89th regiment of infantry. Severe inflammation and swelling ensued, and no apparatus was employed until the twelfth day; a compress was then laid over both fragments, and they were bound on with a roller, the limb being laid upon an inclined plane. The bandages were removed at the end of four months, when the upper fragment at once drew up toward the body. It was eighteen months before he could walk without a cane. This is the account given to me by himself.

Twenty-nine years after the accident, March 27, 1855, I found, when the limb was straight, that the upper fragment lay two and a half inches

¹ Velpeau, Anat. Chir., vol. 2, p. 400.

above the lower, and when the limb was flexed it separated five inches. No trace of a ligament or other bond of union could be felt. He walked well, without a cane, there being very little or no halt, but he could not walk fast.

Jeremiah Murphy, of No. 3 Bridge Street, New York, æt. 56, broke his *left* patella transversely, below the middle, by a fall upon the knee. A surgeon was called, and applied bandages. He was four or five weeks in bed, and then went out, using a cane. The fragments were then found to be much separated. Aug. 30, 1879, seventeen years after the accident, I found the fragments separated $3\frac{1}{2}$ inches when the leg was straight, and $4\frac{3}{4}$ when it was flexed. Fragments of normal size. No ligament between the fragments; but along their outer and inner margins the tendinous fibres of the quadriceps are prominent, and especially on the outer side. He cannot extend the leg by muscular action when sitting, but he can flex it to an acute angle with the thigh. Standing, he can flex and extend it perfectly. In extending he turns the foot out, in order to bring into action the outer portion of the quadriceps. He has always, since this accident, been somewhat lame, but could walk several miles and carry loads without a cane.

May 25, 1879, he slipped and fell, striking upon the right knee, and breaking the *right* patella transversely about its middle. June 1, a surgeon applied adhesive strips over and above the patella, then a plaster-of-Paris bandage from the hollow of the foot to above the knee. Fragments were separated an inch or more. Began to walk. A few days later the leg suddenly gave way, and he fell back. The skin became discolored, and it swelled very much.

When he consulted me the fragments of the right patella were separated $1\frac{3}{4}$ inches, when the limb was straight, and three inches when it was flexed. He walked slowly without a cane, but was in constant fear of falling. I advised him to submit to a second trial to obtain a more satisfactory result in the case of the right leg, but he declined to do so.

Peter Waters, æt. 23, mason, 1830 Third Ave., while running caught his heel, and in his effort to save himself fell back. At this moment he heard his patella crack, and found at once that he could not stand.

On the following day, April 30, 1874, he was admitted to Bellevue. The fracture was found to be transverse below the middle, and the fragments separated three-quarters of an inch. Evaporating lotions were applied.

May 5. A silicate-of-lime splint was applied, the fragments having been previously approximated by adhesive strips locked over the front of the patella.

13th. Splint removed, as it did not have sufficient firmness, and plaster-of-Paris splint substituted, which was soon cut open.

16th. Seventeenth day. Discharged at his own request, with instructions to report from time to time. (No farther record.)

I saw and examined this man Oct. 22, 1879, more than five years after the accident. The fragments were separated two inches, and united by a firm ligament. No hypertrophy of fragments. He can use the leg almost as well as the other—can flex and extend fully, and run up and down stairs.

When he left the hospital, with the plaster splint on, he wore it about two weeks; the joint was then very stiff. On taking off the splint he moulded a piece of sole-leather and made for himself a knee-cap, which he wore a few weeks longer. Gradually the ankylosis disappeared, and in about one year he resumed work as a mason.

I have found the fragments *tilted*, in consequence of a yielding of the new ligament, or because of a pressure of the bandages, in four cases. In three of these it was the inner portion of the ligament which had given way, and in one the outer. If from so few examples it is proper to infer the existence of a rule, and to declare that the inner portion gives way most often, we may perhaps find a reason for the rule in the fact that the inner portion of the quadriceps is more powerful than the outer portion, and might therefore act more energetically upon the inner margin of the upper fragment, and cause it to separate more widely from the lower.

Malgaigne made the same observation which I have made, and does not hesitate to speak of it as a rule, or absolute law; declaring that it is always the inner portion which is found elongated; but I have mentioned one example in which the fact was otherwise. Boyer also alludes to the tendency in the upper fragment to tilt outwards; and both of these writers think that the phenomenon is due to the manner in which the pressure of the apparel was made to bear upon the upper end of the upper fragment. The upper margin of this fragment is not horizontal, but oblique, its outer portion being considerably above the plane of its inner portion; so that any form of adjustment in which the plane of pressure from above is horizontal, will press more effectively upon the outer than upon the inner portion, and cause the upper fragment to tilt, or incline outwards. It seems to me that both unequal muscular action and the direct but unequal, or maladjusted mechanical pressure of nearly all forms of apparel employed to bring down the upper fragment, may be considered as alike responsible for this result. This, as will hereafter be seen, I have sought to avoid by employing a somewhat elastic cotton roller for the purpose of making the downward pressure.

Occasionally it is found, when the fragments have united, that one or both of the fragments are *inclined a little forwards* at the point of fracture, forming an angle salient in front. Usually it is but one of the fragments that is thus inclined; and in most cases, if not in all, that fragment which is the longest is the one which projects. Thus, of my published cases, 9 and 31 were transverse and in the upper third, and when union was completed the upper margins of the lower fragments overhung the lower margins of the upper.

The longest fragment resting upon a convex surface, and being no longer held in position by a counter-force, the ligamentum patellæ or the quadriceps must inevitably incline forwards. Indeed, I have seen this condition present in a recent fracture before any apparatus had been applied; but in such cases very slight pressure, applied from before backwards, was sufficient to restore it to place; and it is quite certain that for this result after union is consummated, the apparatus employed to bring the fragments together is mainly responsible. Both the quadriceps and the ligamentum patellæ have their insertions nearer the ante-

rior than the posterior margins of the patella, a thin layer of tendinous fasciculi actually traversing its anterior face. The upper and lower margins of the patella, therefore, present no elevations for the application of concentric pressure; and if by any form of apparatus, except Malgaigne's hooks, concentric pressure is made, it must be accomplished by causing a depression in these firm ligamentous bands, or a recession from the tegumentary surface, in order that the concentric forces may have a *point d'appui*. This pressure must depress the corresponding margins of the two patellar fragments, and elevate their broken margins; and in this case the longest fragment will suffer the greatest displacement. To a certain degree this must occur even with Malgaigne's hooks, as we shall easily see when we consider their mode of application as recommended by himself; but in a much less degree than by any of the usual modes of treatment; such, for example, as those in which two hard crescents or a padded ring are employed to bring the fragments together. No doubt it is occasioned also sometimes by the pads which some surgeons place in front of the patella, and which get displaced and press unequally.

Both these displacements, namely, the tilting and the forward projection, are imperfections which contribute their proportion to the subsequent maiming; causing in the one case a relative loss of strength in the ligament, and in both cases causing some irregularity in the movements of the patella over the surface of the femur.

There is another form of displacement to which I have not yet referred, but which seems in most cases to be temporary, although it is probable that it is not in all cases, namely, a simple *lateral displacement*. This existed in case 9, before the treatment was fully terminated. The upper fragment was found displaced inwards one-quarter of an inch, and it could not be moved from this position—at least not without greater force than it seemed proper to apply. In this case, however, the fragment subsequently, when he had used the limb some time, gradually loosened and resumed its natural position. I think the same happened in one or two other cases, and that they subsequently came into line. Probably in each case it was caused by the lateral pressure of the bandage or of other parts of the dressing, and might, therefore, have been avoided. It is easy to imagine that if the fragments are thus displaced the bond of union may be imperfect or unequal on the two sides, or that it might diminish the chances of union, and in either case the evil results might be permanent and serious.

Hypertrophy of the fragments. This must be distinguished from an exostosis, such as is frequently observed along the margins of the fracture, and which is never considerable, only causing a slight irregularity in the surface of the bone, but which may be present without any peripheral enlargement or expansion of the fragments.

This actual hypertrophy has been observed by me in nine cases, namely, twice in the upper fragment alone, once in the lower fragment alone; and six times in both. The occasional hypertrophy of the fragments has been noticed by other writers, and Malgaigne has furnished two illustrations. The same thing is known to happen pretty often in some of the long bones when broken near their extremities, where the

structure is cancellated. I have noticed it often in the fracture of the humerus near its lower end, the lower fragments being in all such cases the ones which become hypertrophied. In the case of the humerus the hypertrophied fragment, sometimes after many months or years, is found to diminish; but whether such a gradual diminution in size takes place in examples of hypertrophied patellæ I am not certain. It has not seemed to me that it does occur.

Period required for Recovery of the Perfect Use of the Limb.—I will quote what Malgaigne says upon this subject: "Camper has stated that in one or two years the power is recovered, whatever may have been the interval between the fragments. An evident exaggeration, since he himself speaks of a lady with a separation amounting to three fingers' breadth, who still limped four years after the receipt of the injury. Mr. Benjamin Bell makes one inch the limit of separation, allowing for the restoration of the firmness of the knee; Boyer follows him; M. Velpeau, on the contrary, affirms that he has seen the functions of that joint completely reëstablished, with an interval of two or three inches between the fragments. Such assertions are, in my opinion, only accounted for by some inaccuracy of examination, and for my own part I have never seen the functions of the limb completely restored, even when the separation was limited to one-third of an inch."¹ For myself, I have seen three or four perfect results, so far as the use of the limb is concerned. For example, in case 31, after nineteen years, when I examined the patient carefully, there was not the slightest difference in the freedom of use of the two limbs; yet the union is by a ligament of three-quarters of an inch in length.

The fact seems to be, that more or less loss of freedom in the motions of the joint, and of strength and stability in the limb, remains in the majority of cases for a long period of time, and often during life; but that in a few exceptional cases, where the separation does not exceed one inch, the functions of the limb are completely restored within one or two years. It is remarkable, also, how well the functions are restored, after a long time, in some cases where the separation is very great, as, for example, in case 23, in which the separation was five inches when the knee was flexed, without bond of union of any kind; yet when I examined him at the end of twenty-nine years he walked well without a cane, and with very little or no halt, but he could not walk fast.

The first and main impediment in the restoration of the functions of the joint is the *ankylosis*, which is in many cases at first nearly complete. This ankylosis being due to the passive contraction of the articular ligaments, as a consequence of long disuse; to adhesions and inflammatory infiltrations among the torn muscular and tendinous fibres, and between these latter and the upper fragment of the patella as it lies more or less buried in the torn tendinous tissues. It is never safe to attempt to overcome this ankylosis by force, consequently the process of restoration must be slow and uncertain, and it will generally be found to be many years before the leg can be flexed upon the thigh to the same angle as in the case of the opposite limb.

¹ Malgaigne, op. cit., p. 606.

In a certain degree, also, the changed relations of the fragments to the articular surface of the femur may be responsible for the lameness.

As to what influence the nature and length of the new bond of union have upon the usefulness of the limb, I am prepared to say, first, that the fact that it is generally fibrous and not bony is probably of no consequence, provided the bond of union does not exceed one inch in length. It certainly is in no way responsible for the ankylosis; and, as to its effect upon the stability or strength of the limb, there is no reason to suppose that this slight diminution in the range of the contraction and elongation of the quadriceps will have, after one or two years of use, any appreciable effect upon the stability of the limb. Indeed, so far as I have been able to ascertain, in most of these cases the patients have been able, after a time, to extend the limbs as completely if not as forcibly as before.

If, however, the length of the fibrous bond is much more than one inch, there is generally an appreciable loss of the power of complete and fixed extension.

We have had recorded too few well-attested examples of bony union to enable us to declare whether the fibrous union or the bony union is most liable to a secondary accident—a refracture. It would seem reasonable to suppose that the newly formed bone would be thinner than the original bone and less spongy, and that in consequence of its compactness and thinness it would break more easily under a cross-strain than would an equally thick, but flexible, ligament. It is well known that a rupture of the ligamentum patellæ, or of the united tendon of the quadriceps, occurs much less often than a fracture of the patella.¹

March 11, 1874, Miss E. B., of Hayesville, Ohio, æt. 51, fell a distance of several feet, striking upon frozen ground, breaking the left patella transversely below its middle. Dr. E. V. Kendig being called, dressed the limb with a straight splint and adhesive plasters, which were removed in seven weeks. Inflammatory reaction was moderate. In ten weeks she began to use crutches. About this time I was consulted by letter, and was informed that the motions of the joint were quite limited. I advised continuance of passive motion, and use of the crutches. This practice was adopted, but gradually the motions of the joint ceased, until there was complete ankylosis. Subsequently she began to have pains in her left hip, then in the right, and in other parts of her body, especially in the sternum, where a tumor formed of considerable size, which felt like bone, but which disappeared under the use of iodine. Her health steadily declined, and in the spring of 1874 she began to take opium to relieve her pains. Her left femur was broken from some slight cause a short time before her death, which took place two years and six months after the fracture of the patella.

Dr. Kendig, having made an autopsy, has kindly sent the specimen to me. Union of the two fragments of the patella has taken place by means of two thin plates of bone, corresponding to the inner and outer

¹ "Relative Value of Bony and Fibrous Union in Transverse Fracture of the Patella," a lecture delivered at Bellevue Hospital, Dec. 1880, by the author. Med. News and Abstract, April, 1881, p. 195.

margins of the patella, leaving between them an open space, which in the recent state was probably occupied by fibrous tissue. Of the two plates which compose the bond of union, the inner is much the largest.

It is evident, upon the most superficial examination, that the least flexion of the limb would have been sufficient to have caused a rupture of the bony callus; indeed, the outer plate was broken and partly destroyed in cleaning it. It will be inferred, also, from the description given, that the bony union did not take place at first, and that the treatment,

FIG. 211.



Dr. Kendig's case of bony union after a fracture of the patella. (From author's collection.)
Front view.

FIG. 212.



Side view.

which seems to have been judicious throughout, was in no way responsible for the result. The bony union seems to have been the result of trophic disturbances in the osseous and articular structures, which brought about the ankylosis in spite of passive motion; and which, by placing the new fibrous bond of union completely at rest, encouraged the formation of bone as a secondary event.

My conviction is that a fibrous union of less than one inch in length is quite as advantageous as a bony union, and probably much stronger—a conviction which is enforced, also, by a case which Dr. James L. Little, of this city, has brought to my notice. John Mullen, æt. 22, broke his left patella transversely below its middle in March, 1879. It united by fibrous tissue with a separation of half an inch. About five and a half months later he slipped in walking, and the same patella was found to be fractured at a point about half an inch above the first fracture and transversely. This had united also by fibrous tissue of the same length as the first. I saw him soon after he left St. Luke's Hospital, where he had been treated by Dr. Little. The three fragments were movable upon each other, and no doubt can exist as to the character of the accident. In this case at least, then, after the lapse of a little more than five

months, the new ligament has proven itself to be stronger than the original bone. The same is true also of the case illustrated in Fig. 213.

Rupture of the newly formed Ligament.—In the prognosis of original fractures we have to include the danger of a rupture of the newly formed bond of union. Indeed, my statistics, already referred to, show a startling frequency of this accident. It is known to have occurred in twenty-five cases, and in two additional cases the ligament has given way partially.

FIG. 213.

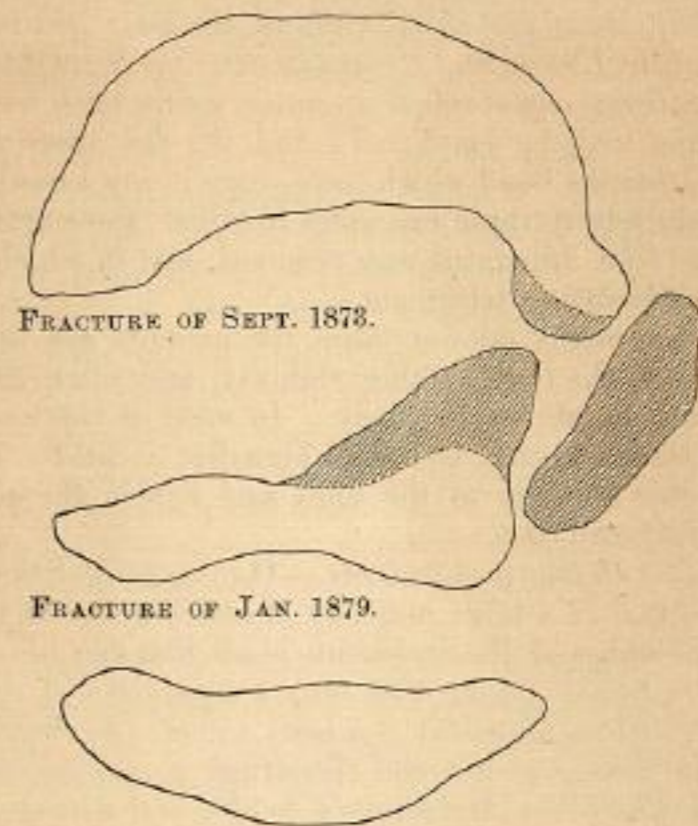


Fig. 213 represents the position of the fragments after two successive fractures, in the person of Dr. E. Cutter, of New York, examined by the author in 1884. Actual size. Fragments united by ligament. The shaded lines represent new bone.

Some of these cases were persons who sought my advice only after the treatment had terminated, and they might not therefore correctly represent the true proportion in a given number of consecutive cases. On the other hand, it will be remembered that a considerable number of the one hundred and twenty-seven tabulated cases were not seen or heard from by me, after the treatment was terminated; so that, on the whole, I think that twenty-seven out of every one hundred and twenty-seven represents fairly the average ratio of these accidents.

A knowledge of this fact, which now for the first time has been revealed to me, is of the greatest importance, as indicating the necessity for great care in the use of the limb after the surgeon has practically dismissed the patient; but it is reassuring to know that two-thirds of the whole number were ruptured very soon after leaving off the apparatus; that is, within ten weeks after the original fracture had taken place; and

that five of these took place gradually, commencing when the patient began to walk. Only two occurred later than five months after the injury, or about three months after the apparatus was removed. It would seem, therefore, that it is only necessary to provide against the accident during the first three months after removal of the splint, and that after this a rupture is no more likely to take place than if it had not been broken.

Fracture of the Opposite Patella.—This has happened five times in the one hundred and twenty-seven cases, and was no doubt due in each case to the greater effort made by the quadriceps of the sound limb to sustain the body, when the equilibrium of the body had been disturbed.

Character of the Union, and Prognosis after the Secondary Accident.—A majority of these cases refuse to unite again, even by fibrous tissue, whatever means may be employed; and the few cases of union after rupture of the fibrous bond which have come to my knowledge, are confined almost entirely to those examples in which the rupture took place very soon after the apparatus was removed, and in which the limb was immediately subjected to treatment.

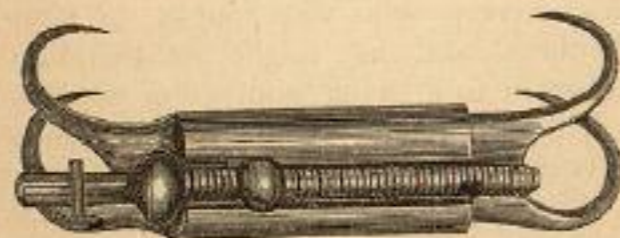
When the fragments do not unite the patients are for a long time seriously maimed, the limb lacking stability, and often giving way suddenly under the weight of the body. In most of these cases, however, a judicious treatment, such as I shall hereafter indicate, will eventually give considerable stability to the limb, and enable the patient to walk with much safety and ease.

Treatment, in Primary Accidents.—Our investigations have brought us to conclude that in a large majority of cases, under any plan of treatment, a fibrous union of the fragments is all that can be expected; and that probably a fibrous union, with only a separation of a half or three-quarters of an inch, is as useful as a bony union. Probably more useful.

The only methods which could encourage a reasonable hope of procuring a bony union, are Malgaigne's hooks, and wiring the fragments together.

Malgaigne's hooks have hitherto not been proven to have accomplished this result, not even in the hands of the distinguished inventor. In fact,

FIG. 214.



Malgaigne's hooks.

contrary to what I would have expected, there has been among the cases reported as many examples of fully recognized fibrous union, as have occurred where some other plans of treatment have been followed; the fibrous band has been no shorter; and the number of cases in which a bony union has been said, but not proven to exist soon after the removal

of the apparatus, is no greater than almost every other method has supplied.

On the other hand, several cases have been reported of dangerous or disastrous inflammation induced by the hooks, and to this objection many other methods are never liable. There seems no possible reason, therefore, why in any ordinary, simple transverse fracture, in which the original separation does not exceed one inch or even one and a half inches, the hooks should be employed; but in cases in which the original separation exceeds this, and especially in cases of a refracture or rupture of the fibrous bond, accompanied with great separation, it is my opinion that Malgaigne's hooks are entitled to a farther trial.

"That Malgaigne's hooks," says Volkmann, "have caused ulceration of the joints and death of the patient in a number of cases, is only too true; I myself know of two which occurred in the practice of friends, and which were never published; and another sad experience was met with in my own clinic a number of years since."¹ A death occurred in a London Hospital from the use of these hooks.²

The modification of Malgaigne's method suggested by Valette, of Lyons,³ in the substitution of adjustable forks for the hooks, does not render the apparatus less liable to do harm.

Farther modifications of the apparatus have been made by Levis, of Philadelphia, Verneuil, Le Fort, and Trélat, but without materially diminishing the possible or probable danger.

Séverin was the first to suggest exposing the bone "by an incision, so as to refresh the surfaces directly;" "which happily," says Malgaigne, "was not done."⁴

Norris⁵ declares that he knew of one case in which the fragments were exposed and approximated by wire (Dec. 1842), and the patient died on the fourth day. Dr. J. Rhea Barton, of Philadelphia, operated in the same manner and his patient died.⁶ Dr. Moses Gunn, of Chicago, lost his patient from suppuration.⁷ Dr. Cabot,⁸ of Boston, had the same result. Cooper⁹ and Logan,¹⁰ of San Francisco, made a similar operation, and Dr. Byrd¹¹ says it was made "many years ago" by Dr. George McClelland, of Philadelphia. The precise dates and results of the three latter operations are not published.

We are thus supplied with four cases in relation to which we have precise information, namely, the cases reported by Norris, Barton, Gunn, and Cabot, in which the operation was made without Lister's antiseptic precautions, and all of the patients died in consequence.

Since the introduction of Mr. Lister's antiseptic treatment it has been thought, by some, that the operation of exposing and wiring the fragments together could be made with more safety. The operation, under anti-

¹ Volkmann, *Cent. f. Chir.*, 1880, 24.² *London Lancet*, Nov. 22, 1879.³ Valette, *Poinsot*, French ed. of this treatise, p. 611.⁴ Séverin, *Chir. efficace*, part 2, chap. 7. Malgaigne, *op. cit.*, tom. i. p. 775.⁵ Norris, *Am. Journ. Med. Sci.*, Jan. 1842, p. 51.⁶ Barton, *Gross's Surgery*, 5th ed., vol. i. p. 1004.⁷ Gunn, *Wyeth's paper*, *Med. Rec.*, July 3, 1882.⁸ Cabot, *Ibid.*⁹ Cooper, *San Francisco Med. Press*, 1861.¹⁰ Logan, *Pacific Med. and Surg. Journ.*, Dec. 1866.¹¹ McClelland, *N. Y. Med. Journ.*, Dec. 1866.

septic precautions, has therefore been lately practised by a considerable number of surgeons; notably by Van der Meulin, of Utrecht, in July, 1879, by Cameron,¹ of Glasgow, Rose,² of London, Mr. Lister,³ Metzler, Socin, Langenbeck, Trendelenberg, R. Bell, Henry Smith,⁴ and Wyeth.⁵

I shall not think it necessary to examine all of the cases reported as having been wired under antiseptic precautions. I will however take the liberty of presenting a summary of the discussion upon this subject in the *Société de Chirurgie* of Paris, Oct. 7 and Nov. 4, 1883, as I find it in the *Virginia Medical Monthly* for Jan. 1884, p. 649:

"M. Chauvel had collected the records of 43 cases, in 38 of which the bone had been broken without solution of continuity of the overlying structures. In one set of cases, the sutures were employed after all other methods had failed; in the other class, they were employed as soon as the injury was received. In 18 cases, two sutures were employed and the substance generally used was silver wire, though occasionally catgut and silk were employed. All the details of the antiseptic method were rigorously carried out.

"The results of the operation were very various; in twelve cases the reaction was violent, while in eight it was moderate. The results were said to have been favorable in seventeen cases; in twelve cases bony union occurred! while in seven it was fibrous; three cases terminated fatally, and in one the thigh was amputated; the result in the other cases is not stated.

"M. Chauvel, comparing these results with those obtained by other methods, concludes that the suture may be useful when all other methods of treatment have failed, but it should not be practised as a general thing on account of the dangers incident to it.

"M. Pozzi had performed the operation once on a lunatic with success, so far as the bony union was concerned, but the joint was very stiff when motion was first tried and in attempting to move the joint the fracture was reproduced.

"M. Le Fort said he believed in bold surgery when the end to be attained justified the risk; but in the present case there was nothing whatever to justify such temerity. MM. Desprès and Labbé entertained similar opinions, and M. Trélat thought the operation proper only after all other modes of treatment had failed.

"M. Richelot thought the dangers incident to the operation of opening the joint were far too serious to make the operation justifiable except in very exceptional cases, and he called attention to the fact that with fibrous union, a very excellent limb often results.

"M. Gillette strongly opposed immediate arthrotomy unless there was an external wound.

"M. Verneuil protested against the procedure. The results of the ordinary treatment were far from being bad—the immense majority of patients treated in a hospital being cured and able to walk well—while

¹ Cameron, *Glasgow Med. Journ.*, July, 1878, vol. x.

² Rose, *Lancet*, Nov. 22, 1879.

³ Lister, *British Med. Journ.*, 1877, vol. 2, p. 850.

⁴ See Poincot, *Rev. de Chir.*, t. 2, 1882, p. 60.

⁵ Wyeth, *Med. Record*, July 3, 1882.

in the forty-three cases of suture, there were three deaths, one amputation, and ten absolute failures."

Among all those present, only M. Lucas-Championnière took a different view of the subject.

It will be proper for me to add that in the case operated upon by Wyeth, and already referred to, it became necessary to amputate the thigh, and Dr. Wyeth also informs me that Dr. Bull, of this city, has lost a patient in the same way.

Says Volkmann, "I concede with Kocher, that laying open the articulation for the purpose of making a bone suture is not justifiable, at least it should not be recognized as a method for general adoption."

To the testimony thus accumulated against this operation, I wish to add my own, that it is offering a very grave and dangerous substitute for others perfectly safe, and, so far as is yet proven, equally efficient methods; it is hazarding the life of the patient without offering any equivalent. Indeed I do not see why anything less could be reasonably expected from this kind of surgery than tedious recovery, ankylosis, amputation, or death; at least in a considerable proportion of cases, and this is precisely what has happened.

Kocher, recognizing the dangers attending the use of bony sutures, substituted a metallic suture which, by means of a curved needle, was passed under the upper and lower margins of the fragments and secured in front of the patella by twisting the extremities. It is difficult to see how this method should materially diminish the dangers, as the suture, or ligature more properly, "is drawn through the joint." (Volkmann.)

Volkmann² says: "Long before the introduction of antiseptics I attempted suture of the *tendons* in fracture of the patella, and though the ligature was left in place only a very short time, until the plaster-of-Paris bandage which was at once applied had hardened, I twice met with very satisfactory success. The two cases were described in Virchow's and Hirsch's *Jahresbericht*, f. 1868, Bd. II., p. 364. 'In two cases I drew through the tendon of the quadriceps and the ligamentum patellæ, while the integument was strongly retracted, at first in an upward, then in a downward direction, a simple loop of thread, and knotted the same over the patella; by this means the fragments were brought into contact, and at the same time the prominent edges were depressed. Then a very tightly fitting plaster-of-Paris bandage was applied, and directly after it had hardened, a fenestra as large as a two-cent piece was cut into it, corresponding to the spot where the ligatures had been tied, and the latter were cut and withdrawn. In one case, firm osseous union resulted; in the other, a very narrow, fibrous, intermediate substance was formed; in a third case, one of my clinical assistants applied the bandage in the same manner, and though the ligature was removed after remaining in place hardly a quarter of an hour, ulceration of the articulation and death from pyæmia ensued.' The autopsy showed that in this unfortunate case the ligature had been introduced too deeply, and transixed the joint, and that the plaster dressing had not been padded, but applied directly to the limb after enveloping the latter in moist blotting paper.

¹ Volkmann, *Central. f. Chir.*, 1880, 24.

² *Ibid.*

More recently I repeated the above operation with some slight variations, and the result was all that could be desired."

One would suppose that a single experience such as that related above by Volkmann would have been sufficient.

Volkmann¹ advises opening the joint for the purpose of evacuating the extravasated blood; but Kocher calls attention to the fact that the blood has been found coagulated as early as the third day, and he thinks therefore that the opening ought to be made as soon as possible. Schede² proposes to wash out the joint with carbolyzed water; but Kocher says he has seen this produce carbolic acid poisoning. In regard to suggestions of this character, as applied to simple fractures of the patella, I do not think it necessary to say more than to call the attention of surgeons to them.

Lastly, it is proposed to aspirate the joint for the purpose of evacuating the synovial fluids, and thus relieve the distention which tends to separate the fragments.

The objections to this procedure are that it is not unaccompanied with danger; that the joint will, in most cases, become speedily refilled; that usually the effusion begins to be absorbed as early as the seventh day and soon disappears entirely, so that practically it does not seriously interfere with the process of union.

In a case aspirated by Dubrueil³ purulent arthritis ensued, but the final result is not given. In a case reported by Dr. Robert McDonald,⁴ aspiration of the knee-joint having been made for chronic effusion, inflammation ensued ending in death on the seventh day.

And in the same manner Dr. George H. Hammond, one of the house staff at Bellevue Hospital, lost his life in 1881.⁵

Cutting the quadriceps, a method said to have been adopted by Mr. Gould,⁶ demands a very extensive subcutaneous incision, as any one will easily convince himself by looking at this muscle, with its broad and strong tendinous insertion into the top and sides of the patella; and I venture to say that no surgeon has divided all of its fibres, or even the fibres of the rectus, in his subcutaneous incision, and certainly not without carrying his incision freely into the upper part of the joint.

The method employed by Ollier, Goujon, and Wyeth (example 47 of my published cases), of injecting between the fragments fresh marrow cells, has as yet yielded no results. Nor do I think it is likely to succeed for many reasons, and especially because the "germs" cannot be placed actually between the fragments without being in the cavity of the joint, where of course they could serve no purpose. To place them in the thin tegumentary covering, which alone remains, when the separation exceeds half an inch, would be, I think, equally useless.

Finally, in order to accomplish the best results, with the least possible

¹ Volkmann, Kocher, loc. cit.

² Schede, *Central für Chir.*, 1877, p. 657.

³ Dubrueil, *Bull. de Soc. Chir.*, Oct. 1872, p. 438.

⁴ McDonald, *Am. Journ. Med. Sci.*, April, 1873, p. 548; from *Irish Med. Gaz.*

⁵ *Med. Record*, June 11, 1881.

⁶ Gould, debate on Mr. Rose's Case, *Am. Journ. Med. Sci.*, Jan. 1880, p. 278; from *Lancet*, Nov. 22, 1879.

danger to the life or limb, that is, to produce the shortest ligament, while the complete integrity of the joint is preserved, there are presented four simple indications of treatment, namely:

First. Approximation of the lower fragment to the upper by straightening—extending—the leg upon the thigh.

Second. Securing immobility of the knee-joint by a splint.

Third. Relaxation of the quadriceps muscle. This indication is accomplished in a small degree by flexing the thigh upon the body; but the effect of this posture is not so great as some writers have supposed. The quadriceps has but one origin from the pelvic bones, and consequently flexion of the thigh does not very greatly relax its muscular fibres. Yet that it possesses some value in this direction is easily demonstrated by experiment. The quadriceps is chiefly relaxed by extending the leg upon the thigh, that is, by placing the limb in a straight position and maintaining it in this position.

The fourth indication is to approximate the fragments by direct pressure; so far as this can be done, without inflicting serious injury upon the integument, or other structures. Without this pressure the relaxation of the muscle will not bring the fragments into actual juxtaposition, or even make them approximate this condition.

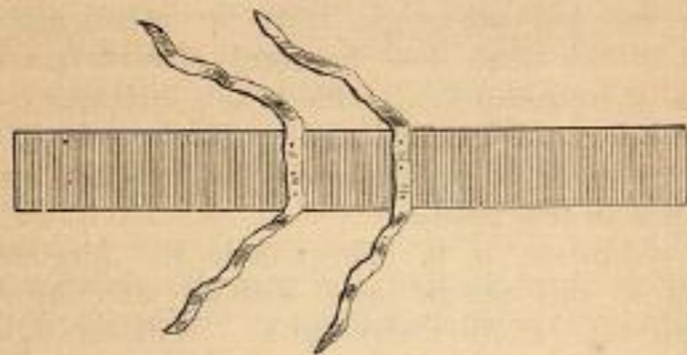
In order to make direct pressure, surgeons have devised a great variety of methods; most of which are liable to the serious objection that they press too tightly upon the entire circumference of the limb to render them perfectly safe under all circumstances; and especially when the opposing forces, which are intended to approximate the fragments, are applied with the view of securing absolute coaptation, as many of the inventors declare to be their intention. That danger exists from this source, the following case will illustrate: "A vine-dresser, æt. 40, of a good constitution, fell, and received a simple transverse fracture of the patella, on the 15th of January. The medical officer called upon to attend him applied first a bandage, for the purpose of drawing together the fragments, and afterwards a starched bandage, extending from the toes to the upper part of the thigh. The limb was placed upon an inclined plane. The patient was visited a few times, but, as he scarcely suffered, the apparatus was in no way disturbed. On the first of March (sixteenth day) the attendant returned to remove the bandage, when the odor arising from the limb led him to believe that gangrene had taken place." Dr. Defer, who was called, found the toes, which were not covered by the bandage, "completely insensible and mummified." The bandage being removed, the gangrene was found to extend to within seven inches of the knee. The ankle-joint was opened and the ligaments destroyed. The bones of the leg were also exposed in their lower third, and the tendons were in a sloughy state. Amputation was performed, and the patient recovered.¹

In case 28 of my published cases, plaster of Paris had been upon the limb one week when gangrene was threatened, and the plaster had to be removed. Cases 87 and 100 illustrate the danger also of tight bandages in causing gangrene after a fracture of the patella.

¹ *Amer. Journ. Med. Sci.*, vol. xxiv, p. 462, from *Gaz. Méd.*, No. 28.

Dr. Dorsey, of Philadelphia, employed an apparatus which will serve to illustrate in its most simple form the principle of approximating the fragments by the use of a splint and bandage. His apparatus consisted of a piece of wood half an inch thick and two or three inches wide, and long enough to extend from the buttock to the heel; near the middle of this splint, and six inches apart, two bands of strong doubled muslin, a yard long, are nailed. The splint is then cushioned, and the limb laid

FIG. 215.

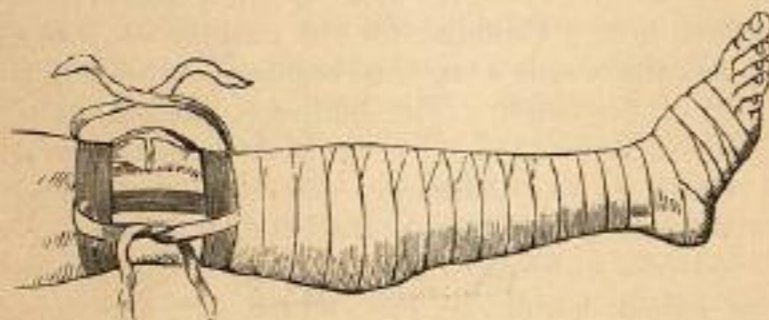


John Syng Dorsey's patella splint.

upon it, a roller being first applied from the ankle to the groin, encompassing the knee in the form of the figure of 8; after which the two muslin bands are secured across the knee in such a manner as that the lower one shall draw down the upper fragment, and the upper one elevate the lower fragment.

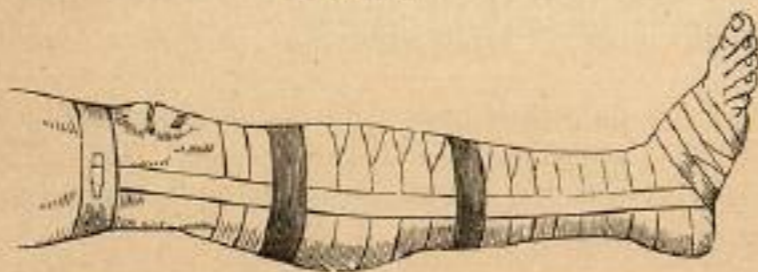
Sir Astley Cooper employed two methods of approximating the fragments, which will be sufficiently illustrated by the following woodcuts:

FIG. 216.



Sir Astley Cooper's method by circular tapes.

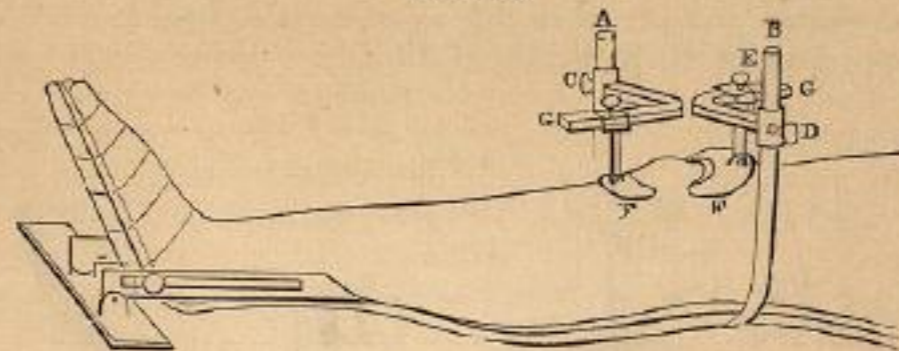
FIG. 217.



Sir Astley Cooper's method by a leather counter-strap.

Mr. Lonsdale devised a very complicated apparatus.

FIG. 218.



Lonsdale's apparatus for fractured patella.—A B. Two vertical iron bars, each supporting a horizontal one; these horizontal arms slide upon the vertical bars, but can be secured at any point by the screws C D. To the horizontal beams are attached other vertical rods, which are movable, and yet fixable by screws, as at E. Finally, to each of these last upright pieces is fixed an iron plate, F F, by means of a hinge-joint, which keeps the patella in place. The foot-piece is movable up and down upon the main body of the apparatus, and can be made fast at any point, so as to adapt the splint to limbs of different lengths.

The apparatus devised by Lonsdale, U. S. N., is more simple than Lonsdale's, but both of them can only approximate the fragments when

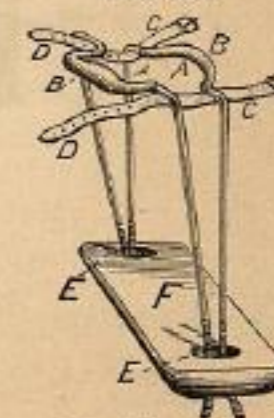
FIG. 219.



Lonsdale's apparatus.

they press very firmly, and then they will necessarily tilt the fragments and expose the patient to the risk of ulceration at the points of pressure.

FIG. 220.



Beseh's apparatus.

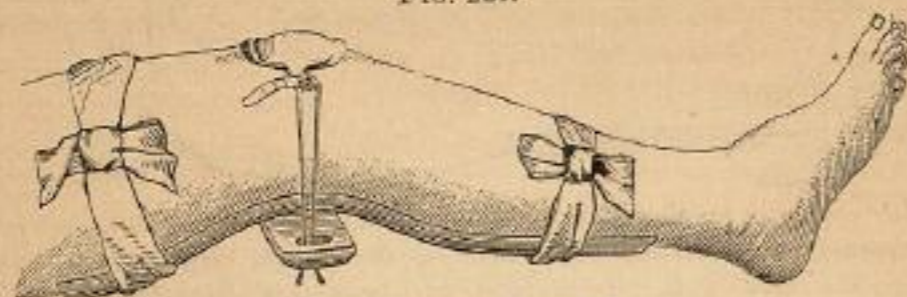
Wires in semicircular form (A), the posterior part of each segment (B) being curved upwards and the sides a little depressed. A shoulder is formed (C) on each side of the segments for the reception of the two straps (D), which connect them, and projects far enough on each side to permit the wires to be bent downwards at right angles with the shoulder, and descend perpendicularly to the slot or mortise (E) which is placed near each end of the block (F).

This happened in the only case which I have seen which had been treated by Lonsdale's apparatus on the fifth day after it was applied. This is

the case of Assist. Surg. Meyers, reported near the close of this chapter. In neither of these forms of apparatus can bandages be properly applied to restrain the tilting of the fragments, and to give the knee-joint a smooth and equal pressure when it is swollen, as it usually is.

The apparatus of R. E. Beach, of Illinois, is liable to the same objection.¹

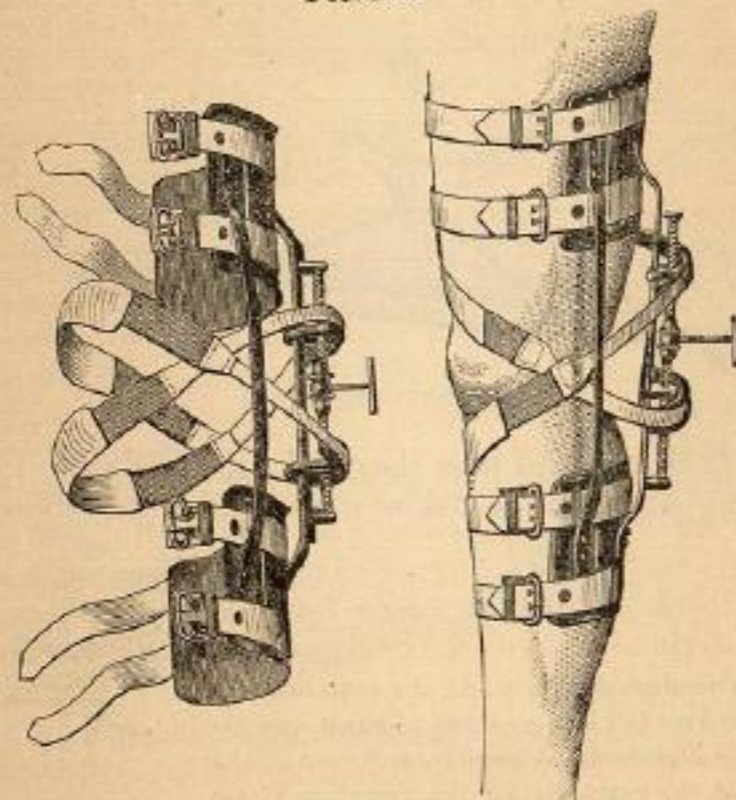
FIG. 221.



Beach's apparatus applied.

The device of J. H. Hobert Burge, of Brooklyn, in which the fragments are approximated by carefully adjusted leather pads, operated upon by weights, cords, and pulleys, is too complicated, and possesses

FIG. 222.



Turner's apparatus.

no marked advantages over the simple roller employed in my own dressing.²

The apparatus of Dr. Turner,³ of Brooklyn, and of Dr. John A.

¹ Beach, St. Louis Med. and Surg. Journ., Jan. 1875.

² Burge, Med. Record, April 15, 1868. For illustrations see 5th ed. p. 471.

³ Turner, Med. Rec., July, 1867.

Wyeth, of this city, involve the same principles, and are equally liable to objections, on account of the limited surface against which the pressure is made.

In Dr. Wyeth's¹ apparatus the phalanges of the pad furnish a protection to the vessels which course along the sides of the knee, and upon which the vitality of the integuments of the front of the knee mainly depends.

Gibson, of St. Louis, has revived, in a modified form, the circular ring of Albucasis.² Drs. Eve, of Nashville, and Blackman, of Cincinnati, have spoken favorably of this method.³ Its application must, however, be limited to such cases as are unattended by inflammation, and can tolerate the pressure applied only to a small point of the surface. It is essentially the same as Beach's apparatus, but has the advantage of being more simple. Its efficiency depends upon its holding firmly upon the fragments, and not permitting them to slide from its grasp. All the tendinous insertions into the patella are continuous with the anterior margins and surface of the bone; so that there is no natural sulcus to receive the ring, or uplift against which the ring or any similar form of dressing can obtain a bearing, unless it is very firmly pressed into the tissues above and below, as I have before explained. Such pressure as is required in the case of a ring, or any similar hard and unyielding mode of pressure, will not often be borne by an inflamed and swollen structure.

Plaster-of-Paris and all other forms of immovable dressing do not possess one single point of excellence or advantage. When first applied they are liable to constrict the limb dangerously; and how insidiously a fatal gangrene may progress, giving no sign either by pain or general disturbance until the destruction is nearly complete, the case seen by Defer, and referred to in the preceding pages, will show. The cases which I have reported also in the preceding pages demonstrate how inefficient these dressings are as means of approximating the fragments; the examples of the widest separation being drawn almost exclusively from cases treated by the plaster of Paris or the silicates. The dressings, which within a few days or hours are apt to become very tight in consequence of the increased swelling, soon begin to loosen, from the subsidence of the swelling at first, and finally from atrophy of the muscles and other soft tissues, and the limb lies loose in its case, which may not even touch the patella, much less make any effective pressure upon it. Whatever the result may be under such circumstances, so far as the separation of the fragments is concerned, the dressing has nothing to do with it. It may be that the final separation will be found to be very little, but, if it is, it would have been the same if the limb had been laid horizontally in bed without dressings or apparatus of any kind.

Some have attempted to remedy this serious objection to these dressings by first applying adhesive plaster in the form of a lock strap, and in various other ingenious ways, above and below the fragments. I have seen this done repeatedly at Bellevue, and my reported cases furnish

¹ Wyeth, Med. Rec., May 11, 1878.

² Gibson, Amer. Journ. Med. Sci., Jan. 1867, p. 281.

³ Eve, Blackman, Nashville Journ. Med., February, 1867; Western Journ. Med., May, 1868.

quite a number of examples; but, in almost every case, the straps soon became painful and had to be removed, and this required the opening of the plaster splint or its entire removal. In one of the cases (33) reported by me, the adhesive strips held in place by elastic bands caused such excessive pain as demanded the use of hypodermic injections of morphine repeatedly, and it resulted in an almost complete paralysis of the extensor muscles of the foot, which continued many months after the treatment was suspended; yet from all this there was no appreciable gain, inasmuch as the fragments united by ligament with the usual amount of separation. Indeed, so far as the position of the fragments is concerned, the dressings had only proved mischievous by thrusting one of the fragments laterally.

Plaster of Paris is of all the forms of immovable dressings the worst, because it is the heaviest; but of them all it must be said that they are unnecessarily cumbersome as a form of portable apparatus; they are to some extent dangerous, especially in the hands of inexperienced surgeons; they are inefficient as means of approximating the fragments; they actually serve but one single purpose, namely, to keep the limb straight, and this they do too effectually in many cases, causing an unnecessary degree of passive ankylosis. The limb can be maintained in a straight position by a much simpler and lighter dressing than a plaster-of-Paris splint, and by means which permit it to be daily examined and the condition of the fragments noted and corrected, and which will allow slight passive motion occasionally to the knee-joint; a practice which has been found in my experience perfectly safe, and useful in some measure, so far as the ankylosis is concerned.

In short, to apply the plaster of Paris, and permit the patient to go about on crutches, as is generally recommended by its advocates, is to abandon, practically, every acknowledged indication of treatment, except straightening the limb and securing immobility at the knee-joint.

The Author's Method of Treatment.—The limb being placed extended, with the foot elevated about six or eight inches, a long splint is applied to the back of the thigh and leg. This splint may be made of leather, of gum-shellac cloth (not felt), or of any other material having the necessary qualities of firmness, lightness, and plasticity, so that it can be properly moulded to the limb. Of late I have preferred the gum-shellac cloth, as possessing in a greater degree the necessary qualities than either of the others. The splint should be long enough to extend from above the middle of the thigh to two or three inches above the heel. Its width should be sufficient to inclose the posterior semi-diameter of the leg and thigh. It should be placed in hot water, and then moulded to the back of the limb: only that it is rather better not to fit it accurately to the popliteal space, in order that a small amount of cotton-batting may be placed between the splint and the skin.

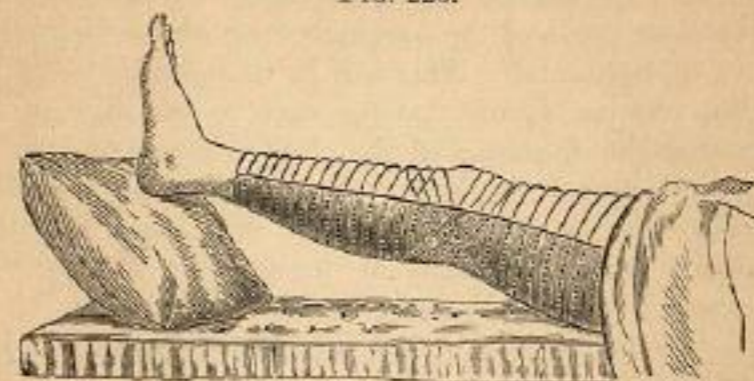
The splint should then be removed; and, if made of shellac cloth, in a few minutes it will be sufficiently hard to retain its form. It is now covered completely with a firm cotton or woollen sack, and the sack stitched along the back of the splint. The splint having been curved to fit the circumference of the limb, the sack must hang loose across the concave surface of the splint, so that the limb may be allowed to fall

back to the splint, but the ends of the sack may be drawn and stitched tightly.

One object of the covering is to furnish a protection to the skin against the splint; but the chief object is to supply a basis to which the bandage, which is to inclose the limb and splint, may be stitched.

The splint must be applied while the limb is in the position already described, a small wad of cotton-batting having been placed in the ham. A roller, made of unglazed cotton cloth, is then turned around the leg and splint to within about three inches of the knee, and another from the upper end of the splint over the splint and thigh to within three inches of the knee. While an assistant approximates the fragments with his

FIG. 223.



The Author's mode of dressing.—(The final turns of the roller, in the front of the knee, are not shown in the woodcut.)

fingers, the surgeon makes two or three turns with a third roller around the limb and splint, close above the knee; after which the roller descends below the knee, and an equal number of circular turns are made close below the lower fragment of the patella; and finally, a succession of oblique and circular turns are made above and below the fragments, which turns are to approach each other in front until the whole of the patella is covered—the last turns being again circular. The dressing now being completed, the rollers are carefully stitched to the cover of the splint through its whole length, on both sides; and the limb is left supported in the elevated position by a suspending apparatus, or by some other mode which will insure its maintenance in this position.

I have been thus particular in my description because all of my readers may not have had experience in the application of bandages, and because to many of the details I attach importance. A few words of explanation of some of these points may not be amiss.

The cotton cloth roller is preferred, especially for the purpose of approximating the fragments, because, if unglazed, it yields a little, and adapts itself smoothly to the skin, even sinking down a little just above and below the patella, thus rendering it less liable to slide over. Reversed turns are omitted altogether, because they cause sharp cords where they are folded, and sometimes produce painful constrictions and excoriations. Adhesive strips, recommended by me in the first edition of this work, I have long since laid aside. They are just as liable to slide, they are apt to cut at their free margins, and they have to be

raised up from time to time to be tightened, and they cannot be stitched and thus permanently secured to the cover of the splint. No pads above and below the knee are recommended, because they are apt to become displaced, and if they remain in place they no more effectually press the fragments together than does the cotton roller. No pad is placed in front of the patella, because the last turns of the roller press back the fragments as effectually as a pad. Care must be taken when the roller is applied and the fragments are approximated, that the loose skin in front of the patella is not pressed between the fragments. No lotions must be applied, to saturate the dressings. They render the skin more liable to excoriations, and they are in no way useful.

All that remains to be done is easily said. On the second or third day the swelling of the knee will be found, probably, to have subsided somewhat, and the oblique turns of the bandage from above and below the patella will need to be tightened. This will be done by over-stitching, with strong thread, the oblique turns; taking care to do this on both sides and so far back that the doubling of the cloth will not be over the sides of the exposed portions of the limb. The same thing may be required to be done every day, or every second or third day, for two or four weeks. Meanwhile it will generally be found—for the position of the fragments can always be felt—that the space between them has not been increased, and in most cases that it has sensibly diminished from the day of their first adjustment.

At the end of about four weeks the apparatus should be removed carefully. It is now observed, generally, that the knee is pretty stiff, and that the upper fragment cannot without considerable force be displaced in any direction. It is ankylosed, and there is very little danger that it will thereafter draw up further, and it is not probable that any apparatus will make it descend. But as a matter of safety, an assistant should now press the upper fragment gently downwards while the surgeon flexes the knee very slightly, so as to diminish its stiffness. He ought, in doing this, never to cause pain or to use any degree of force.

The splint is then to be reapplied in the same manner as before. Daily, thereafter, the splint should be removed with the same care, and the limb gently flexed. In the meanwhile the patient may go about upon crutches if he chooses.

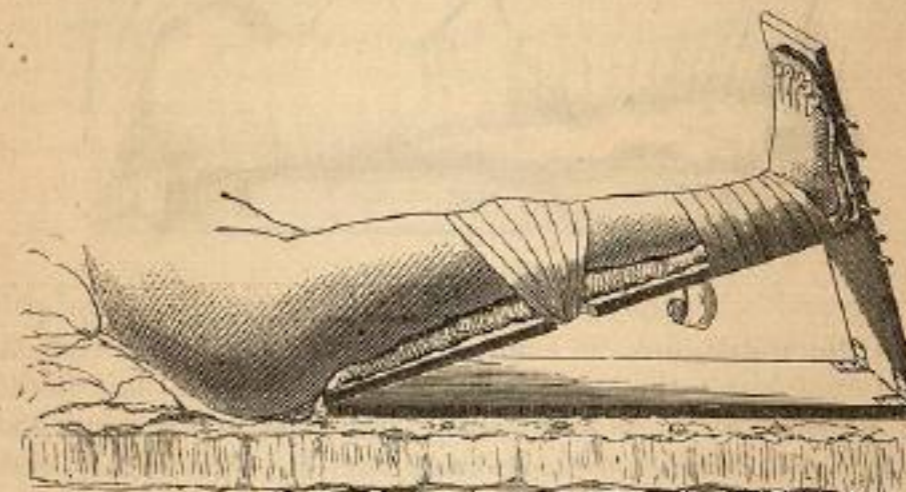
In six or eight weeks the bond of union may be considered completed, and the patient may be dismissed from the immediate care of the surgeon, but not until he has been fully informed of the danger of a rupture of the new ligament, and has been provided with the means of protection as far as possible. He must be taught that for the next three or four months this danger is great; and that any sudden flexion of the limb may cause it; and, indeed, that it may be caused by simple muscular action, when the limb is not flexed. During this period he should walk only upon crutches, and the knee-joint should be constantly supported, unless he is completely at rest.

The knee-caps usually furnished for this purpose are wholly unreliable. They allow the knee to bend too freely. Indeed, nothing but an inflexible splint can insure safety; and the same splint employed in the treatment, reduced one-half in length and secured by straps and buckles, is the best I have yet employed.

Under no circumstances, in my opinion, is the surgeon justified in attempting to overcome the ankylosis by force, either with or without an anæsthetic. The chances are more than equal that he would substitute a ruptured ligament and an ununited patella for an ankylosed knee. I have been informed that this accident actually occurred at one of our city hospitals a few years ago, in the presence of a class of students. In time, and generally within a year or two, the ankylosis will disappear wholly under careful and moderate use of the limb.

It will be seen that I no longer recommend the wooden inclined plane (Fig. 224) in all cases, as I have done in my earlier editions. The principle of its construction is correct, and the results have been satisfactory, but it is unnecessarily cumbrous for a majority of recent and primary accidents, and I reserve it now only for exceptional cases, such, for example, as those in which the separation is very great, or the inflammation and swelling are unusual.

FIG. 224.



The author's wooden inclined plane. To be used only in exceptional cases.

Mr. Hutchinson, of London, has of late omitted to elevate the foot in the treatment of this fracture, and he thinks that the fragments are maintained in apposition with quite as much ease.¹ I cannot agree with him that nothing is ever gained by the elevation of the foot. On the contrary, in the treatment of a certain proportion of cases this position will be found essential to the best success, while in others it may be of little consequence whether the foot is elevated or not.

The dressing and apparatus employed by Wood, of King's College Hospital, are very similar to my own wooden inclined plane, but, as will be seen by the accompanying drawing, the splint is only five or six inches wide. Dr. Wood has substituted hooks for the notches.²

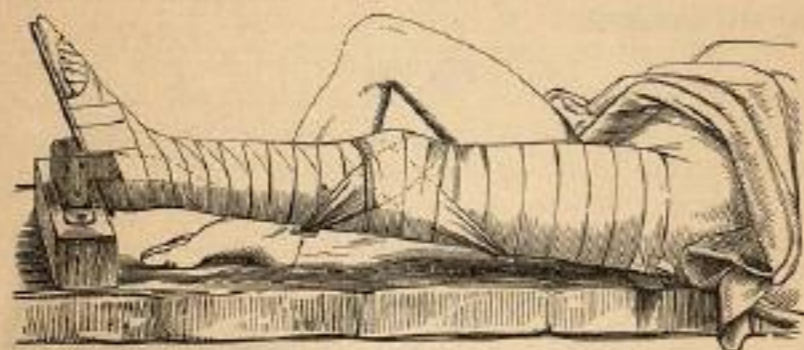
I will add now, although somewhat out of place, what that distinguished surgeon, Corradi, of Bologna, has said on the subject of fibrous and bony union:³

¹ Hutchinson, London Hosp. Reports, vol. xi. ² Fergusson's Surgery, p. 307.
³ Della Chirurgia in Italia, dagli ultimi anni del secolo scorso fino al presente. Commentario di Alfonso Corradi, p. 216. (A concours prize essay, approved by the Med. Chir. Soc. of Bologna, An. 1870.) The author refers to a letter written and published by Albertis in defence of Andrea Veronica; being a dissertation on the fracture of the patella, printed at Macerata in 1695.

"Long before Ledean and Pott, a Venetian surgeon, Pietro de Albertis, had made the observation that it was not necessary to the *freedom of ordinary motion* that a perfect union of the fracture of the patella should take place.

"Flajani, from his own experience, was convinced that the danger of ankylosis and lameness was diminished by adopting no other means than the simple and natural situation of the parts, after having at first applied emollient or resolvent remedies," etc.; enjoining also early passive motion. "These views of Flajani were corroborated by Manzotti" (Dissert. on Frac. of Patella, Milan, 1700), "and subsequently confirmed by modern surgeons, particularly by Velpeau. It is proper to point to the fact that the Roman professor, in the same way as Pott,

FIG. 225.



Wood's apparatus.

abandoned apparatus, not, as some one has strangely asserted, for the purpose of increasing the separation of the fragments, but because he regarded position alone as sufficiently efficacious in the approximation of the fragments, but when these fragments are very much separated, position is not always efficient, nor are we much aided by apparatus, even although we employ the best."

Treatment of a Rupture of the New Ligament.—I now come to consider briefly the treatment of a rupture of the newly formed ligament, called sometimes, improperly, a refracture.

In all cases the patient should, as soon as possible, be subjected to the same plan as I have recommended for original fractures, but with smaller hope of a reunion. It is here when the separation is great, and in old cases of ununited fracture, that I could justify the use of Malgaigne's hooks; but of their value even in these cases, I am not prepared to speak confidently.

In employing Malgaigne's hooks the lower hooks are made to overlap, or grasp the lower margin of the lower fragment, and the upper hooks are projected forcibly into the top and front of the upper fragment. The upper hooks are therefore quite apt to loosen and slide.

The time always arrives, according to my experience, both in primary fractures and secondary accidents or ruptures of the new ligament, when supporting and retentive apparatus is worse than useless. The period is within five months after the original accident, and within about the same period after the secondary accident.

A reference to some of the cases I have reported, and especially to

that of Assistant Surgeon Myers, of the United States Navy (case 40), will illustrate the importance of removing all support after a time, and teaching the muscles to rely upon themselves alone. Under proper and free use of the limb, aided by friction, electricity, etc., the muscles will become developed in size and strength, and through their remaining attachments to the sides and front of the leg, below the knee, will give to the patient often a very useful limb. The case is as follows:

Assistant surgeon T. D. Myers, æt. 29, broke his right patella May 19, 1874, when returning from the U. S. ship Kearsage, from muscular action in attempting to save himself from a fall. The fracture was transverse, and below the middle—at the upper end of the lower fourth. The fragments at once separated fully four and a half inches. Surgeon Bloodgood in charge. May 21st he was sent to the hospital at Yokohama. A long posterior splint was applied and the fragments secured with a figure-of-8 bandage. May 24th, Lausdale's apparatus was applied. This was worn five days, when it was found to have caused a slight ulceration above the upper fragment, and it was removed. A straight splint, secured at the knee by adhesive strips, was substituted, and kept on several weeks; and soon after he began to walk, the fragments being united by a ligament one-half an inch in length on the inside, and one-quarter of an inch on the outside.

August 2, 1874, seventy-five days after the first injury, and not long after he began to walk, he slipped and ruptured the ligament from muscular action. He was still in the hospital at Yokohama. A plaster-of-Paris splint was now applied, which was renewed once in about eight days, and finally removed at the end of eight weeks. While this splint was on the limb he was allowed to go about on crutches. On removal it was found that no union of any kind had taken place. From this time forwards, a period of over five months and two weeks, he supported the limb with a leather splint, and walked about on crutches or with a cane. He consulted me March 17, 1875. I found the fragments separated four and a half inches, with very little motion at the knee-joint. Could not detect any bond of union. I advised the removal of the leather splint, and daily use of the limb by passive motion and active exercise in walking, also electricity, shampooing, etc.

In a letter from him, dated May 23, 1875, he says: "Since consulting you, March 17, 1875, I have steadily pursued the plan of treatment suggested by you," etc. "The functions of the limb have gradually returned till now I am able to walk very well, with very little or no limping." . . . "The atrophy of the muscles is gradually disappearing." . . . And he concludes with expressions of gratitude for the happy result of the change in the mode of treatment.

Compound and otherwise Complicated Fractures.—Post, of New York, has reported three cases of compound fracture of the patella extending into the knee-joint, brought to a successful termination.¹

In a case mentioned by Eve, of Augusta, occasioned by the kick of a horse, and in which amputation became necessary on the tenth day, "the knee-joint was found filled with dark grumous blood; a portion of

¹ Post, New York Journ. of Med., vol. ii., first series, p. 367.

the cartilage of the internal condyle of the os femoris was chipped off, and the patella broken into a number of fragments."¹

Lewitt, of Michigan, has related a case of fracture in a lad æt. 16, produced by striking his knee against a piece of timber, which resulted in suppuration of the knee-joint, but from which he finally recovered with the perfect use of the limb. The fracture of the patella was oblique, traversing only its upper and outer margin, and it was never much displaced.²

Dr. Levergood, of Pennsylvania, has reported a similar case, in which it became necessary to open the joint freely, yet it was followed by an excellent recovery, only a slight ankylosis remaining at the knee-joint.³

Dr. E. Mason has reported a case in which considerable ankylosis resulted from the plaster-of-Paris treatment. A refracture occurred, and although no blow was inflicted directly upon the knee, the adhesions which had ensued upon the previous fracture had so united the skin and subjacent tissues that the soft parts gave way with the bone, opening the joint freely. Extensive suppuration ensued and the patient died.⁴

Thomas A. Gallagher, æt. 17, fell, May 24, 1880, thirty feet, striking with his right knee upon a rock, and breaking the right patella at its lower and outer third into several fragments—the wound communicating with the joint. He was placed immediately under my charge, and the limb was laid at rest in the horizontal position. No bandages or other restraints were employed. On about the fifth day suppuration occurred in the joint, and the limb became greatly swollen. I opened the joint freely, removed all of the small fragments, and made a counter-opening, through which a large drainage-tube was passed. Hot water fomentations were applied to the whole limb, and the knee-joint was daily washed thoroughly with a weak solution of carbolic acid. The inflammation and suppuration began to subside from this date, and on the first day of July, thirty-seven days after the accident, he was walking on crutches, the wounds having nearly closed, the joint being free from inflammation, and sufficient motion remaining to render it probable that the functions of the joint will be completely restored.

CHAPTER XXXI.

FRACTURES OF THE TIBIA.

Development of the Tibia.—The tibia is formed, usually, from three centres of ossification—one for the shaft, and one for either extremity. Ossification commences in the shaft at or about the fifth week of foetal life. In the upper epiphysis it appears at birth, and unites with the

¹ Eve, Southern Med. and Surg. Journ., 1848; also Boston Med. Journ., vol. xxvii. p. 427.

² Lewitt, Medical Independent, Sept. 1856.

³ Levergood, Amer. Journ. Med. Sci., Jan. 1860.

⁴ Mason, N. Y. Journ. Med., April, 1875, p. 416.

shaft at about the twenty-fifth year. Generally it forms the tubercle, but occasionally the tubercle has a distinct point of ossification. The lower epiphysis commences to ossify during the second year, and unites with the shaft at about the twentieth year. The malleolus internus is occasionally formed from an independent centre.

Etiology of Fractures of the Tibia.—Fractures of the tibia alone are, in a large majority of cases, produced by direct blows, such as the kick of a horse, or a blow from a stick of wood; in one instance I have seen it broken by a kick from a Dutchman's boot. It is occasionally broken by a fall upon the foot, the force of the impulse being expended before the fibula gives away, but almost always the fibula breaks at the same moment, or immediately after the fracture has taken place in the tibia.

Heydenreich relates the case of a man 42 years old, in a Bordeaux hospital, whose tibia was broken above the tubercle in an attempt to straighten an ankylosed knee. The patient died on the eighth day, from a hæmorrhage caused by the pressure of the displaced fragment upon the popliteal artery.

Dr. Proudfoot, of New York, has reported an example of fracture of the tibia *in utero*, produced in the sixth month of pregnancy, by violent pressure upon the abdomen.¹

Pathology, Division, etc.—In an analysis of twenty-seven fractures of the tibia, not including fractures of the malleoli, six were found to have occurred in the upper third, eleven in the middle third, and eight in the lower third. Six of the twenty-seven are known to have been transverse, or only slightly oblique. It is probable, also, that several of the remainder were transverse. In this respect, therefore, fractures of the tibia alone will be found to differ materially from fractures of the tibia and fibula; but it is only in accordance with the general observation that indirect blows produce almost constantly oblique fractures, and direct blows somewhat more frequently transverse.

According to Heydenreich² fractures of the upper third of the tibia occur most often between the 30th and 50th years of life, and he has not found a case recorded in a person under 22 years of age. I have myself, also, noted the fact that fractures above the tubercle are most common in old persons. Fractures of the tibia extending into the knee-joint are in most cases compound, or otherwise so seriously complicated as to render amputation necessary.

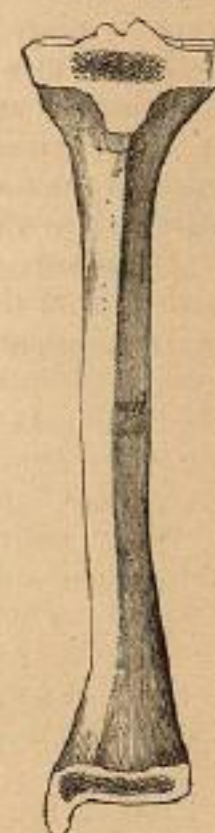
The malleolus internus is broken frequently at the same time that the ankle-joint is dislocated, and this accident will be considered in that connection, and in connection with fractures of the lower end of the fibula.

Separation of Epiphyses.—We have already mentioned that Madame Lachapelle has reported a case of

¹ Proudfoot, Boston Med. and Surg. Journ., vol. xxxv. p. 268, 1846; from New York Journ. Med.

² Heydenreich, Frac. Ext. Sup. du tibia, th. de Paris, 1877, No. 43.

FIG. 226.



Development of the tibia. (From Gray.)