need therefore of an osteoclast, such as was devised by Rizzoli, and later by Taylor,[1] with which they proposed however only to break limbs which were anchylosed in positions which rendered them useless.

After a careful study of the nine cases of refracture reported by Roberts, of Philadelphia, as having been performed by Levis, Hewson, Morton, and Hunt, at the Pennsylvania Hospital, I find no occasion to modify the preceding statements. In only two of the cases had more than ten weeks elapsed between the date of the receipt of the injury and the refracture.[2] Nor do the cases reported by Dupuytren[3] lead one to question the soundness of the precept I have attempted to teach. I am compelled to say, also, since Dr. Roberts has called attention to Dupuytren's table, that it is constructed in a manner very loose and unsatisfactory. Of the nine cases which he probably saw, some are not in the text, and not all of the cases mentioned in the text are in the table. The only refracture of the femur is reported in the table as in the person of a "man" four years old. Nor did Dupuytren see one case in which the refracture was made after ten weeks, the cases in which the period was longer—four cases—being obtained from "authentic" sources.

CHAPTER VII.

DELAYED UNION, FIBROUS UNION, AND NON-UNION OF BROKEN BONES.[4]

Causes and Varieties.—Most surgical writers concur in the statement that non-union of broken bones is an uncommon event. Walker, of Oxford, affirms that of not less than one thousand fractures which have come under his treatment at some period of the repair, he does not recollect more than six or eight instances. According to Lonsdale, not more than five or six cases of false joint, excepting those within a capsule, have occurred out of nearly four thousand fractures treated at the Middlesex Hospital. In a table of 367 cases, collected and arranged by W. W. Morland, from the books of the Massachusetts General Hospital, extending through a period of nineteen years, only one example of false joint is recorded; but as only seventy-four days had elapsed when this patient was discharged, it is doubtful whether this might not have proved to be a case of delayed union simply.[5] In 946 cases of recent fracture

[1] The Medical Record, April 21, 1877.

[2] J. B. Roberts, Refracture for the Relief of Deformities after Fracture. Philadelphia, 1878.

[3] Dupuytren, Injuries and Diseases of Bones, London edition, 1857.

[4] I shall in this chapter avail myself freely of the labors of George W. Norris, of Philadelphia, whose paper, entitled "On the Occurrence of Non-union after Fractures, its Causes and Treatment," published in the American Journal of the Medical Sciences for Jan. 1842, constitutes one of the most complete and reliable monographs upon this subject contained in any language.

[5] Address on Fractures, by A. L. Pierson, read before the Massachusetts Med. Soc., May 27, 1840.

treated in the Pennsylvania Hospital, between the years 1830 and 1840, there was no instance of false union.[1] Sir Stephen Hammick, Mr. Liston, and Malgaigne affirm also the infrequency of these accidents in the cases which have come under their personal treatment. I myself have seen a large number of examples of non-union, but in not one of my own patients, whether in hospital or private practice, except in cases involving joints, has the bone refused finally to unite; and my opinion is that, in proportion to the number of fractures everywhere, these cases are very rare, perhaps not in a larger proportion than one in five hundred.

The humerus and femur would appear to be the bones most liable to non-union, as shown by Norris's statistics; in which forty-eight belonged to the humerus, forty-eight to the femur, thirty-three to the leg, nineteen to the forearm, and two to the jaw. In my own experience, I have found the humerus ununited more often than the femur.

Bérard has shown that in the growth of the long bones the period at which the epiphyses are united to the diaphyses depends upon the direction of the nutritive artery; for example, "It is found that in the humerus, where the direction of this vessel is from above downwards, consolidation takes place soonest at its inferior extremity. In the forearm, the course of the nutrient vessels is from below upwards, and here consolidation of the epiphyses is found to occur at the elbow sooner than at the wrist. In the inferior members, on the contrary, the epiphyses composing the knee are the last which become firm, because in the femur the nutritious artery runs upwards, and in the bones of the leg it courses from above downwards." A knowledge of these facts led Guéretin to inquire into the influence of these arteries upon the consolidation of fractures; and the cases collected by him did indeed seem to show a positive relation between the direction of the artery and the union of the bone: that is to say, the examples of non-union were chiefly found where the fracture had taken place on that side of the nutritious foramen from which the artery entered, as if to imply that the non-union was in some measure due to the imperfect nutrition of this extremity of the bone. In thirty-five cases of non-union analyzed by Guéretin, ten belonged to that portion of the bone which was traversed by the artery, and twenty-five to the other portion. But an analysis of forty-one cases, made by Norris, does not seem to confirm this observation of Guéretin, since twenty-seven were in the direction of the nutritious arteries, and only fourteen in the opposite portion, or in that which is supposed to be less nourished.

Another observation, made by Curling, that in fractures of the long bones the portion below the entrance of the nutrient artery, or on that side of the nutrient foramen toward which the blood flows, being defrauded of its proper supply, is subjected to a species of atrophy, presenting a larger medullary canal, with thinner walls, and a spongy tissue less dense, also needs confirmation. Malgaigne has not noticed this fact in any of the specimens contained in the public museums of Paris; and

[1] Norris, loc. cit.

I do not know that any other writer has made the question a subject of especial inquiry.

According to Norris, there are four principal kinds of false joint:

In the first, the bones are united and completely enveloped in a cartilaginous mass or callous tumor, but, in consequence of some retardation in the process, bony matter is not deposited, and, as a consequence, it wants solidity, the part continuing easily movable. This may be regarded as a proper example of delayed union, as distinguished from complete non-union, or false joint.

In the second, there is entire want of union of any sort between the fragments, the ends of which seem to be diminished in size and extremely movable beneath the integuments. The limb in these cases is found wasted and powerless.

In the third and most common class, the medullary canal is obliterated in both fragments, and the ends are more or less absorbed, rounded, and covered, in part or in whole, with a dense tissue resembling the periosteum. A connection also exists between the opposing fragments in the form of strong ligamentous or fibro-ligamentous bands, which, if of any length, are quite flexible, and allow of considerable motion at the seat of fracture.

Fig. 16.

Clavicle united by ligamentous bands.

In the fourth, "a dense capsule without opening of any kind, containing a fluid similar to synovia, and resembling closely the complete ligaments, is found." In these cases the points of the bony fragments corresponding to each other are rounded, smooth, and polished, in some instances eburnated, and in others covered with points or even thin plates of cartilage, and a membrane closely resembling the synovial of the natural articulation. It is in this kind of cases, Norris remarks, that the member affected may still be of use to the patient, the fragments being so firmly held together as to be displaced only upon the application of considerable force.

M. Bérenger Féraud, in a treatise on non-united fractures, has added a fifth class of pseudarthroses, which he designates as "pseudarthrose osteophytique;" it being characterized by excessive osseous growths in irregular forms, at or near the seat of fracture. I can hardly see the propriety of considering this as a distinct class, inasmuch as it is a complication, which in certain conditions of the general system, under certain circumstances of treatment and of fracture, in certain portions of the osseous system, especially at the neck of the femur, may be found associated with either or most of the other forms of non-union described by Norris.

The existence of the newly formed joints, or true diarthroses, has been called in question by Boyer, Hewson, Chelius,[1] and others; but the observations of Sylvestre, Brodie, Beclard, Home, Howship, Otto, Kuhnholtz, Houston, Cooper, Langenbeck, Féraud, and Breschet prove that

[1] Malad. Chirurg., t. iii. p. 103, Paris, 1831; North Amer. Med and Surg. Journ., No. ix. p. 7, 1828; Traît. de Chir., trad. par Pigné, p. 150, 1836. (Norris, loc. cit.)

such examples are occasionally found.[1] I myself have met with several examples.

A case is reported as having occurred in Boston, Massachusetts, in which a young man, æt. 18, broke his humerus near its middle. Before union had been completed it was accidentally refractured, and from this time the fragments showed no disposition to unite; on the contrary, a gradual process of absorption took place, until at length the whole of the humerus disappeared; and that, too, "without any open ulcer." Eighteen years later he was perfectly well, and the arm was strong and useful, but no portion of the bone had been reproduced.[2]

Norris is a disciple of Dupuytren, and accepts his doctrine of the formation of callus, without reservation; consequently he finds no necessity for but one form of delayed union, namely, that which we have described as belonging to the first class. In all of this class he assumes the existence of a cartilaginous ring or ferrule; but we think the error of this exclusive theory has been sufficiently shown by the observations of Paget and others, and we should be warranted therefore in affirming the existence of as many varieties of delayed union as there are varieties in the manner and position of the deposit of callus, even if their actual existence had not been repeatedly demonstrated by dissections.

The causes of delayed union and of non-union are either constitutional or local.

The constitutional causes are chiefly those conditions of the general system which manifest themselves by anæmia, debility, or some peculiar dyscrasy.

Sanson, Beulac, Condie,[3] and many others have mentioned cases in which the existence of syphilis in the system has seemed to prevent the formation of callus; but, on the other hand, Lagneau and Oppenheim,[4] incline to the opinion that syphilis exerts in this respect but little influence; and even Bérard, who admits the pertinence of one case observed by Nicod, concludes, after numerous researches, that it has been very rarely shown to affect the formation of callus.[5]

Pregnancy and lactation have been known to interfere with the union of bones. Werner, Hildanus, Wilson, Hertodius, Alanson, Bard, of New York, and Condie, of Philadelphia,[6] have all reported examples, in some of which the process of union was resumed and brought to a rapid completion as soon as the period of pregnancy was closed, or when lactation ceased; but three cases reported by Sir Stephen Love Ham-

[1] Nouvelles de la Répub. des Lettres de Bayle, p. 718, 1685; Lond. Med. Gaz., xiii. p. 57, 1833; Beclard, Gen. Anat., trans. by Hayward, pp. 149, 248; Transac. Med.-Chir. Soc. of Edinburgh, i. p. 233, 1793; Med.-Chir. Trans., viii. p. 517, 1817; Otto's Path. Anat., trans by South, i. p. 138; Journ. Complément., iii. p. 291; Dub. Med. Journ., viii. p. 493; Cooper on Frac. and Disloc., fourth London ed., p. 508; Recherch. sur les Formation du Cal, 1819, p. 34. (Norris, loc. cit.)

[2] Boston Med. and Surg. Journ., July 11, 1868, p. 368.

[3] Dict. de Méd. et Chir. Prat., iii. p. 492; Journ. de Méd. Chir. et Pharm., t. xxv. p. 216. (Norris, loc. cit.)

[4] Exposé des symp de la mal. Vén., p 525; Oppenheim on False Joints, 1837. (Norris, loc. cit.)

[5] Op. cit., p. 21.

[6] Cooper's Dict., ed. 1838, p 546; Opera Hild., 1681; Wilson on the Human Skeleton, p. 214; Bib. Choisie de Méd., xxiv. p. 595; Med. Obs. and Inquiries, 4, 1772; Philosoph. Trans., xlvi. pp. 397, 760. (Norris, loc. cit.)

mick would seem to show, what, indeed, other evidences render probable, that the delay was less due to the fact of the pregnancy and the lactation than to the debility occasionally consequent upon these conditions.[1]

As to the question whether cancer ever causes a delay in the union of bones, it may be said that where the fracture arises in consequence of a true cancerous deposit around or in the interior of the bones, producing absorption of their tissue, no union takes place; but that the mere presence of the cancerous cachexy does not usually prevent the formation of callus.

Scurvy, fevers of a low type, and, on the other hand, fevers of a highly inflammatory character, profuse uterine and vaginal discharges, and rachitis, conduce to the same result.

The withdrawal of an habitual stimulus, and especially a change from a good to a low diet, or copious bleedings, may either of them delay the deposit of ossific matter, or prevent it altogether.[2]

Bonn has furnished two cases in which advanced age seemed to have retarded the formation of callus, but Horner saw a fracture of the humerus in a woman ninety years old unite in five weeks.[3] I myself have noticed a good many similar examples in advanced life, and it is now rendered quite probable that surgeons have generally overestimated the influence of old age upon the formation of callus.

The local causes are, arrest of the arterial circulation by bandages; arrest of the venous circulation by pressure, by rupture of veins, or by the formation of venous clots;[4] paralysis or impairment of the nervous circulation; the occurrence of the fracture within a capsule; obliquity of the fracture; overlapping of the fragments; interposition of a piece of bone, of a tendon, muscle, or of a clot of blood, or separation of the fragments from any cause whatever; erysipelas; acute phlegmonous inflammation; suppuration; necrosis; too much motion; exclusion of light and air inducing local scurvy; wet, and especially cold and moist dressings; too early use of the limb, etc.

Treatment.—In order to hasten the consolidation when it is simply delayed, we resort to all of those expedients which are calculated to invigorate the general system; and for this purpose the employment of a nutritious diet and the use of mineral or vegetable tonics may not be properly omitted; but in our experience nothing has proved so efficient as encouraging the patient to leave his bed and get out into the open air; for which purpose, if the fracture is in the lower extremities, crutches will be necessary.

As local means, we may enumerate first the removal of those local causes which seem to have interfered with the consolidation or with the union. If the fragments have been officiously disturbed, it may be sufficient to impose upon the limb absolute rest for a certain length of time; and the fragments may be more closely pressed against each other; in other cases it will be found necessary to remove the bandages, expose the limb freely to the light and air at least once or twice daily, and to

[1] Practical Remarks on Amputations, Fractures, etc., p. 121. (Norris, loc. cit.)
[2] Norris, loc. cit.
[3] Ibid., p. 29.
[4] George W. Callender, Brit. Med. Journ., Nov. 30, 1872.

rub it gently with the dry hand or with some moderately stimulating oil, so as to induce a more healthy condition of the soft parts, and encourage the natural circulation.

Moving the fragments freely upon each other, sufficient to determine a degree of excitement in the adjacent tissues, and upon the opposing surfaces of the bones, and then confining them during one or two weeks in firm and well-fitting splints, will sometimes succeed when other means have failed.

Indeed, I may say that by one or another of the simple methods now enumerated I have never failed, sooner or later, to effect consolidation in recent fractures; and it has only been in fractures of at least four, six, or eight months' standing that I have been compelled to resort to more extreme measures.

As a means of combining immobility with compression and healthful exercise, the "apparatus immobile," in many of its forms, is peculiarly adapted. White, of Manchester, employed a firm leather sheath for the thigh. H. H. Smith, of Philadelphia,[1] recommends a more complex artificial support, upon which the limb may be allowed to rest while in the act of progression. With some surgeons, the object of allowing the patient to walk, in fractures of the thigh or leg, is chiefly to excite in the tissues adjacent to the seat of fracture some degree of inflammatory action; but which, as the result in one of White's patients has sufficiently shown, may be carried too far, and even determine suppuration.

Dr. E. R. Hudson, artificial limb maker, of New York, has applied in similar cases, which have come under my observation, an apparatus of his own construction, made of willow, and secured in place by leather straps. In case the purpose of the apparatus is to encourage bony union, no motion is allowed at the knee-joint.

Recently, also, Tiemann and Stollman have adapted to one of my patients successfully an apparatus of their own construction. This was a case of ununited fracture of the femur, of long standing, and in which I had succeeded by the use of Brainard's drills, the gimlet, and other operative procedures, in securing a very close and firm fibrous union. The fibrous band became finally converted into bone, after the lapse of a few months, while walking with crutches, the limb being supported by Mr Tiemann's very ingenious apparatus.

Blisters, mustard cataplasms, the tincture of iodine,[2] caustics,[3] etc., applied externally over the seat of fracture, can have no other effect than to increase moderately the congestion of the tissues, and in so far they may aid in the accomplishment of the bony union; but in this respect they are inferior to the violent twistings, flexions, and rubbings of the broken ends of which we have already spoken.

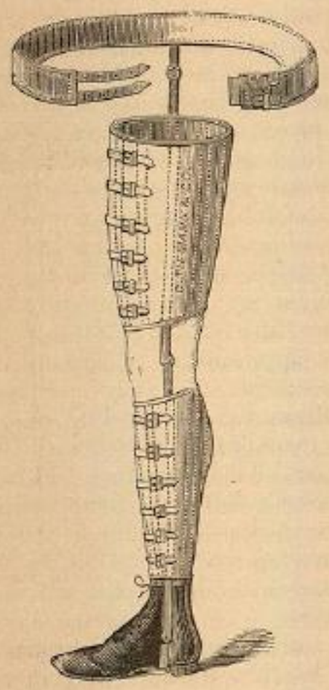
Electricity was first employed by Mr. Birch, of London, but Dr. Valentine Mott obtained no effect from it in two cases in which he seems to have given it a fair trial.[4] Lente, of the New York Hospital, has fur-

[1] H. H. Smith, Am. Journ Med. Sci., Jan. 1855, Jan. 1876.
[2] Hartshorne, Eclectic Rep., vol. iii. p. 114, 1813.
[3] Willoughby, Am. Journ. Med. Sci., Aug. 1834, p. 444.
[4] Mott, Med. and Surg. Rep., pp. 21, 375.

nished an account of three cases treated in that institution by electricity in connection with acupuncturation; the mode of using which was to pass a needle down to the periosteum on each side of the bone, and to attach the poles of the battery to these opposite points. Lente thinks that electricity employed in this way is much more efficient than when the poles are merely applied to the surface. He informs us also, that other cases than these now reported have been treated successfully in this hospital by means of electricity.[1]

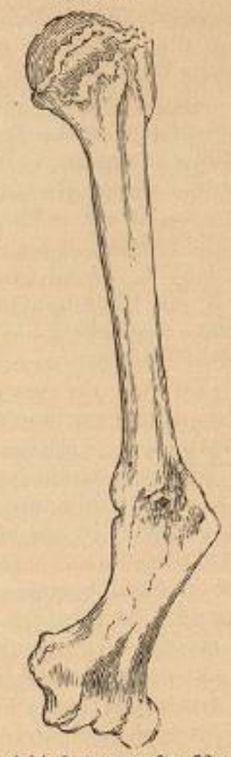
Mercury will no doubt prove serviceable occasionally by virtue of its powers as an anti-syphilitic, but its beneficial influence in other cases is far from having been established.

FIG. 17.



Tiemann & Co.'s apparatus for ununited fracture of the femur.

FIG. 18.



Physick's first case, after 28 years. (From Am. Journ. Med. Sci.)

The seton is said to have been first suggested by Winslow, in 1787; but, what is of much more consequence, the credit of its first successful application and its general introduction into practice is due to Dr. Philip Syng Physick, of Philadelphia, by whom it was employed in 1802.[2]

Physick used for his seton, generally, silk ribbon or French tape; and this he introduced, by means of a long seton needle between the

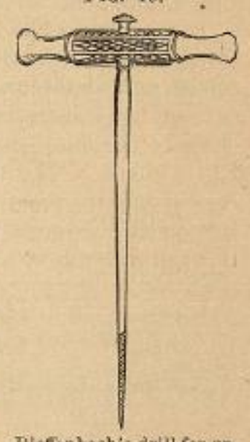
[1] Lente, New York Journ. Med., Nov. 1850, p. 317.
[2] Physick, Med. Repository of New York, vol. i., 1804.

ends of the fragments. He recommended that the seton should remain in place four or five months, and longer if necessary, and it was his opinion that the failures were generally due to its being removed too early. At the present day, however, surgeons who employ the seton think it serves its purpose better when it remains in place but a few days, not longer, perhaps, than ten or fifteen, always taking care that it is removed before excessive suppuration is induced. It has been found especially valuable in fractures of the inferior maxilla, clavicle, and of the upper extremities; but in the case of the femur it has so frequently failed, that Dr. Physick himself did not recommend its use.

In case the seton cannot be passed directly between the opposing fragments, as recommended by Physick, we may adopt the practice suggested by Oppenheim, and carry two setons, one on each side, close to the bone.

Sommé, of Antwerp, preferred a loop of wire to the silk seton employed by Physick.[1] Seerig passed a ligature around the ligamentous mass connecting the two fragments, and then proceeded to tighten the ligature until it fell off.[2] Dr. Hulse, of the U. S. Navy, employed stimulating injections with success in a case of non-union, accompanied with an external and fistulous opening.[3] In 1848, Dieffenbach recommended that ivory pegs be introduced into holes previously made in the bone[4] by means of a gimlet or drill, and Mr. Stanley has succeeded once by this method.[5] Mr. Hill introduced the ivory pegs in a case of ununited fracture of the femur, pyæmia supervened, and the patient died.[6]

FIG. 19.



Dieffenbach's drill for ununited fracture.

Malgaigne, in 1837, tried to introduce acupuncture needles between the ends of an ununited fracture, but, although he thrust the needle down to the bone thirty-six times, he was unable to make it pass once between the ends of the fragments. Wiesel succeeded better. In a case of ununited fracture of the ulna, of nine weeks' standing, having passed two needles between the fragments, at the end of six days, the needles being removed, consolidation rapidly ensued.[7] This practice does not differ essentially from the metallic hoop of Sommé. It is only a modification of the seton.

Brainard, of Chicago, has attempted to show that setons of any kind, whether of wood, ivory, or metal, placed in contact with the bone, occasion absorption, caries, and necrosis, but that they never directly give rise to bony callus; and that the occasional success of the seton, which

[1] Amer. Journ. Med. Sci., vol. vii. p. 497.
[2] Norris, loc. cit., p. 46.
[3] Hulse, Amer. Journ. Med. Sci., vol. xiii. p. 374.
[4] Malgaigne, trans. by Packard, op. cit., p. 258, note.
[5] Stanley, New York Journ. Med., Nov. 1854, p. 441, from Dublin Press.
[6] New York Med Gaz., July 4, 1868, from the London Lancet.
[7] Wiesel, Amer. Journ. Med. Sci., vol. xxxiv. p. 254, July, 1844.

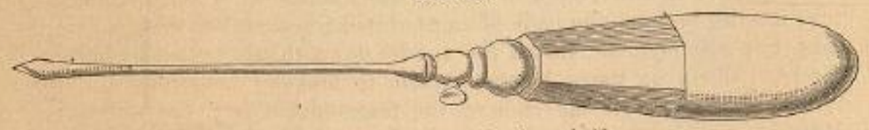
success he believes to have been greatly exaggerated, has not resulted from any tendency to favor the formation of callus, but from the induration and tenderness of the soft parts produced by it; circumstances which, by conducing to rest, indirectly favor the consolidation.[1]

In May, 1848, Miller, of Edinburgh, reported five cases treated successfully by subcutaneous puncture. The operation consisted in passing the point of a needle or small tenotomy bistoury down upon the ends of the bone, and freely irritating the surfaces at several points.[2] George F. Sandford, of Davenport, Iowa, has successfully imitated this practice in two cases.[3]

In 1850 Dr. William Detmold, of New York, performed the operation of drilling or perforating the fragments in a case of ununited fracture of the tibia, employing for this purpose a large gimlet. He first bored two holes between the opposing fragments, and then, introducing the gimlet one and a half inch below the fracture, he penetrated the tibia upwards and inwards until he had traversed, also, the upper fragment to the extent of an inch. In three weeks the bone appeared firm, but from this time the patient was not seen.[4]

Brainard employs for this same purpose a strong metallic perforator, consisting of a handle, into which points of different sizes may be inserted, and which have been hardened so as to penetrate the hardest bone or even ivory in every direction easily. The points are "somewhat awl-shaped; but more pointed in the middle rather than like a drill, which leaves chips." His manner of using this instrument is as follows: "In case of an oblique fracture, or one with overlapping, the skin is perforated with the instrument at such a point as to enable it to be carried through the ends of the fragments, to wound their surfaces, and to transfix

FIG. 20.



Brainard's perforator, reduced one-half.

whatever tissue may be placed between them. After having transfixed them in one direction, it is withdrawn from the bone, but not from the skin, its direction changed, and another perforation made, and this operation is repeated as often as may be desired." Dr. Brainard, who succeeded by this procedure in a number of cases of ununited fracture, thinks it better to commence in most cases with not more than two or three perforations, in order that the effect produced shall not be too severe. It is scarcely necessary to add that, after the punctures have been made, the limb should be put completely at rest in appropriate splints, or in apparatus of some kind.

[1] Brainard, Trans. Amer. Med. Assoc., vol. vii., 1854; Prize Essay. Report on Surgery to Illinois State Med. Soc., May, 1860.
[2] Miller, New York Journ. Med., July, 1848. p. 134.
[3] Sandford, Trans. Amer. Med. Assoc., vol. iii. p. 355, 1850.
[4] New York Med. Gazette, Oct. 12, 1850.

Brainard's drills have been made latterly, not as originally directed by himself, with flattened points. Brainard directed that the point should be triangular; the flattened points are liable to catch in rotation, and to break. This, indeed, happened in a case operated upon by Dr. Weir, at the New York Hospital, in consequence of which suppuration ensued, with erysipelas, and the patient died.[1]

Mr. Tiemann has made for me a bone-drill which is rotated by the movement of a handle upon a rod or shaft composed of twisted wire, and which possesses the advantage of being worked with great facility and rapidity. Perforators of any size or shape may be fitted to the shaft at pleasure. This instrument may be seen illustrated by a wood-cut in the third, fourth, and fifth editions of this treatise. M. Bérenger Feraud has also constructed an instrument which is practically identical with mine, and with which he has operated satisfactorily (Poinsot, French ed. of this treatise, p. 71). In my opinion neither of these instruments is in all respects trustworthy. They are liable to be suddenly arrested in hard bone, and to break. I prefer to recommend Brainard's drill, since it may be guided more carefully under the pressure of a sensitive and intelligent hand.

I have recently employed, as an addition to the surgical procedures above enumerated, common shawl-pins, of steel, about four or six inches in length, having glass heads. Several of these are thrust between the ends of the bone, and are left in place seven or ten days; to be inserted again from time to time as may seem desirable.

Scraping or rasping the ends of the bones is a practice which dates from a very early period. Mr. Brodie scraped the ends of the bones, and then interposed a bit of lint.[2] Mayor, in 1828, contrived to introduce an iron, previously heated in boiling water, through a canula, and thus brought the heat to bear directly upon the ends of the fragments; and, by repeating the application several times, a cure was effected.[3]

Resection of the ends of the bones, first brought into notice by White, of Manchester, in 1760,[4] and opposed by Brodie[5] as dangerous, and by Malgaigne regarded as generally useless or unnecessary, has still been practised a great number of times, with more or less success. It is especially applicable to superficial bones, and in cases where the bones overlap. Its value is now sufficiently demonstrated, except, perhaps, in the case of the femur.

Roux practised resection in one instance, and then managed to engage the point of one of the fragments in the medullary canal of the other.[6] I have succeeded in doing the same.

White, of Manchester, Henry Cline, of London, Hewson, Barton, and Norris, of Philadelphia, have applied caustics directly to the ends of the fragments, after having exposed them by a free incision.[7] Petit applied the actual cautery.[8]

Tying the fragments together by means of metallic ligatures after a

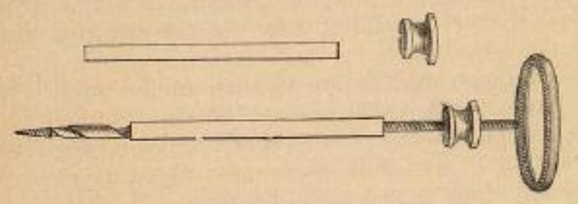
[1] Dr. Weir's Report to Path. Soc., Med. Record, March 8, 1879.
[2] Brodie, Lond. Med. Gaz., July, 1834.
[3] Norris, loc. cit., p. 48.
[4] Dict. de Méd., vol. xxiii. p. 503.
[5] Brodie, New York Journ., vol. viii. 1st ser., p. 133.
[6] Norris, loc. cit., p. 49.
[7] Ibid.
[8] Ibid.

recent fracture is as old as the days of Hippocrates; but in 1805 Horeau adopted the same procedure in a case of ununited fracture;[1] since which date it has been practised successfully by many surgeons. My own experience confirms the value of the method, especially when the fragments overlap.

E. S. Gaillard, of Louisville, Ky., proposes to secure the fragments in place by means of a metallic pin. The instrument which he employs is composed of a steel shaft with a handle, a silver sheath, and a brass nut. For a broken femur the shaft is six inches long, its lower extremity being constructed like a gimlet, while two and a half inches of its upper extremity are cut for a male screw, being intended to carry the brass nut. The sheath is three inches long.

Through an incision made over the seat of fracture, the sheath, detached from the shaft, is carried down to the bone. The shaft is then passed

FIG. 21.



Gaillard's instrument for ununited fractures.

through the sheath, and made to penetrate and transfix the two fragments; as soon as this is accomplished, the nut is turned down firmly upon the top of the sheath, and apposition of the fragments is thus secured. The whole instrument is permitted to remain until bony union is effected.[2]

Fitzgerald, of Melbourne, has practised successfully the injection of five to ten minims of glacial acetic acid between the fragments. It causes at first a sharp pain, and he thinks it accomplishes its beneficial results by causing a resolution and absorption of the interposed fibrinous cartilaginous materials and encouraging the substitution of bone.[3]

Finally, having thus brought rapidly before us all of the various modes of treatment which have been suggested and practised for non-union of broken bones, we are prepared to affirm the following conclusions, or summary of what has been our own practice, and of what we believe ought to be the general course of procedure in these cases:

First. Improve the condition of the general system.

Second. Remove as far as possible the local impediments, such as a separation of the fragments, local paralysis, local scurvy resulting from long exclusion from light and air, congestions, etc.

Third. Increase the action of the tissues immediately adjacent to the fracture, upon which tissues, rather than upon the bone, as Malgaigne

[1] Norris, loc. cit., p. 49.
[2] E. S. Gaillard, New York Journ. Med., Nov. 1865.
[3] Boston Med. and Surg. Journ., Aug. 15, 1878, from Medical Press and Circular.

thinks, the formation of callus depends: a theory which, as applied to old and ununited fractures, we are not prepared to deny. This may be accomplished by frictions, and violent flexions of the limb at the seat of fracture: possibly in some measure by the application of vesicants or of other stimulants to the skin itself.

Fourth. Employ again compression and rest for a period of from two to four or eight weeks.

Fifth. Resort to the method recommended by Brainard, or to some of its modifications, to interfragmentary injections, etc.

Sixth. If in the lower extremity, allow the patient to walk about with the fragments well supported.

Seventh. If the fracture is not in the femur, and as an extreme measure, employ the seton, or resection, and the wire suture.

Where these measures have failed, after a fair trial, we should cease to hope for success from operative measures, and subsequently rely only upon retentive apparatus, under the continued use of which consolidation is sometimes effected.

More precise rules of procedure will be given hereafter in connection with the various fractures.

Dr. Frank Muhlenberg, of Philadelphia, has made a very valuable contribution to this subject in a collection of cases drawn from the medical journals, and published in a tabular form by Dr. Agnew in his treatise on surgery. The student will do well to consult this table, which occupies fifty-seven pages of Dr. Agnew's excellent book. In a summary of the whole number, 656 cases, it is stated that 565 were males, and 91 females. The youngest was 13 years old and the oldest 70, the largest number being within 28 and 40 years. In 61 the fractures had existed less than three months; the shortest period being three weeks, and the longest ten years. The whole number cured by the various plans of treatment was 385; of the remaining 271, 43 were relieved—that is, the amount of motion between the fragments was lessened—in 204 no benefit was derived from the operation, 19 proved fatal, and in 5 the result is not known.[1]

It might have been well to have noted what proportion were cured after five months, after six months, and after one year, since I would not regard a case as properly one of non-union until after the fifth month.

It is also scarcely necessary to say that unsuccessful, and especially fatal, cases are not so likely to find their way into the journals as successful cases, so that it must be assumed that the actual proportion of failures is greater than these tables represent.

[1] Principles and Practice of Surgery, by D. Hayes Agnew, M.D., LL.D., Prof. of Surg. in Univ. of Pa., vol. i. pp. 752–808.