

Ruptured arteries, if within reach, ought always to be tied; and if arteries situated remote from the surface bleed freely and for a long time, we may make some effort to find the open mouths in the wound; but in this we rarely succeed, nor is it safe generally to trust to a ligature of the main branch which supplies the limb. Fortunately, this bleeding, although at first profuse, generally ceases in a few hours under the steady employment of cold lotions, moderate compression, and rest. If it does not, the chances are that the case will call for amputation.

To ligate the main arterial trunk which supplies the injured limb, as suggested by Poincot, would, in my opinion, expose the life of the patient to greater dangers than to amputate the limb. Under such circumstances, with the limb bruised and infiltrated with blood, to cut off its main arterial supply, would render the occurrence of gangrene almost inevitable. Compression at the point of lesion and upon the main artery, at the same time, as suggested also by Poincot, would ensure the same result.<sup>1</sup>

The rule generally laid down by surgeons, that we should at once close the wound in compound fractures, with sutures and adhesive straps if necessary, or with bandages, is far too absolute. This practice will do when there is no great contusion or extravasation of blood; but if blood is flowing, it is much better to leave the wound open, so as to permit it to escape freely; and if the severity of the injury warrants the supposition that much inflammation is to ensue, the danger of gangrene is greatly lessened by thus allowing the opening to remain as a channel of exit for the inflammatory effusions.

It has, however, been claimed of late by Mr. Lister, of Edinburgh, and by many others who have adopted his practice, that by the use of carbolic acid in the manner which will presently be described, we may again return safely to the old practice of closing at once all wounds connected with fractures, without regard to the degree of contusion, laceration, or comminution; indeed, it is affirmed that by the adoption of this method of treatment we may avoid suppuration and its consequences in a very large proportion of cases. It is believed by Mr. Lister that suppuration is mainly due to the presence of certain germs which constantly float in the air, and which carbolic acid is fully able to destroy. Every possible precaution is therefore taken to exclude the air, and to disinfect that which is unavoidably brought in contact with the wound. The interior of the fresh wound is freely washed with a solution of one part of carbolic acid to twenty of water; nor does he hesitate to throw this into wounds communicating with joints. The fluid being afterwards carefully expressed, the surface of the wound is covered first by the "protective," which is a piece of oiled silk coated with a thin layer of a mixture composed of one part of dextrine, two of powdered starch, and sixteen of a cold solution of carbolic acid; the latter being of the same strength as the solution employed for injecting the wound; or a piece of oiled silk, covered upon one side with shellac varnish, is applied. Over this is laid a piece of gauze, soaked in fresh carbolic solution, followed by half a dozen layers of the same material, a piece of mackintosh cloth, and finally the antiseptically prepared gauze

<sup>1</sup> Poincot, French edition of this work, p. 56.

roller is applied carefully and lightly. Meanwhile carbolized spray from an atomizer is constantly thrown upon the parts until the dressings are completed. In certain cases a drainage-tube, treated with carbolic acid solution, is left in a depending portion of the wound. All the subsequent dressings are to be made with equal care and formality. The knives and other instruments employed are to be thoroughly washed in the carbolized solution; also the hands of the surgeon, and whatever else may come in contact with the wound.

The reputation enjoyed by Mr. Lister, and the distinguished names reckoned to-day among his disciples, afford a guarantee that, as against certain other methods, it ought to have a preference, and that its actual claim to a superiority over all other methods is entitled to respectful consideration. Nevertheless, while I admit its excellence, I am far from being convinced that, in the case of compound fractures or of other wounds, it is capable of doing all that is claimed for it. I do not believe—indeed, from actual experience I know—that the knee-joint cannot be "freely laid open" under the Lister treatment "with the certainty that no danger will follow." Nor have I seen compound fractures treated any more satisfactorily or successfully by this method than by methods employed by myself and others. Only very recently a compound fracture of the leg, in one of our best metropolitan hospitals, was progressing rapidly from bad to worse under this plan, the limb becoming more and more inflamed and swollen and being threatened with gangrene, when, the hot water-dressing being substituted, the inflammation speedily subsided, and the limb was saved. It is impossible to exclude atmospheric germs from wounds which have been long exposed to the air before they are placed under antiseptic treatment, and it can easily be shown that absolute exclusion of air does not prevent, necessarily, suppuration and decomposition in those cases, nor insure against the presence of bacteria. That carbolic acid and many other antiseptics do this to some extent is true; but this is all that can be justly claimed for any of the antiseptics; and this is no more than surgeons have understood for a long time.

In short, if the method of Mr. Lister has any advantages, and it no doubt has, these advantages consist in the continuous application of a mild stimulating lotion, in the exercise of great care and tenderness in the removal and reapplication of the dressings, in the absolute rest imposed, in the occasional use of the drainage-tube, and in the antiseptic properties of the carbolic acid, and not, as has been taught by some surgeons, exclusively, or even mainly, in the employment of an antiseptic.

Most wounds, including the wounds caused by fractures, need at the first, and not unfrequently during the whole course of their treatment, a certain amount of gentle stimulation, such as dilute carbolic acid is capable of causing; and especially is this true since the introduction of anaesthetics, which suspend for a time many of the vital forces, and cause a delay in the effusion of organizable materials, and in the process of repair. Carbolic acid, or any other mild stimulant, hastens the return and accelerates the progress of this repair.

<sup>1</sup> Joseph Lister, F.R.S. Remarks at the International Med Congress, in Philadelphia, 1876. Transactions, p. 535.

The really essential things in the successful treatment of compound fractures are, that no additional injury shall be done to the limb by rude handling—by thrusting the fingers and instruments unnecessarily into the wound—by forcible extraction of slightly detached fragments—by violent wrenching and pulling of the limb in order to complete a diagnosis, or to adjust the fragments, or to wholly overcome the shortening—by tight bandages or badly adjusted splints; that the sponges and other materials applied to the sore shall be free from infectious agents; that the dressings be not disturbed too often, but often enough; that each dressing be made without disturbing the limb, or in any degree inflicting pain upon the patient; that pent-up matter be timely evacuated, but not rudely pushed out by manual pressure. The limb has enough to contend with in the original accident, without the added dangers of rough handling, or of probing, so generally practised by badly trained nurses, and badly trained and reckless surgeons.

Drainage-tubes are no doubt often useful and even essential; but they are as capable of doing harm as of doing good. They may be thrust in and drawn out from time to time unnecessarily, often causing pain and hæmorrhage; or they may be allowed to become blocked, and thus actually dam up the fluids instead of facilitating their escape. In short, in many cases they are wholly unnecessary, and in some injurious.

To insure absolute rest to the limb some very light but firm splints may be employed to secure immobility, or a plaster-of-Paris splint, and the limb may require to be suspended; but these are points upon which the surgeon must use his own judgment.

If inflammation threatens the safety of the limb it may be necessary to remove all apparatus or splints, and to wrap the limb in sheet-lint saturated with water at a temperature of 95° or 100° Fahrenheit; or if gangrene has occurred, or its occurrence is imminent, water at a temperature of 105° or 110° should be substituted, and this elevated temperature should be maintained assiduously by constant or very frequent flooding with the hot water.

There are no circumstances known to me when, according to my later experience, it would be proper to apply ice or cold dressings in compound fractures, unless it be to restrain hæmorrhage.

Bleeding is rarely if ever necessary, and in a large majority of cases it would prove injurious by lowering the vital forces, which need to be husbanded in view of the requirements of the process of repair, and of the probable long and exhaustive confinement. It might even prove speedily fatal by adding to the immediate depression.

Cathartics should also be administered cautiously for the same reason; and because they are liable, and especially in fractures of the lower extremities, to occasion a serious disturbance of the limb.

Many years since, Dr. J. Rhea Barton introduced into the Pennsylvania Hospital what has since been called the "bran dressing" for the treatment of compound fractures of the leg; the limb being made to repose in a box filled with this material.<sup>1</sup> I have used it very frequently in Bellevue and in other hospitals, and can speak of it as possessing many

<sup>1</sup> Amer. Journ. Med. Sci., May, 1835, p. 81 April, 1842, p. 515.

qualities of excellence, especially as a summer dressing. The peculiar mode of using this apparatus I shall describe more minutely when treating of fractures of the leg.

*Bones badly united.*—Bones which have united with serious deformity are occasionally refractured for the purpose of securing a more comely or a more serviceable limb. This may be done when the union is recent and the callus and adjacent tissues are vascular, with almost an assurance of a prompt union. Indeed, if the bone be refractured within four or eight weeks after the occurrence of the original fracture, it will in general unite more speedily than at first; and this is especially true in the case of children; but if the refracture be delayed much beyond the latter period, the chances of prompt reunion become lessened, and after the lapse of several months or years the danger that a refracture will result in only a fibrous union is considerable. In the case of an old fracture it becomes therefore a question, whether the deformity and maiming are sufficient to warrant the surgeon in assuming the risk that it may not unite at all, or that it may result in a fibrous union. The cause of this delay and uncertainty in the proper union after refracture of bones which have been long united, is probably the fact that the bond of union becomes at length harder than the original bone, and although it may break as easily as, or even in most cases more easily than, the natural bone, it is less vascular, and the tissues adjacent are also perhaps less vascular, having undergone certain textural or cicatricial changes in consequence of the original lesion.

In deciding this question, then, we will be governed by the degree of deformity and maiming, by the time which has elapsed since the union, by the general condition of the patient as to constitutional vigor and capacity of repair, and especially by the bone, or the portion of the bone, which is the seat of the deformity. Refractures of the shafts of the humerus and of the femur are less likely to unite by bony callus, than refractures of the forearm or leg. If only one bone is broken in the forearm or leg, the danger of non-union after refracture is lessened, and especially if the lower end of the radius is the part involved.

There is one popular error in reference to refracture, and indeed the error is by no means confined to the laity, namely, that by a refracture at any period after four or six weeks we can materially add to the length of the limb. The permanent contraction of the muscles which by this time has taken place, the presence at an early stage of inflammatory effusions, and at a later stage of adhesions, will in most cases effectually prevent any considerable elongation of the limb. It may be lengthened by being rendered more straight, and in a small degree perhaps by actual stretching of the soft tissues, but this is all that can be reasonably promised or expected, in a large majority of cases.

In general, no fear need be entertained that the refracture will endanger the life of the patient, unless the fracture involves a joint. No doubt death may have been caused in this way, but a scientifically conducted refracture is vastly less likely to cause death than the original accident. Nor need we generally fear that the bone will break at any other point than at the place of the old fracture, provided at least we take proper care to make the pressure at the right point; we have no

need therefore of an osteoclast, such as was devised by Rizzoli, and later by Taylor,<sup>1</sup> with which they proposed however only to break limbs which were ankylosed 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.<sup>2</sup> Nor do the cases reported by Dupuytren<sup>3</sup> 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.<sup>4</sup>

*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.<sup>5</sup> In 946 cases of recent fracture

<sup>1</sup> The Medical Record, April 21, 1877.

<sup>2</sup> J. B. Roberts, *Refracture for the Relief of Deformities after Fracture*. Philadelphia, 1878.

<sup>3</sup> Dupuytren, *Injuries and Diseases of Bones*, London edition, 1857.

<sup>4</sup> 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.

<sup>5</sup> 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.<sup>1</sup> 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

<sup>1</sup> Norris, *loc. cit.*