

site lesion and action, and it will occur as certainly when there is no fracture at all, but only a caries, a necrosis, or a simple bony or periosteal inflammation; and whilst it is doubtless true that in fractures it sometimes renders valuable aid to the surgeon, it is equally true that it often proves a source of hindrance.

Dupuytren, in determining the limits of his "third" period, or of that in which a provisional callus is formed of sufficient strength to support the fragments, has given what has been usually quoted as the natural period within which bones may be said to be united, that is, "from the twentieth or twenty-fifth day, to the thirtieth, fortieth, or sixtieth." But this depends so much upon the age of the patient, his general condition of health, the condition and position of the broken ends, as well as upon the bone itself, and the point at which it is broken, with many other circumstances, that it would be unsafe to establish any absolute laws in reference to this point.

In very early infancy, union is accomplished in half the time required in adult life, and it is generally thought to be still more retarded in advanced age, but Malgaigne has not found this latter observation confirmed by his own experience; nor have I observed any marked difference, in this respect, between persons of middle and old age.

Various constitutional causes, as we shall hereafter explain more fully, retard bony union. Motion, also, sometimes delays consolidation; fragments which are overlapped do not unite as speedily as those which are placed end to end; and other complications interfere in a similar manner, such as lesions of nerves, of bloodvessels, comminution of the bone, the interposition between the ends of the fragments of a blood-clot, a portion of muscular, tendinous, or other tissue, etc. In general, the bones of the lower extremities, independently of their size, unite more slowly than the bones of the upper extremities.

Epiphyses, when separated, unite by the same process as fractures of the bone. It is observed, however, that when certain epiphyses unite with much displacement, the shafts from which they have been separated cease to grow, or grow more slowly, and the limbs become atrophied.

For a more complete consideration of the causes which retard the union of bones, I beg to refer the reader to the chapter on "Delayed Union, and Non-Union of Bones."

CHAPTER V.

GENERAL PROGNOSIS.

THE prognosis in fractures must vary greatly according to the place, character, and complications of the accident; and for this reason it is impossible to give anything beyond a few general maxims at this time, leaving the more precise and detailed statements until we come to consider each individual fracture.

We have already, in the preceding chapter, considered some of the points of prognosis, especially those relating to the average time in which bones unite, the causes of delayed union, and of non-union, etc.

In general it may be said that simple, oblique fractures occurring in the shafts of long bones unite with some shortening. Indeed this rule presents but few exceptions. This is due to the overlapping or to the impaction, both of which we are in most cases unable completely to overcome. It is scarcely necessary to say that the inevitable result of such overlapping is a more or less manifest irregularity, or deformity at the seat of fracture. In general, however, the natural line of the axis of the limb may be preserved.

Simple transverse fractures of the shafts of long bones, which are of rare occurrence, when completely displaced and made to slide past each other, are seldom effectually replaced, and are, like oblique fractures of the same class, apt to result in shortening and some deformity.

All compound, comminuted, and complicated fractures, which in their very nature present additional obstacles in the way of complete adjustment and of proper support, are likely to entail deformity. Contrary, however, to what is generally supposed, certain compound fractures of the shaft of the femur, caused by thrusting a sharp fragment through the flesh and skin, if promptly reduced, unite as speedily and with as little deformity as simple fractures.

Gunshot fractures, which are necessarily in most cases compound and comminuted, are in a much less degree amenable to treatment with adjusting and supporting apparatus than are most other fractures, and they necessarily entail greater deformity, both in the matter of shortening and lateral deviation. A certain proportion of these, as well as of other compound and comminuted and complicated fractures, demand, for the purpose of obtaining the best possible results, a course of treatment having in view the control of the inflammatory action as the primary consideration, and the relief of the deformity by lateral supports and by extension as the secondary consideration; although perhaps in most cases both are to be regarded as necessary indications of treatment. We do not of course include in this statement those cases which demand immediate amputation.

Simple, green-stick fractures, denticulated fractures, and most transverse fractures do not become displaced in the direction of the axes of the bones in which they occur, and may generally be made to unite without shortening or deformity. They unite also very speedily.

Fractures occurring in infancy and childhood unite more quickly than fractures occurring in adult life; more speedily in the robust than in the feeble; and there are certain special conditions, as we have already stated in the chapter on delayed union, which tend to retard bony union.

Fractures of the upper extremities unite in general more speedily than fractures of the lower extremities. The smaller bones unite more rapidly than the larger bones. In the case of the bones of the face and jaws, and of the clavicle, union is especially rapid. This is probably true also of the ribs; and this notwithstanding the fact that in the case of most of these bones we encounter peculiar and often insurmountable difficulty in securing absolute quiet during the treatment.

Fractures at or near the extremities of certain long bones are less liable to displacement, and therefore unite with less shortening and deformity than most fractures of the shaft. They unite also more quickly. This is true especially of fractures of the surgical neck of the humerus, when the fragments remain in place, of fractures of the lower end of the radius, of extracapsular fractures of the neck of the femur, of fractures of the lower end of the femur and of the upper end of the tibia. But some of these fractures are liable to be complicated with injuries to the joints, and to either endanger life or entail a partial or permanent ankylosis. Ankylosis is less liable to result, however, in fractures of the neck of the humerus, and in extracapsular fractures of the neck of the femur, than in fractures of the lower end of the femur, of the lower end of the tibia, and of the lower end of the humerus and of the radius.

Fractures which actually involve the joints are in general much more dangerous to life than other fractures. This statement, however, does not include intracapsular fractures of the neck of the femur, and is most especially applicable to fractures involving the knee-joint. If old people pretty often die not long after receiving intracapsular fractures of the neck of the femur, the death is seldom due to the fracture, but rather to the shock received and the prolonged confinement and recumbency which is perhaps necessitated. In this last-named fracture, the union, if it takes place at all, is almost invariably fibrous, and the limb usually shortens very much.

When the patella, or the acromion process, or the olecranon process, is broken, the bond of union is generally fibrous, but if the bond is short, this does not materially affect the future usefulness of the limb. In the case of the patella, when the fracture is caused by muscular action, as it generally is, and it is a simple transverse fracture, the new bond of union is almost invariably fibrous.

Ankylosis, more or less complete, is the result of nearly all fractures. This may be temporary or permanent.

Temporary ankylosis is due, first, to disuse and atrophy of the muscles, and to passive contraction of the ligaments about the joints. Second, to inflammatory effusions and adhesions among the muscular fibres; between adjacent tendons and in the sheaths of tendons; in the capsules of the joints and among the ligaments.

All of the forms of ankylosis above described may, but do not often, become permanent. Usually the products of inflammation are removed by the natural action of the absorbents in the course of a few months, and especially when the natural efforts are aided by friction, passive or active motion, or by other appropriate means. Passive contraction of ligaments and atrophy of muscles are never overcome except by motion, either passive or active. If they are not overcome in some degree within a year, they are likely to be permanent, or to require for their relief active surgical interference, such as *brisement forcé*, or some of the graver surgical operations.

Permanent ankylosis, sometimes the result of what ought to have been only temporary ankylosis, is more often due to the presence of cicatricial tissue resulting from lesions of the muscles, to actual lesions of tendons or of ligaments, to firm intracapsular adhesions, and finally to

bony deposits in or about the joints, to bony consolidation of the adjacent bones, to malposition of fragments, to encroachment of fragments upon the joints, and to hypertrophy of fragments.

Pain, tenderness, and more or less loss of strength in the limbs, lasting for months or years, are common as sequelæ of these accidents; but which phenomena have in general little or no direct relation to the previous existence of a fracture, unless they are present as the natural results of the deformity which remains. They are quite as likely to be entailed upon severe injuries where no fracture has occurred.

After the removal of the splints and bandages the limb is apt to become cedematous; a condition which in old and feeble persons may continue many months, and the existence of which has been lately ascribed to the temporary obliteration of the deeper veins in the region of the fracture. This will no doubt furnish a sufficient explanation in a certain proportion of cases, and perhaps a partial explanation in all cases; but the partial paralysis or loss of tone in the superficial veins, and in all the superficial tissues, due to the long-continued pressure of the bandages, is probably quite as responsible for these results as the deeper seated changes due to the injuries arising directly from the fracture. It is generally found to exist in a pretty exact ratio with the long continuance and tightness of the bandages.

Having thus briefly stated the general prognosis in fractures, it seems necessary to call attention to certain statements recently made by a gentleman who enjoys a reputation, and who occupies a position as a public teacher of surgery in one of our most flourishing medical colleges, and which statements are widely at variance with my own views as above given, and with the published views of all other surgeons who have given sufficient attention to the subject to entitle their opinions to respect.

Dr. Sayre, of this city, in a Report on Fractures made to the American Medical Association in 1874,¹ says:

"Fractures of the long bones require that *extension* and *counter-extension*, under the influence of *chloroform*, or other anæsthetic, if necessary, should be made in a *proper direction*, until perfect accuracy of adjustment is obtained, and after this, *retention and fixation in this normal condition* until *consolidation*. [The Italics are Dr. Sayre's.]

"By accuracy of adjustment, I mean the perfectly normal condition of the bone as to length and position. When the extension and counter-extension have been properly made, the muscles and other tissues surrounding the bones will necessarily and positively force the fractured extremities into their natural position, as above described, unless some foreign body, as a shred of muscle or connective tissue, has got between the fragments."

Dr. Sayre closes his remarks, which are comprised in less than four pages, by presenting, as a "supplement," a "Table of the Fractures treated in Bellevue Hospital in the year 1873, which has been compiled from the hospital wards by Dr. Van Wagenen, late House Surgeon to Bellevue Hospital" (actually from April 1, 1872, to April 1, 1873).

¹ Report on Fractures, by Louis A. Sayre, M.D., Prof. of Orthopedic and Clinical Surgery, Bellevue Hospital Med. Col., Surgeon to Bellevue Hospital, etc. Transactions Amer. Med. Assoc., 1874, p. 301 *et seq.*

The table referred to, however, does not comprise all the cases treated in Bellevue during that year, but only those treated with the plaster-of-Paris dressing, and of this class only those which Dr. Van Wagenen found "thoroughly" recorded; so at least the author informs us.

There is no danger, perhaps, that such extraordinary statements will affect the opinions of experienced surgeons in any part of the world, but they will be read probably by many inexperienced surgeons, and may with them have the weight of authority; and, indeed, they have already been quoted by the author of a treatise on Civil Malpractice, intended as a guide to jurists, and which is widely read by lawyers and medical men.¹ The author has, however, modified the force of the authority by expressing his belief that while such results might be possible with Dr. Sayre, they can hardly be expected from the "ordinary" surgeon; but how will it be with Dr. Sayre's peers, nearly all of whom, in every part of the world, and with the same appliances used by him, declare their inability to make all long bones unite without shortening, and who, indeed, affirm that with them union without some shortening is the exception, and not the rule, a doctrine against which Dr. Sayre entered his earnest protest, before the American Medical Association, both at Detroit and Buffalo.

Our personal interests, as well as the interests of science and humanity, demand that we shall know positively whether shortening can always be avoided, or even made the exception rather than the rule; but we need something more than mere assertion, however notorious may be the author's reputation for accuracy of observation and for truthfulness of statement.

Having myself, with the assistance of my staff, very thoroughly searched the records of Bellevue Hospital from time to time, I am prepared to say that the evidence we need is not to be found there, nor has it been supplied in such cases treated by my distinguished colleague as have come under my personal observation, yet having for a number of years served alternately in the same wards at Bellevue with himself, my opportunities of observing the results of his practice have not been few. That I have not generally adopted his practice, also will be accepted, I trust, as evidence that I did not consider his results satisfactory, and that although my declared ability to perform was much below his.

So far as we know, the only proof ever offered is found in the tables which Dr. Sayre presented as a supplement to his brief paper, showing the results in certain cases at Bellevue by the plaster-of-Paris treatment, which is known to be at present Dr. Sayre's favorite method. Presumably a portion of them are his own, although it is not so stated. At any rate, they all had the benefit of that "skilled assistance" and "the mechanical paraphernalia pertaining to a hospital" which Dr. McClelland regarded as the necessary condition of Dr. Sayre's remarkable success, or of the success which in his belief all surgeons ought to attain.

Some of the cases, Dr. Van Wagenen informs us, were imperfectly recorded, and all such were rejected. It will be found, however, on

¹ Civil Malpractice, a treatise on Surgical Jurisprudence, etc., by Milo A. McClelland, M.D. New York, Hurd & Houghton, 1877.

examination of the tables, that not a few have been retained in which the results are not exactly known. We are not informed that Dr. Sayre himself measured any of the limbs, or personally noted the amount of resulting deformity. Accepting, however, the testimony as it stands, and confining our analysis to simple fractures, we find twenty-two simple fractures of the shaft of the femur. Of these, only three have united without shortening; the shortening being given in the nineteen cases as ranging from one-fourth of an inch to two inches. In one it is one inch and an eighth, in one an inch and a quarter, and in a third it is two inches. Of those which are not shortened, one was seven years old, one was seventeen years old (and in this latter the fragments were never displaced, there being observed only crepitus when the patient was admitted, without shortening or deformity), the third was in a man twenty-three years old. A reference to the tables constructed from my own personal experience by other modes of treatment, which will be found in the chapter on "Fractures of the Femur," will show that these results do not compare favorably with my own in the matter of length. In one of Dr. Sayre's cases the femur is bowed out somewhat at the seat of fracture. In one the fracture did not unite, and no explanation is offered of this fact except that the plaster-of-Paris splint became loose.

Two simple, intracapsular fractures of the neck of the femur are recorded; also two extracapsular, and one trochanteric fracture. These are all shortened; the shortening ranging from one-quarter of an inch to one inch.

The remaining fractures of long bones included in these tables are fractures of the tibia and fibula, of the humerus, and of the radius and ulna. Rejecting the compound, complicated, and comminuted fractures, as belonging to an exceptional class, although Dr. Sayre has not spoken of them as exceptional; and confining our attention only to simple fractures, in which it will be admitted the best results ought to be obtained; and rejecting all fractures of the forearm and leg in which only one bone was broken, and in which shortening is never expected to take place; there remain sixteen simple fractures of both bones of the leg, seven simple fractures of the humerus, and two of both bones of the forearm. In only one of this whole number (twenty-five cases) is there any reference to the question of shortening, and in this one case the limb is said to be shortened five-eighths of an inch. Of the remainder it is occasionally said that there is no record, or it is incomplete, although we are informed in the caption of the tables that all such cases were rejected.

What are we to infer from this almost universal omission of the relative length of the two limbs in these latter cases? In the table of fractures of the femur it is never omitted: but simple fractures of the humerus, of both bones of the forearm and leg are recorded variously as "cured," "union and position good," or "union and position perfect;" but that these phrases are not used to imply a restoration of the limbs to their normal length, is evident from the fact that in certain other complicated fractures the "union and position" are said to be "good" or "perfect," and they are nevertheless marked as "shortened."

The truth is, probably, the limbs were never measured. If they

were, these omissions cannot be excused, inasmuch as they render the tables valueless for the purpose for which they were prepared and presented to the Association. So far as the question of angular deformity is concerned, its existence is mentioned sufficiently often to indicate no improvement upon the practice of surgeons generally, although, as is well known, this species of deformity, especially that which is caused by a simple overlapping of the fragments, while the general line of the axis of the limb is perfect, is seldom seen very distinctly until a long time after the treatment is suspended, and the patient has been dismissed from the hospital, and therefore, if it existed, it may not have been observed when the records were made. In short, these tables are not what they might be thought to be, reliable testimony as to results; and even as they stand they do not in any measure sustain the statements made by Dr. Sayre, that even simple fractures of the short or long bones can always be made to unite without shortening: but, we repeat, Dr. Sayre makes no such exceptions, in favor of fractures of the neck of the femur, or of comminuted fractures and compound or complicated fractures, provided they do not demand amputation, or there is not some foreign body interposed between the ends of the fragments.

Jan. 4, 1875, Henry Balchmeider, æt. 37, was admitted to Ward 14, Bellevue, with a simple fracture of the left femur near its middle. Five hours after the receipt of the injury two of our most experienced house surgeons put the patient under ether, and with pulleys made extension until, as they declared, the limbs were of the same length. They then applied the plaster-of-Paris splint. The patient was on crutches in a few days. Five weeks and three days from date of the dressing, the man was brought before the class in my surgical clinic at Bellevue, in presence of Dr. Sayre and the late Dr. Krakowizer. The splints being removed, the limb was found united with a slight outward bend at the seat of fracture, and the knee-joint very stiff. On measurement I found it shortened one inch. Dr. Krakowizer and others made it the same, but Dr. Sayre thought it was a "little lengthened." It will not be difficult to understand, from the results of measurement in this case, that Dr. Sayre would meet with examples of perfect restoration of the bone oftener than Dr. Krakowizer or myself.

In the previous editions of this book, I have, in connection especially with fractures of the femur, alluded to the difficulty of making accurate measurements of limbs, so as to determine the amount of shortening; and I have also mentioned the fact that, as long ago as 1862 or 1863, Dr. Corydon La Ford, of Brooklyn, N. Y., had demonstrated by measurement upon the skeleton that occasionally the malleoli of the leg were of unequal length in the opposite limbs. I have now to call attention to the fact that a certain amount of asymmetry in all the long bones of the extremities is the rule and not the exception. The observations which led to these conclusions were first made upon the lower extremities by Dr. W. C. Cox, of Philadelphia, while he was a student of the Pennsylvania Hospital. They were subsequently confirmed, and the examination then extended to the upper extremities, by Dr. Wm. Hunt, of Philadelphia, by Prof. J. S. Wight, of Brooklyn, by myself and others, Prof. Wight

having especially studied the whole subject.¹ In 1879, Dr. J. Garson,² of London, published the results of the measurement of seventy skeletons, and in a later reference to these observations he says: "The lower limbs were equal in length in only seven instances, or in ten per cent.; in twenty-five instances, or 35.8 per cent., the *right* limb was longer than the left, while in thirty-eight instances, or 54.3 per cent., the *left* limb was longer than the right. The left leg I found not only to be more frequently longer than the right, but the difference in length between the two limbs is greater on an average when the left is the longer. Inequality in length is not confined to any particular age, sex, or race, but seems to be universal in all respects. My observations corroborated those of several American surgeons made on the living subject." Measurements of fifty skeletons showed a like asymmetry in all the long bones, but in the case of the arms the right is most often the longest. The conclusions reached by all have been nearly identical, namely, that throughout the long bones of both extremities there existed usually a certain amount of asymmetry in regard to length. Ordinarily the difference is inconsiderable, ranging from one-eighth of an inch to one-half, but sometimes much exceeding this without having been noticed by the patient or by his friends. In the case of the lower extremities the left is more often the longer than the right.

These conclusions by no means render the measurements of limbs valueless, although they place a serious obstacle in the way of our attaining that precision which is desirable when we seek to determine the relative value of different plans of treatment in preventing shortening. Unfortunately, I may say, we have not yet devised a method of extension so effective that our ignorance of the original normal differences causes any embarrassment. The fact is, and always has been, that measurement of the limb in which a long adult bone has been broken obliquely and has united, shows, in a large majority of cases, that it is shorter than the other; and the frequency of this occurrence is evidence that in many cases it becomes the shortest limb, although it was originally the longest, and it leaves a possible question whether those few cases which we have regarded as perfect results, because the opposite limbs were after consolidation of the same length, were not then symmetrical solely in consequence of the shortening; and we may consider it probable that in other cases the actual shortening is much more than is indicated by the measurements. Nevertheless the unpleasant fact remains, and is rendered only the more conspicuous, that oblique fractures of the long bones in the adult generally shorten, inasmuch as we find in nearly all cases the broken limb the shortest. When we have found an apparatus or a mode of dressing which will make a broken limb as long as or longer than the other as often as it is found to be normally, then we may lay aside the tape and line, for it will be of no further use; practically, also, our labors will be ended, for shortenings no greater

¹ Philadelphia Medical Times, Jan. 16, 1875. Amer. Journ. Med. Sci., April, 1875. Archives of Clinical Surgery, Feb. 1877. Hospital Gazette, April 12, 1879.

² Garson, Journal of Anatomy and Physiology, vol. xiii. p. 502, 1879. Nature, Jan. 26, 1884.

than normal deviations occasion no maiming or halting, and are of no consequence.

A distinguished English surgeon has recently said that he has given up measuring broken thighs,—because of the uncertainty of measurements, I infer. This is a return to the practice of surgeons for many centuries preceding the present century. Until within the last thirty years no systematic attempt was ever made to determine the exact length of limbs after fractures. Tables were given from various hospitals at home and abroad, declaring how many were cured, with some slight notices of deformity, but with no reference to the amount of shortening. It was this which led Mr. Johnson, the famous editor of the *London Medico-Chirurgical Review*, to say of Mr. Radley's results, that he would "like to know something about the length of the cured limb, and a few other matters of that sort."

In the April number of the *Buffalo Medical Journal* for 1849, I published the results of a careful measurement of 136 cases of fracture of the long bones, treated in various ways by different surgeons. So far as I know, this was the first publication of the kind ever made. In 1853, Dr. John Boardman published from my notes additional cases, making 461 in all. In my report on deformities made to the American Medical Association in 1855-6-7, additional cases were reported at length, making a total of 605.

The results of these observations were startling, both to the author and the public generally, and led, I have reason to believe, to that widespread interest which has since manifested itself in this country, as to the causes of the apparent defects in this department of surgery, and to serious inquiry as to the remedy. Surgeons everywhere were stimulated to a new exercise of their ingenuity and skill. Then followed speedily the abandonment of all the double inclined planes for fractures of the femur, and also of the long splints of Desault, Boyer, Liston, Hagedorn, Gibson, Physick, and others, which, while they gave better results so far as the form of the limb was concerned, made little or no improvement in the matter of length. I do not hesitate to say that within these last thirty years, through the more intelligent efforts and correctly applied genius of surgeons, the proper treatment of fractures has made more progress than it had in all the centuries preceding; and especially is this true of fractures of the femur, where the defects were most apparent, and the remedies were most needed.

Shall we cease these efforts now, when the attainment of practical perfection is almost within sight? So far as the lower extremities are concerned, with the present appliances, lateral obliquity, or deformity from this cause, in the case of simple fractures, is, according to my personal experience, no longer necessary; while the average length of the limbs is greatly increased. We shall have abandoned the further advancement of this branch of science when we cease to measure limbs.

As to the mode of measuring limbs, I shall speak in connection with particular fractures.

I think it proper to mention venous and fatty embolisms in connection with prognosis in fractures, since modern pathological investigations have

established their occasional connection as sequences, if not as consequences.

Virchow, in 1846, was the first to call attention to an example of pulmonary embolism due to the presence of a venous clot and consequent upon a fracture. Since then, similar examples have been reported by other surgeons; the accidents having taken place usually at periods varying from two to six or seven weeks after the fracture occurred, and being due, as is believed, to the displacement of a clot from a vein in the vicinity of the fracture, whose channel had been temporarily closed by inflammation and pressure.

The presence of a pulmonary venous embolism in the lungs may be recognized by the sudden occurrence of pain, cough, and dyspnoea, accompanied, perhaps, with bloody expectoration, and the usual physical signs of localized congestion or consolidation. In some cases, the symptoms are more urgent, and the patient dies in a few minutes.

In 1864, Flournoy reported a death from fatty embolism, consequent upon a fracture of the leg, death having occurred thirty-six hours after. Since then, Busch, Wagner, Czerny, and others have reported similar examples. The accident is supposed to be due to the absorption into the venous and capillary circulation of the crushed fat globules contained in the marrow at or near the point of fracture. The symptoms are said to resemble those of shock and of traumatic and alcoholic delirium; but an interval always exists between the occurrence of the accident and the accession of the symptomatic phenomena, which latter are by no means uniform, the most reliable signs being referable to pulmonary and cardiac obstructions. The breathing becomes suddenly difficult or labored; the pulse becomes feeble and rapid, the countenance pale or cyanosed, and delirium, followed by coma, terminates speedily in death. It is affirmed also, that in other cases, where the fatty embolisms are less extensively distributed, the symptoms, although presenting the same general type, are less urgent, and may terminate in recovery.

It is gratifying to know that both of these forms of embolism, as sequences of a fracture, are probably exceedingly rare, and that some excellent pathologists have even denied that any relation whatever has been shown to exist between the presence of the oil-cells in the blood-vessels and capillaries and the symptoms which have been attributed to them.

CHAPTER VI.

GENERAL TREATMENT OF FRACTURES.

ALL that has been said in relation to the propriety of handling a broken limb gently, when the surgeon is examining the position and character of the fracture, is equally applicable to the lifting and transporting of the patient to his bed, to the removal of the clothing, and to the general management of the limb before it is dressed. Rude or