

the child weighed fourteen pounds, and was perfectly healthy, but one of the thighs had suffered a complete fracture, occasioned probably by the strong contractions of the cervix uteri. With careful splinting and bandaging, the bone was finally, but not without some difficulty, kept in position and made to unite, so that at the date of the report one would not discover that the bone had been broken, except by close inspection.¹

CHAPTER III.

GENERAL SEMEIOLOGY AND DIAGNOSIS.

FRACTURES are liable to be confounded with contusions, and with various other local injuries, but most often with dislocations, and especially when the fracture has taken place near one of the articulations is the differential diagnosis sometimes rendered exceedingly difficult. It is with particular reference, therefore, to the general points of distinction between fractures and dislocations, that I now propose to speak. The special signs or points of difference which belong to each individual case will be considered in their proper places.

The most important general or common signs of fracture—and by “common” signs I mean those which are common to most fractures—are crepitus, mobility, and an inability on the part of the fragments to maintain their positions when reduced; indeed, in many cases, this constantly recurring displacement is due to the fact that the surgeon is unable to accomplish a complete reduction. While, on the other hand, dislocations are almost as uniformly characterized by the absence of crepitus, by preternatural immobility, and by the fact that, when reduced, the bones do not usually require support to retain them in place, or indeed, we may say, by the fact that they are generally reducible.

Let us study these phenomena a little more in detail.

Crepitus, occasioned by the chafing of the broken surfaces upon each other, when actually present, is almost positive evidence of the existence of a fracture. It is possible, however, to confound the chafing of engorged tendinous sheaths, or of inflamed joints upon which fibrinous effusions have occurred, or of emphysema even, for the true crepitus of a fracture, but to the experienced ear and well-practised touch these sensations are seldom a source of error. The one is rough, crackling, even clicking sometimes, while the other is more subdued, and imparts a more uniform sensation to the hand, and but rarely conveys an actual sound, unless the ear is directly applied or the stethoscope is employed. It is only when the crepitus is transmitted obscurely through a great mass of soft tissues, or sufficient time has elapsed for the ends of the fragments to become softened by inflammation and partially covered with a plastic material, or when, indeed, a dislocation is actually coinci-

¹ Vanderveer, Amer. Journ. Med. Sci., May, 1847, p. 378.

dent with the fracture, that the surgeon is left in doubt. Occasionally, also, the existence of caries or of necrosis, in connection with a dislocation, might lead to the supposition of a fracture; but the history of the case, aside from the remaining common signs, and the special symptoms hereafter to be enumerated, would prevent any possibility of error. In a few cases the diagnosis may be facilitated by the application of the ear or of the stethoscope, as first recommended by Lisfranc.¹

It must not be forgotten, moreover, that a fracture at one point may transmit the sensation of crepitus distinctly enough, but in such a direction, owing to the relations of other bones to the one broken, as to mislead the surgeon, and induce him to locate the fracture in the wrong bone. Several examples of this species of deception I shall hereafter have occasion to mention.

Valuable and important as is crepitus in its relations to differential diagnosis, unfortunately it is not always present, and for reasons which must be plainly stated. First. We cannot, in a pretty large proportion of cases, bring the broken ends again into apposition. Whatever mere theorists may say to the contrary, and notwithstanding surgeons up to this time have rarely ventured to allude to this subject, the fact is that we do not usually “set” broken bones. We do not, even at the first, bring them into complete apposition, unless it is as the exception. I speak of the bones once completely displaced by overlapping, and these constitute the majority of examples which come under the surgeon's observation. Second. In transverse fractures of the patella, and in fractures of the olecranon process of the ulna, of the acromion process of the scapula, and in all similar detachments of processes and apophyses, the action of the muscles, by displacing the fragments, may prevent crepitus from being readily produced. Third. In a few cases, such as certain fractures of the neck of the femur, of the neck and head of the humerus, in a Colles fracture, etc., the broken ends may be impacted, or so driven into each other as to forbid the production of motion and crepitus; or they may be simply denticulated, and the consequences, so far as crepitus is concerned, will be the same.

Finally, in very many incomplete fractures, crepitus does not exist; and even when it is present, the sensation is feeble, or very much modified, sometimes giving only a faint and single click. Under the head of crepitus we may properly include the sharp crack sometimes felt, or even heard, by the patient at the moment of fracture.

Preternatural mobility, less valuable as a means of diagnosis than crepitus, is, nevertheless, more constantly present, being never absent, in some degree, in all complete, non-impacted, and non-denticulated fractures; but its presence does not, like crepitus, render the existence of a fracture quite certain. Whenever the bony lesion takes place in the vicinity of a joint, it may be difficult or impossible to determine whether the mobility of the limb is due to motion in the joint or to motion at the supposed seat of fracture. While, on the other hand, the preternatural immobility so generally observed in dislocations may give place to preternatural mobility, as when the ligaments and tendons

¹ New England Med. Journ., 1824, p. 220.

surrounding the joint are extensively torn, or the system itself is laboring under the shock of the accident, or when from any other cause there exists great general prostration.

As to the third common sign mentioned, namely, that broken bones do not generally support themselves, but demand for this purpose, in most cases, the interposition of splints, bandages, and even of extending and counter-extending forces, its authority rests upon the same evidence as does the assertion already made, that bones once separated entirely, cannot generally be "set," that is, placed again end to end in such a manner as to be made effectually to support each other. It rests upon the evidence of my own personal experience; to which I am permitted to add, also, the personal experience of Malgaigne, who, with a frankness which does him great credit, and which, I am sorry to say, has hitherto found few imitators, remarks: "Second. That overlapping is the most stubborn of all. Here I will add a disagreeable truth, which classical authors have kept too much out of sight, namely, that it is so stubborn that in an immense majority of cases the efforts of art are unable to overcome it."¹ And it must be observed further, that if we shall often find it possible to bring the broken surfaces sufficiently into contact to develop crepitus, they may still be unable to maintain themselves in this position, owing to the obliquity of the line of fracture.

The other common signs of fracture may be briefly stated. Pain at the seat of fracture; swelling; ecchymosis; deformity, produced by either an angular, transverse, or rotatory displacement of the fragments, and which is quite as often due to the direction and force of the impulse which occasioned the fracture as to the action of the muscles; separation of the fragments, as in fractures of the patella and olecranon process; and inability to move the limb, a phenomenon due in part to the breaking of the bony lever upon which the muscles acted, and in part to the intense pain caused by any such attempts. This latter symptom is, however, often entirely absent. It is not generally present in impacted fractures, in serrated and partial fractures, or in many other fractures in which the periosteum has not yet completely given way.

Velpau was the first, I think, to call attention to the fact that patients with broken clavicles could very generally raise the arm above the shoulder and even to the head, and I have repeatedly verified the observation, notwithstanding the separation of the fragments has been complete, and the overlapping considerable. In fractures of the neck of the femur and of the tibia it is no uncommon thing for the patient to walk some distance after the receipt of the injury.

As has been previously stated, fractures of long bones, caused by muscular action, generally occur near the middle of the shaft, and they are usually transverse. Direct fractures are also more nearly transverse than indirect fractures, but less so than those caused by muscular action; while those indirect fractures which are caused by a force applied in the direction of the axis of the bone are, in general, very oblique. But what is of more importance in connection with diagnosis is, that in this latter class of cases the fracture usually takes place near the point upon

¹ Malgaigne, *Traité des Fractures et des Luxations*, Paris ed., t. i. p. 102.

which the force of the blow is received. Thus, for example, a fall upon the hand generally causes a fracture of the lower end of the radius—a Colles fracture—or if both bones break, it is generally below the middle, and very seldom indeed in the upper third. A fracture of the shaft of the humerus near the condyles is a frequent result of a fall upon the elbow. The classical fracture of the clavicle, at the junction of the middle and outer thirds, is usually caused by a fall upon the shoulder. A fall upon the foot causes a fracture, in most cases, near the lower end of the tibia, and the same is true, quite often, of the lower end of the femur. Exceptions to the rule above stated are most commonly met with in advanced life, when falls upon the elbow occasion fractures at the surgical neck of the humerus, and falls upon the shoulder sometimes cause fractures near the sternal end of the clavicle. Similar accidents, in old people, also sometimes break the tibia near its upper extremity, and the femur within its capsule.

I cannot dismiss this subject without calling attention to the necessity of exercising care and gentleness as well as skill in the examination of broken limbs.

Nothing, in my opinion, betrays a lack of judgment as well as of common humanity, on the part of the surgeon, so much as a rude and reckless handling of a limb already pricked and goaded into spasms by the sharp points of a broken bone. It is not enough to say that such rough manipulation is generally unnecessary, it is positively mischievous; provoking the muscles to more violent contractions, increasing the displacement which already exists, and sometimes producing a complete separation of the impacted, denticulated, transverse, or partial fractures, which can never afterwards be wholly remedied; augmenting the pain and inflammation, and not unfrequently, I have no doubt, determining the occurrence of suppuration, gangrene, and death.

In proceeding to establish the diagnosis in any case, the surgeon should sit down quietly and patiently by the sufferer, so as to inspire in him from the first a confidence that he is not to be hurt, at least unnecessarily. He ought then to inquire of him minutely as to all the circumstances immediately relating to the accident, in order that he may determine as nearly as possible its cause, which alone, to the experienced surgeon, often affords presumptive, if not conclusive, evidence as to the nature and precise point of the injury. From this, he should proceed to examine the disabled limb; removing the clothes with the utmost care by cutting them away rather than by pulling; and when completely exposed, he should notice with his eye its position, its contour, the points of abrasion, discoloration, or of swelling; and not until he has exhausted all these sources of information, ought the surgeon to resort to the harsher means of touch and manipulation. Nor will his sensations guide him to the point of fracture by any other method so accurately as when, the patient being composed and his muscles at rest, he moves his fingers lightly along the surface of the limb, pressing here and there a little more firmly, according as a trifling indentation or elevation may lead him to suspect this or that to be the point of fracture.

The limb, in case of a supposed fracture of a long bone, may now be measured with a tape-line, and compared with the opposite limb, having

first marked with a soft pencil or with ink the several points from which the measurements are to be made.

Finally, if any doubt remains, the limb must be firmly but steadily held while the necessary manipulations are performed, for the purpose of ascertaining the existence of mobility and of crepitus. Mobility is most easily determined by giving to the limb a lateral motion, but in general, crepitus is most effectually developed by gentle rotation. If the place of fracture is already pretty well declared by the previous examinations, the surgeon should place one finger over the suspected point, during this manipulation, by which means the crepitus will be more certainly recognized.

I do not often find it necessary to resort to anæsthetics for the purpose of insuring quietude and annihilating pain in making these examinations, since it is seldom that the patient need to be much disturbed; but if the examination is not satisfactory, and the diagnosis is important, I do not hesitate to render the patient completely insensible, after which the questions in doubt may be more thoroughly investigated and perhaps definitely settled.

The surgeon ought not to forget, however, that while the patient is under the influence of an anæsthetic, violent manipulations are no less liable to rupture bloodvessels, and to lacerate other tissues, than if employed when the patient is conscious. Surgeons have not seemed always to understand this, and the result has been that in too many instances they have inflicted serious and irreparable injury; in one instance which came under my notice, the injury thus inflicted caused tetanus and death.

It is scarcely necessary to say that the earlier the examination is entered upon, the more readily will the diagnosis be made out; and if, unfortunately, some time has already elapsed before the patient is seen by the surgeon, and much swelling has taken place, the examination is still not to be omitted; and whatever doubts remain we must endeavor to remove by repeated examinations, made from day to day, until the subsidence of the tumefaction has brought the surfaces of the bone again within the reach of our observation.

CHAPTER IV.

REPAIR OF BROKEN BONES.

It is not my intention to enter very fully into a consideration of the process of repair in fractures, preferring to leave this subject where it more properly belongs, to the general treatises on surgical pathology.

I only propose to state very briefly a few practical, and I trust I may now say, pretty well-established facts, such as the manner or position in which this reparative material, whenever it is employed, is applied to the broken bones, the length of time which is usually required for the com-

pletion of the process of repair, and the causes which may impede or prevent bony union.

If I think it necessary to say anything more upon this subject, it will be simply to announce my belief that the reparative material, consisting originally of a plastic lymph, is poured out from the vessels of the Haversian canals, the medullary tissue, the periosteum, and more or less from all of the lacerated tissues which are immediately adjacent to the seat of fracture; but probably in greatest abundance from the periosteum; that after a period, longer or shorter, this lymph becomes organized, and begins to receive from the same sources particles of bony matter, through which the consolidation is finally effected; that the transition from the original plastic material to bone is in adults almost constantly through the interposition of connective tissue, rarely, unless in the case of children, through a cartilaginous tissue, and sometimes through both consentaneously or consecutively; that, perhaps, in a few fortunate examples bones unite directly or immediately, without the intervention of a reparative material; and finally, that granulation-tissue sometimes becomes transformed into bone, in certain cases of compound fractures, or of fractures in which the process of inflammation exceeds certain limits.

Dupuytren, enlarging upon the doctrines taught by Galen, Duhamel, Camper, and Haller, declared that "nature never accomplishes the immediate union of a fracture save by the formation of two successive deposits of callus;" one of which is derived from the periosteum, the adjacent tissues, and from the medulla; while the other, derived, perhaps, from the broken extremities of the bone itself, is found at a later period directly interposed between these surfaces. The material or callus derived from the tissues outside of the bone, and which Galen compared to a ferrule, but which Mr. Paget calls "ensheathing," together with the material derived from the medulla, compared often to a plug, and by Mr. Paget named "interior" callus, is by Dupuytren spoken of as the "provisional" or temporary callus, by which the fragments are supported, and maintained in contact until the permanent callus is formed. This temporary splint is completed or has arrived at the condition of bone in a spongy form, at periods varying from twenty to sixty days; but it does not assume the character of compact bone until a period varying from fifty days to six months has elapsed; after which it is gradually removed by absorption. The second process, by which the ends of the bone are definitively or permanently united, commences when the provisional callus has arrived at the stage of spongy bones, and is not completed usually within less than eight, ten, or twelve months, "when," says Dupuytren, "it acquires a solidity greater than the original bone."

While it is certain that this eminent surgeon and most accurate observer has described faithfully the various phenomena which usually accompany the repair of bones in those animals which were the subjects of his experiments, and that his conclusions have a certain degree of application to the human species, it is equally certain that he erred in assuming that in man simple fractures always unite by this double process; yet, such is the power of authority, these doctrines were accepted from the first without hesitation or debate, and for nearly half a century they have occupied the minds of surgeons, to the almost complete exclu-

sion of every other theory. Mr. Stanley was among the first to question the solidity of the doctrines of Dupuytren, but it remained for Mr. Paget to expose fully their many fallacies; nor has Malgaigne, although not strictly a disciple of Paget, failed to detect certain of these errors.

I should also do injustice to myself were I not to mention that at the very moment when Mr. Paget was making his observations upon the specimens in "the large collection of fractures in the museum of the University College," I myself was employed in similar researches both among cabinet specimens and in the hospitals of this country and of Europe; and that the conclusions to which I had arrived were nearly identical with, although the inferences were far from being so complete in their detail as those to which this distinguished pathologist was himself brought.¹ I do not, however, wish to make Mr. Paget responsible for any of the opinions upon this subject which I shall hereafter express, except so far as they may be found to agree with his own published views.²

I think it may now be fairly stated that the repair of bones by the double process described by Dupuytren is, in man, only an exception to a very general rule; and that fractures may unite by either one of the following modes:

First. Immediately, or in the same manner that the soft tissues sometimes unite, by the direct reunion of the broken surfaces, and without the interposition of any reparative material. This happens probably sometimes in the spongy bones, and in the extremities or spongy portions of the long bones, especially when one portion of bone is driven into another and becomes impacted; as, for example, in some extracapsular impacted fractures of the neck of the femur, in certain impacted fractures of the head or neck of the humerus, of the lower end of the radius, etc.

Second. By interposition of a reparative material between the broken ends; as when the fragments remain in exact apposition, but immediate union fails. This is especially apt to occur, in superficial bones, such as the tibia; or upon those sides of the bone which are most superficial. It is not an unusual circumstance to find the shaft of the tibia during the process of union presenting no exterior callus upon its anterior and inner surface, whilst the posterior and outer section of its circumference is covered with an abundant deposit. In other cases, however, of fractures of the shaft as well as of the epiphyses, the intermediate callus secures a prompt union, but no ensheathing callus is ever formed.

Third. Bones broken and not separated, unite occasionally by the process described by Dupuytren, namely, by the formation, first, of an ensheathing callus, whilst at the same moment the cylindrical cavity becomes closed by a spongy plug, or its canal is merely interrupted by a compact septum of bone; and, second, by definitive callus deposited between the broken ends. It is probable that this happens generally in children, or during the periods of the greatest activity in the development of bones; and it is a common mode of union in the ribs, which

¹ Paper on "Provisional Callus," by Frank H. Hamilton. Buffalo Medical Journal, Feb. 1853.

² Lectures on Surgical Pathology, by James Paget, Phila. ed., 1854, Chapter XI.

bones, during the whole progress of the union, are necessarily kept in motion. My cabinet furnishes many illustrations of ensheathing callus in ribs; and also a few in fractures of the tibia and fibula.

Fourth. Under similar circumstances, where no displacement exists, the fracture may unite by ensheathing and interior callus alone, no intermediate callus ever being formed between the broken ends; in which case it may be probably said that the bone itself has never united, and the ensheathing callus, instead of being provisional, is permanent or definitive. This was essentially the doctrine of Galen, Haller, and Duhamel before Dupuytren added his "fifth period," or the formation of definitive callus; and by these older surgeons it was held to be of universal application, except, perhaps, in the case of children. To this doctrine also Malgaigne has returned; at least to the question, "Is there always a definitive callus, or complete union of the fragments?" he has made this laconic reply: "Galen admitted its occurrence, but only in young subjects; it has been obtained in animals, where there had been no displacement. I would willingly believe that such is sometimes the case in human adults; but I must confess I have seen only the instance above cited, which might just as well be used to prove the compact ossification of the provisional callus." He accepts, therefore, the doctrine of Galen as having not merely an occasional application, but as explaining the process of union in the large majority of cases; and in support of this extreme view he finds that the exterior callus, which Dupuytren called provisional or temporary, is actually permanent, unless removed by the absorption consequent upon pressure.

To all of which we can only say that an examination of five or six specimens in our own cabinet, after having carefully divided them with a saw, has furnished only one illustration of union by ensheathing and interior callus alone. In each of the other specimens the union was completed by definitive or intermediate callus. We cannot, therefore, avoid the conclusion that Malgaigne has been deceived as to the relative frequency of these different modes of union, and that union without intermediate callus is exceptional.

Fifth. When bones are broken and overlap, they may unite by the interposition of a callus between the opposing surfaces, that is, by an intermediate callus, but which will differ from that described as the second method, inasmuch as the new material will be deposited upon the sides of the fragments and not upon their extremities. The limb being kept perfectly at rest, and all other circumstances proving favorable, this union may take place without any excess or irregularity in the deposit. The surfaces will unite firmly where they are in actual contact; and smooth and well-formed buttresses will fill up all the spaces between the bones where they are not in actual contact, sufficient generally to give the requisite strength to this new bond of union. This mode of union will be completed sometimes when the two ends of the bones are separated laterally an inch or more from each other. I have in my collection the bone of a turkey's thigh (Fig. 4) thus united by a transverse bony shaft, although separated more than one inch; and, what is less common, I possess also a specimen of the adult human thigh (Fig. 5), in which an oblique shaft of solid callus has, after many months,

and while no splints were employed, bound together firmly the two opposite extremities of the broken bone.

Sixth. The fragments being overlapped more or less, and suffering unusual disturbance, or the adjacent tissues having been much torn, or

FIG. 4.



Fracture of the humerus of a turkey; united with the fragments widely separated. From a specimen in the author's cabinet.

much blood being effused, so that considerable inflammation is caused, the amount of callus will exceed what is necessary for the complete union of the bones; and this redundancy may be deposited around and upon the broken ends of the bones, or anywhere in their immediate vicinity, in layers, or in masses of irregular shape and size. Even the bones which are not broken, but which are near, as in the case of the fibula after a fracture of the tibia, may become inflamed, or their coverings may inflame, and they may also contribute to the general mass of bony callus.

Compound fractures, or rather, we ought to say, fractures accompanied with granulations and suppuration, obey no uniform law of repair, so far as the manner and position of the deposit are concerned; but they come together finally with more or less irregular distributions of ossified matter, according to the varying circumstances of imperfect coaptation, mobility, etc., in which they may chance to be placed. Occasionally the amount of callus is less than occurs in simple fractures, and at other times the excess is very great.

That was, no doubt, a beautiful thought, which ascribed the formation of provisional callus to an intelligent efficient cause, which in this manner sought to support the fragments until a reunion of their divided ends was accomplished. But the beauty of a conception supplies no evidence of its truth; and we have grave doubts whether Nature ever allows any interference with her laws even in an exigency, unless by the substitution of a miracle. Provisional callus is, in our opinion, just as much the necessary result of natural laws, as is definitive. It is formed because

FIG. 5.



Fracture of the shaft of the femur; united with an oblique callus. From a specimen in the author's cabinet.

in that condition of the parts and of the general life its formation was inevitable. Whether useful for the purposes of repair or not, it will, under certain circumstances, exist. In the repair of certain fractures, provisional callus, it is conceded, seldom occurs. Thus it is with the cranium, the acromion, coracoid and olecranon processes, the patella, and with all those portions of bones which are immediately invested with a synovial capsule. Will it be affirmed that in the examples just named this callus is not formed because it is not required? To us it seems that nowhere could it prove more useful, since, with the single exception of the cranium, it is in these very cases that the obstacles to a reunion are the most serious. In fractures of the patella, olecranon, etc., the action of the muscles tends constantly and powerfully to displace the fragments, and gladly would the surgeon avail himself of the assistance of a temporary callus, but it is rarely present, at least in any useful degree. So also in fractures of the neck of the femur within the capsule, and in other similar cases, we cannot say that temporary callus would not be advantageous in facilitating the retention of the fragments, yet the "intelligent efficient agent" neglects to furnish it.

The only satisfactory reason which, as we think, can be assigned for the absence of callus in these cases, is found in the doctrines we now advocate; that is to say, it is usually absent because that amount of excitement and irritation is usually absent which alone determines its formation. In the case of the olecranon, patella, etc., the fragments being separated from each other by muscular action, so that no painful pinchings or chafings occur, and their rough surfaces or sharp points being rather drawn away from than protruded into the flesh, no sufficient provocation exists for the production of inflammation and effusion. Hence the failure of provisional callus; but wherever the fracture occurs, and however moderate the action, definitive callus does not fail; still the broken surfaces of the patella and olecranon are softened, and smoothed, and covered over with a new matter, which, if contact could have been secured and preserved, would certainly have served to consolidate and repair the breach. The natural reparative process proceeds, but only the accidental process is omitted. The latter, however, is seen again even here, when from other and unusual causes a sur-excitement is established.

Temporary callus is not formed upon bones invested with synovial membranes, because here, too—as in the neck of the femur—there are not so many structures lacerated and irritated, and the supply of this effusion must be the less not only in proportion to the less intensity of the inflammation, but also to the less amount of structures implicated.

Possibly other and more satisfactory reasons may be assigned why provisional callus is not formed usually when the neck of the femur is broken within the capsule; but we certainly can never admit the common, and, as here applied, the too palpably absurd explanation, that it is not wanted. It is wanted, and in no case so much as in the one now supposed.

Provisional callus has, therefore, no final purpose, but it is the unavoidable result of certain abnormal conditions. It still occurs everywhere when against and in the vicinity of the bone there are the requi-

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.