

PART I.

FRACTURES.

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CHAPTER I.

GENERAL DIVISION OF FRACTURES.

FRACTURES are divided into Complete and Incomplete, Simple, Comminuted, Compound, and Complicated.

A Complete fracture is one in which the line of division completely traverses the bone.

An Incomplete fracture is a partial separation of the bone: under which name are included Bending, Partial fractures, Fissures, Indented fractures, and Punctured or Perforating fractures, the last of which is almost peculiar to gunshot injuries.

A Simple fracture is one in which the bone is broken at only one point. The term has no reference to the question of complications, but in its technical meaning, as employed by both English and American surgeons, it has reference only to the number of fragments into which the bone is broken. It would be more correct, perhaps, to substitute the word "single" for "simple," as has been done by Malgaigne and some other French writers, but I fear that to American surgeons the substitution would be rather a source of confusion than otherwise.

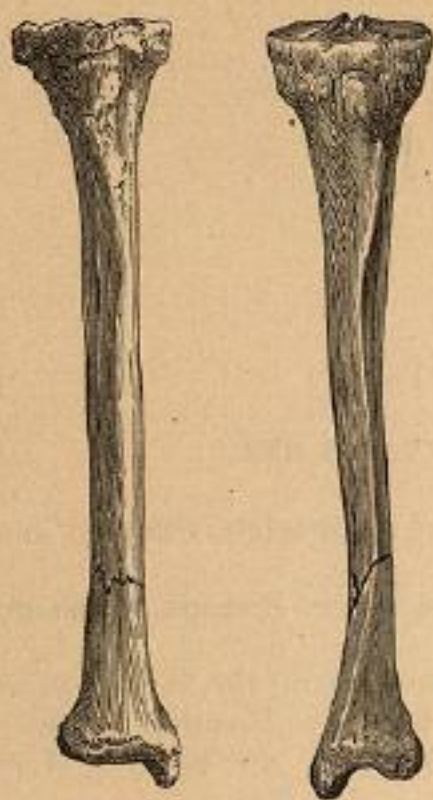
A Comminuted fracture, called by Malgaigne "multiple," is a fracture in which the bone is broken at more than one point, and in which, consequently, the bone is divided into more than two fragments. It is used in a technical sense, and by no means implies minute division or comminution of the fragments.

A Compound fracture is technically one in which there exists also an external wound communicating with the bone at the point of fracture. It may be either partial or complete, simple or comminuted, or even complicated, while at the same time it is also compound.

Complicated fractures are such as present additional complications, or complications for which no other specific term has been invented. Thus, the fracture may be complicated with the lesion of an important blood-vessel or nerve, or with great contusion or laceration of the soft parts, with a dislocation, or with fractures of other bones, or even with some constitutional fault.

Fractures are also divided into Transverse, Oblique, and Longitudinal, according as the direction of the line of separation is at a right angle with the axis of the bone at the point of fracture, or as it deviates more or less from this direction. But a fracture is called transverse when it

FIG. 1.



Transverse, serrated (denticulated) fracture. Oblique fracture. Called also V-shaped. From author's collection.

does not traverse the bone precisely at a right angle; indeed, we usually apply this term whenever the obliquity is only moderate, or when, in the examination of a limb, although we are unable to detect the precise line of the fracture, we ascertain that, without being impacted or serrated, the ends of the bones continue to rest upon each other, or, being replaced, do not spontaneously become displaced.

Longitudinal fractures occur generally in connection with oblique or transverse fractures; as when the lower end of the femur is split vertically into the joint, and the shaft of the bone is traversed horizontally by a fracture which intercepts the vertical or longitudinal fracture. A fracture of a condyle, or of any projection from the body of the bone, is called longitudinal if the direction of the line of fracture is parallel, or nearly so, to the axis of the shaft.

A Serrated or Denticulated fracture is one in which the opposite surfaces denticulate, the elevations upon one fragment being reflected by corresponding depressions upon the other.

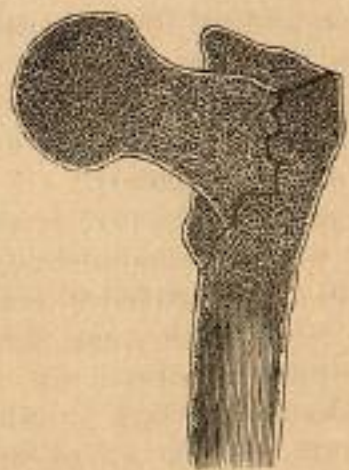
FIG. 2.



Perforating and longitudinal fracture.

Impacted fractures are those in which the fragments are driven into each other, the lamellated structure of one fragment penetrating the cancellous structure of the other.

FIG. 3.



Impacted, extracapsular fracture of neck of femur.—Vertical section.

We speak also of fractures by avulsion, or *arrachment*, which are due in most cases to the action of the ligaments, but occasionally to the action of the tendons. They occur mostly in the vicinity of the joints, and consist in the separation of minute fragments or scales of bone, or of tubercles and tuberosities to which ligaments or muscles are attached, and occasionally of considerable portions of the articular ends of bones.

Writers also occasionally speak of fractures *en rave*, *en bec de flûte*, *en bec de plume*, as V-shaped, stellate, spiroïd, cuneate, etc.; but we do not see the propriety of multiplying the divisions and encumbering our nomenclature by these fancied resemblances. For all useful purposes, the divisions above given are sufficient.

Epiphyseal separations we shall not hesitate to class with fractures, and to submit them to the same rules of nomenclature. These accidents rarely occur after the twentieth year of life; since after this period, and in the case of some bones at a much earlier period, the epiphyses are usually united to the diaphyses by bone. A large proportion of these accidents seem to be due to *arrachment*, the epiphyses being torn off by the action of the ligaments or of the muscles. Suppuration and necrosis are more frequent sequences than in the case of true fractures.

CHAPTER II.

GENERAL ETIOLOGY OF FRACTURES.

THE causes of fracture may be considered as predisposing and exciting.

Predisposing Causes.—Partial fractures, with bending of the bones, are most frequent in infancy and childhood; but complete fractures occur most often during manhood; and if they are again less frequent in old age, it is because the exciting causes are less operative, since the fragility of the bones, as a general rule, increases with age.

The influence of age as a predisposing cause of fractures consists in the changes which the bones undergo in advancing years by interstitial absorption, known as "senile atrophy." The interior or cancellated tissue is especially liable to this change; the cavities of the cylindrical bones becoming increased in size and filled with fat.

It will be noticed, also, that somewhat in proportion as the bone is more brittle, its fracture will be more nearly transverse, so that very old persons have occasionally what has been not inaptly termed the "pipe-stem fracture;" but we must except from this rule fractures occurring in children, which are also sometimes transverse, often denticulated or splintered, and but rarely oblique. In all of the intermediate periods of life, oblique fractures are by far the most common. Females are less liable to fractures than males, except in old age, when the law seems, in general, to be reversed. As to the season of the year, it has been generally observed by surgical writers that fractures are more frequent in winter than in summer, and an explanation has been sought for in the

greater rigidity of the muscles during the cold weather, and the greater liability to falls upon the ice and frozen ground. Some have affirmed that the bones themselves were more brittle; but, aside from the improbability of this last explanation, it is a matter of question whether fractures are actually more frequent in the winter than in the summer. If, on the one hand, the rigidity of the muscles and falls upon slippery walks are active causes in the production of fractures in the one season; on the other hand, falls from buildings and accidents from a great variety of similar causes are equally active agents in the other.

Mollities ossium, rickets, cancer, tertiary lues, scrofula, gout, scurvy, mercurialization, and, in short, all diseases dependent upon cachexia, are believed more or less to predispose to the occurrence of fractures. Gurli thinks, however, there is no evidence that scrofula or gout predisposes to fracture, and that syphilis is not a very frequent cause. Inflammation of the periosteum, also, or of the bone itself, may predispose to fracture. It is said, moreover, that the bones of persons who have lain a long time in bed break easily.

The liability to fracture is also sometimes hereditary, when there exists no recognized cachexia. In such cases, in the absence of any other explanation, we may suppose that the proportion of the earthy salts in the bones is increased; but this supposition has not been confirmed by any observations known to the writer.

Finally, trophic changes consequent upon disease of the nerve-centres may give rise to a fragility of the bones. It has been observed in lunatics, the paralytic, and by Weir Mitchell¹ in persons affected with locomotor ataxia.

Remarkable examples of fragility of the bones have been from time to time recorded. Gibson relates the case of a young man who at the age of nineteen had suffered twenty-four fractures. Arnott speaks of a girl who at the age of fourteen had suffered thirty-one fractures; Esquirol had in his possession the skeleton of a woman in which were found traces of more than two hundred fractures; and we have had, at the Charity Hospital, a man *æt.* 53, who had suffered eleven fractures and two dislocations, in whose case the susceptibility both to fractures and to dislocations appeared to be hereditary.² In most of these cases, so far as is known, union occurred rapidly.

Exciting Causes.—The exciting, determining, or immediate causes of fractures are of two kinds: mechanical violence and muscular action.

Of these two, mechanical or external violence is much the most frequent cause; and this violence may operate in two ways: by acting directly upon the bone at the point at which it separates, and then we say the fracture is "direct," or from "direct violence;" or by acting upon some point remote from the seat of fracture, and then we say the fracture is "indirect," or from a "counter-stroke." When a person falls from a height, alighting upon his feet, and the leg or thigh is broken, the fracture is indirect; so also if the bone is broken by flexion or torsion. Even direct pressure upon one side of a long bone in a child may produce

¹ Weir Mitchell, *Amer. Journ. Med. Sci.*, July, 1873, p. 113.

² *The Physician and Pharmacist*, Feb. 1870. Report by Armenag Assadoorian, House Surgeon.

a partial fracture upon the opposite side, which is properly an indirect fracture; or a direct blow upon the trochanter major may occasion a counter-fracture through the neck of the femur.

Fractures from muscular action occur most often in the patella, calcaneum, humerus, femur, tibia, and olecranon process of the ulna. These accidents may imply some condition of the bones themselves which predisposes them to fracture; but I have seen one example of a fracture of the shaft of the femur in a large and perfectly healthy man, occasioned by a twist of the leg in rolling tenpins. I have also quite often known the tibia to break from natural muscular action in persons of uncommon vigor; and there is reason to believe that the patella is broken more often from muscular action than from direct force. Fractures sometimes occur in the violent contractions of the muscles during convulsions, and where no abnormal condition of the bones could be assumed to exist. Parker, of New York, relates a case of fracture of the humerus in a negro preacher, which occurred in the act of gesticulation; also, a fracture of the clavicle occasioned by striking a dog with a whip; in another case the humerus was broken in attempting to throw a peach; but the most singular case of all was a fracture of the humerus caused by an effort to extract a tooth.¹

I myself have seen the clavicle broken in the case of a man who was reaching back to lift the top of his carriage; and another in which the humerus was broken in a contest to determine the power of the rotator muscles of the forearm.

Lente has seen both femurs broken in epileptic convulsions, in a child twelve years of age. The left femur was broken April 10, 1859, at the junction of the upper with the middle third, and the right femur was broken at the same point eight months after, and about six weeks later he died. The first fracture united with considerable bowing and shortening. The second did not unite at all. He had been subject to epilepsy since he was fifteen months old.²

Nearly all of the cases of fractures occasioned by muscular contraction seen by me were transverse, or nearly so, and most of those occurring in the long bones have been unattended with shortening, the ends of the bones not becoming completely displaced from each other. The example of fracture of the shaft of the femur before mentioned, as having been broken in rolling tenpins, was, however, an exception. The limb was placed by the surgeon in charge, upon a double inclined plane, upon the theory that in this position no shortening was likely to occur. The bone shortened, however, to the extent of an inch or more, and in this position it has finally united.

Intra-uterine fractures are not yet fully explained, but it is probable that they, like extra-uterine fractures, may be ascribed sometimes to external violence, and at other times to simple muscular contraction, both perhaps acting upon bones already somewhat predisposed by a peculiar constitutional cachexy.

November 18, 1872, a child was brought to me having a fracture of

¹ Parker, *New York Journ. Med.*, July, 1852, p. 95.

² *Am. Med. Times and Advertiser*, July 21, 1860, p. 41.

the left clavicle, which had united with considerable deformity, the point of fracture being at the junction of the middle and outer thirds. The mother said that she fell upon her belly about two weeks before the birth of the child, striking upon a tub; delivery occurred at the full period, in the hands of an uneducated female accoucheur. Four weeks later (when I was consulted) union was complete.

Lawrence Proudfoot, of New York, has related a case of compound fracture *in utero* occurring in the practice of Dr. Freeman, which was apparently caused by external violence. Mrs. F., set. 38, always having enjoyed good health, during the sixth month of gestation, while attempting to pass through a very narrow passage, was severely pressed upon the abdomen, and immediately experienced a severe pain in that region, accompanied with nausea and faintness. The following day, uterine hemorrhage, with pain, commenced; and these symptoms continued at intervals, in a form more or less severe, up to the period of her delivery, which occurred at full time, and was perfectly natural. At birth, the right foot of the child, a female, was found to be much distorted, and in a condition of valgus with equinus, the outer side of the foot being laid against the side of the leg above the external malleolus. The tibia, also, of the same limb, near its middle, seemed to have been the seat of a compound fracture; the two ends of the bone having united at an angle slightly salient anteriorly, and the skin presenting over the point of fracture an old cicatrix. The soft tissues adjacent were considerably thickened. Seventeen months after birth, when the child was seen by Drs. Proudfoot, Van Buren, and Isaacs, the foot, although much improved by the means employed by Dr. Freeman, was still considerably deformed, in consequence of contraction of the tendo Achillis; on cutting which, the limb was found to be of the same length with the other.¹

Dr. Aristide Rodrigue, of Hollidaysburg, Pa., has communicated a case of fracture with dislocation, which he ascribes to a similar cause. The woman, when about four months with child, fell on her left side, striking upon a board, and hurting herself severely. At the full period she was delivered of a well-grown male child. Its left humerus was found to be dislocated into the axilla, and both the radius and ulna of the same limb had been broken through their lower thirds, but were now united by bony callus at an angle of about 45°, and slightly overlapped. In all other respects the child was perfect. It does not appear that anything was done to the fracture, and the attempt to reduce the humerus was unsuccessful. Four years later Dr. R. saw the lad, and found him strong and hearty, the dislocated humerus having grown nearly at the same rate with the opposite, but the forearm remained "short and deformed as at birth." The hand was of the same size as the hand of the sound limb.²

Devergie has given an account of a woman, who, when seven months with child, struck her abdomen against the corner of a table. Intense pain followed, lasting some time. She went her full period, however, and the child was then found to have a fracture of the left clavicle, the fragments being overlapped somewhat, and united in this position by a

¹ Proudfoot, New York Journ. Med., Sept. 1846, p. 199.

² Rodrigue, Amer. Journ. Med. Sci., Jan. 1854, p. 272.

firm and large callus.¹ A woman also six months gone met with a similar accident, and at the full time she gave birth to a feeble child, having in one leg a separation of the shaft of the tibia from its lower epiphysis. The end of the shaft was necrosed, and projected through a wound in the integument. This child died on the thirteenth day.²

Schubert reports the case of a female delivered before her term, of twins, one of whom was born with a fracture of the left thigh, which had occurred *in utero*; the fractured bone had pierced the flesh, through which it projected more than an inch, and it was carious. The mother stated that about six weeks before the accouchement, during a movement of the foetus, she had heard a noise like that produced by breaking a stick, and from that moment she had felt pricking pains in her belly.³ It is probable that in this instance the fracture was the result of a muscular action, although it is possible that it was occasioned by the thigh having become entangled between the legs of the twin. Similar cases have been recorded by Ploucquet, Kopp, Carus, Sachse, Moffat, and Brodhurst.⁴

In many other examples upon record⁵ the explanation is plainly enough to be sought for in the abnormal or rachitic condition of the bones. Monteggia saw, in a newly born infant, twelve united fractures. Chaussier, who has published a memoir upon this subject, mentions two very extraordinary cases, in one of which the child presented forty-three fractures, and in the other, one hundred and twelve.⁶ I myself was permitted to see, on the 29th of June, 1853, with Drs. Hawley and White, of Buffalo, an infant only four days old, who was born at the full time, of a healthy mother, in whom nearly all of the long bones were separated and movable at their epiphyses, the motion being generally accompanied with a distinct crepitus. The bones were also much enlarged in their circumference; the bones of the forearm and the femur were greatly curved; the fontanelles unusually open, and the clavicles were entirely wanting. The child was of full size, but looked feeble. It died in a condition of marasmus six months after birth, at which time some degree of union had taken place at several of the points of separation, the limbs having been supported constantly with pasteboard splints and rollers.

Fractures occurring from violence inflicted upon the child by the accoucheur, or from contractions of the neck of the womb while the child is *in transitu*, are more common occurrences, and do not require a separate consideration. I shall mention several in connection with the various bones in which they have taken place; among which, one of the most interesting is that published by Jacob H. Vanderveer, of Long Branch, N. J. The mother came to bed on the 18th of January, 1847, after a labor of more than twelve hours. It was a foot presentation;

¹ Devergie, Rev. Méd., 1825.

² Malgaigne, from Archiv. Gén. de Méd., t. xvi. p. 288.

³ Amer. Journ. Med. Sci., May, 1828, p. 223; from Zeitsch. für Staatsarz. von Henke, 7e Erg. Heft., p. 311. Holmes's Surgery, vol. iv. p. 826.

⁴ Holmes's Surgery, vol. iv. 827, from Med.-Chir. Trans., vol. xliii. 1860.

⁵ Lond. Med. Times and Gaz., April 7, 1860. New Orleans Med. Journ., Nov. 1860.

⁶ Chaussier, Bullet. de la Faculté de Med. de Paris, 1813, p. 301.

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.