

and gradually lowered his head, to enable him to direct his eyes downwards. In the same manner, also, he supported his head from behind in looking upwards. Whenever he was suddenly shaken or jarred, the shock caused great pain, and he was obliged to support his chin with his hands, or to rest his elbows upon a table, and thus support his head. The boy lived in this condition about one year, and after death Mr. Cline made a dissection, and ascertained that the atlas was broken in such a manner that the odontoid process of the axis had lost its support, and was constantly liable to fall back upon the spinal marrow.¹

§ 7. Fractures of the first two Cervical Vertebrae (Atlas and Axis) at the same time.

A woman, æt. 68, fell down a flight of steps, striking upon her forehead, and died immediately. Upon making a dissection, it was found that the atlas was broken upon both sides near the transverse processes, and the odontoid process of the axis was broken at its base. These fractures were accompanied with a rupture of the atlido-odontoid ligaments, and a dislocation of the atlas backwards.²

South says there is a specimen in the museum of St. Thomas's Hospital, showing this double fracture. The man had received his injury only a few hours before admission to the hospital, and died on the fifth day. On examination, the atlas was found to be broken in two places, and the odontoid process of the axis at its root. The fifth vertebra was also broken through its body. With neither fracture was there sufficient displacement to produce pressure, but a small quantity of extravasated blood lay in the substance of the spinal marrow, and its tissue was at one point broken down and disorganized.³

Mr. Phillips relates that a man fell from a hay-rick, striking upon the occiput; after which, although momentarily stunned, he walked half a mile to the parish surgeon, and in two days more he returned to his occupation. About four weeks after the accident he was seen by Mr. Phillips, who discovered a small tumor over the second cervical vertebra, pressure upon which caused a slight pain. He complained also that his neck was stiff, and that he was unable to rotate it. No other disturbance of the functions of the body could be discovered. After a time the tonsils became swollen, and the patient experienced some difficulty in deglutition, and, upon examining the throat, a slight projection or fulness was discovered at the back of the larynx, opposite the second cervical vertebra. Subsequently he became affected with general anasarca and pleuritic effusions, of which he finally died. Up to the last week of his life he was able to walk about his bedroom, and his condition presented no other evidence than has been mentioned, that he was suffering from an injury of the spine. He died forty-seven weeks after the receipt of the injury.

The autopsy disclosed a fracture with displacement of the atlas, and

¹ Cline, Sir Astley Cooper, op. cit., p. 459.
² Malgaigne, op. cit., tom. ii. p. 333.
³ Chelius's Surgery, note by South, vol. i. p. 588.

a fracture of the odontoid process of the axis. The two vertebrae were united to each other firmly by complete bony callus.¹

Wynperse describes a specimen of gunshot fracture of both bones, in which the ball was found imbedded in callus which united the two halves of the anterior arch of the atlas. M. Gaucher has also reported a similar gunshot fracture, the subject of which survived 9 months, death finally ensuing upon a secondary displacement of the fragments.²

CHAPTER XVII.

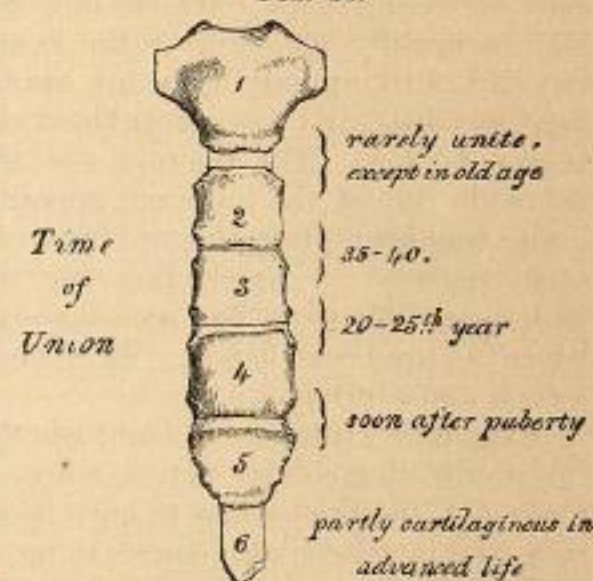
FRACTURES AND DIASTASES OF THE STERNUM.

FRACTURES and diastases of the sternum are of rare occurrence, owing, probably, to the elasticity of the ribs and their cartilages, upon which it mainly rests, and also, in part, to the softness of its structure. In advanced life, the ossification and fusion of all of its several portions becoming more complete, and the cartilages of the ribs also becoming more or less ossified, a true fracture is relatively more frequent.

In some cases no doubt these accidents ought to be regarded as true luxations, inasmuch as occasionally the union of the manubrium with the gladiolus is by a perfectly formed diarthrodial articulation, as was first demonstrated by Maisonneuve in 1842. We have, however, in general no absolute means of knowing whether before the accident the several portions which compose the sternum were united by bone, by a single piece of cartilage, or by two distinct cartilages with a synovial surface interposed; and inasmuch as the causes, symptoms, and treatment must be essentially the same in either case, it seems unnecessary to consider these luxations separately, as Malgaigne, Vidal (de Cassis), and others have done.

Causes.—They are generally the result of direct blows inflicted upon the part, such as the passage of a loaded vehicle across the chest, the

FIG. 46.



Sternum, showing the periods at which its several parts unite by bone. (From Gray.)

¹ Phillips, Med.-Chir. Trans., vol. xx. 1837, p. 384.
² Wynperse, Gaucher. French ed. of this treatise, by Poinot, p. 189.

fall of a tree or of some heavy timber upon the body; the fracture implying always that great force has been applied.

Indirect blows and voluntary muscular action alone have been known also occasionally to produce these accidents.

David, in his *Mémoire sur les Contrecoups*, published as a prize essay by the Academy of Medicine, mentions the case of a mason, who, in falling from a great height, struck upon his back against a cross-bar which intercepted his fall, in consequence of which the abdominal and sterno-cleido-mastoidean muscles were so stretched that the sternum broke asunder between its upper and middle portions.¹ Sabatier reports another case of separation at the same point, produced in a similar manner;² and Roland has described a third example in a woman sixty-three years old, who, falling from a height backwards and striking upon her back, broke the sternum near its centre.³ Gross and Hodgen have recorded similar cases.⁴

Cruveilhier saw a man who, having fallen from a height of twenty feet upon his nates, was found to have a fracture of the sternum.⁵ Cussan saw the same result in a person who fell from a third story, striking first upon his feet and then pitching over upon his back.⁶ Maunoury and Thore have reported an analogous case, where a man fell from a height of twelve or fifteen metres, first striking upon his feet and then falling over upon his back and head.⁷

Mr. Johnson, late editor of the London *Med.-Chir. Rev.*, reports a case as having been received into St. George's Hospital, in which the man, a healthy laborer from the country, had fallen from the top of a hay-cart, striking only upon his head. He walked with his head much bent forwards, and was incapable of either flexing, extending, or rotating it any farther. The fracture was transverse, and about three inches below the top of the sternum, opposite the centre of the third rib, the lower fragment projecting in front of the upper. The fragments were easily replaced by simply throwing the head back, and fell into place with an audible snap, but immediately resumed their unnatural position when the head was flexed. They finally united, but with a slight projection and overlapping.⁸

Malgaigne expresses a doubt whether all these can be considered as the results of muscular action, since, in a certain number of the examples cited, the head seems to have been thrown forwards by the concussion, and in others, also, there is no evidence that the muscles attached to the sternum were put upon the stretch. The only remaining explanation is that in such cases the sternum has been broken by the violent shock, or *contrecoup*. I have myself seen one similar example. In December, 1877, John McLaughlin, æt. 27, was admitted to my service,

¹ Boyer on Diseases of the Bones, first Amer. ed. 1805, p. 57.

² Malgaigne, from Sabatier, *Mém. sur la Fract. du Sternum*.

³ *Ibid.*, from Bull. de Thérap., tom. vi. p. 288.

⁴ Gross, System of Surg., 6th ed., vol. i. p. 964. *Med. Record* (N. Y.), Dec. 22, 1877.

⁵ Malgaigne, from Bull. de la Soc. Anat., Juin, 1826.

⁶ *Ibid.*, from Archiv de Méd., Janv. 1827.

⁷ *Ibid.*, from Gaz. Méd., 1842, p. 361.

⁸ London *Med.-Chir. Rev.*, vol. xvii., new series, p. 536, 1832.

Bellevue Hospital, who had fallen from a height upon his back, causing a separation of the manubrium from the gladiolus. There was no sign of contusion over the point of separation, but crepitus was distinct. The fragments were easily replaced and maintained in position, so that when he left the hospital the line of separation could scarcely be felt.

Dr. Hodgen has reported to me an example of fracture of the sternum caused by a crushing force applied to the back, and in which, we may see plainly, that muscular action was not concerned. A man, seated upon a wagon, was driving under a low bridge, with his head very much bent down. The bridge caught his back, opposite the shoulders, and crushed him forwards, "separating the vertebræ in the dorsal region, and breaking the sternum about three inches below its upper end." This man recovered.

Among the most authentic examples of separation of this bone from muscular action alone are those in which it occurred during labor. Malgaigne collected three of these cases, and to these the American translator, Dr. Packard, added two more, most of which took place at or near the junction of the first and second pieces of the sternum. Dr. Borland has added one more example, which took place at a point near the fourth costal cartilage.¹

Malgaigne relates also the case of a mountebank, who, leaning back to lift with his feet and hands a weight, felt suddenly a severe pain in the sternal region, and fell over with a fracture of this bone.

Caseaux, in his *Midwifery*, says that Chaussier saw two such cases occurring in young women in their first labors (both of these are included in the cases recorded by Malgaigne); the separation having occurred when the head was thrown backwards as far as possible. Compte and Martin,² Luchetti,³ and Posta⁴ have reported similar examples.

Mr. Ancelot has reported a case from gymnastic exercise.⁵

The mere act of violent coughing has caused diastasis or fracture of the sternum. Mr. Howbridge, referring to the *Gazette des Hôpitaux* for March, 1830, remarks that the ribs and the sternum have been broken in this way; but he adds, that in all probability they are weakened by partial absorption or atrophy.⁶

Lutz reports a case also, of a man æt. 38, the subject of rheumatism and asthma, and who had also emphysema of a portion of one lung. During a violent fit of coughing he felt something give way on his chest. Severe pain followed, and some swelling. Lutz found the manubrium separated from the gladiolus, the former being slightly displaced forwards. He was much relieved of his distress by "stretching his neck and throwing his head backwards." Lutz directed him to make a deep inspiration, at the same time throwing back the head and shoulders. A compress was placed over the projection, and secured in place by a broad and firm

¹ J. N. Borland, M.D., Boston *Med. and Surg. Journ.*, April 20, 1875.

² *Classical Diet. Med. and Surgery*, xiv. 70, Venice. Quoted by Borland, loc. cit.

³ *Bulletino delle Scienze Med. di Bologna*, 1857. Quoted by Borland, loc. cit.

⁴ Ancelot, from Lutz.

⁵ Holmes's System of Surgery, 2d ed., vol. ii. p. 37.

band covering the entire chest. Union took place, but with a slight overlapping.¹

Malgaigne says that Duverney was the first to recognize in certain of these accidents a *veritable luxation*; and Malgaigne further affirms that he has collected in all ten cases which should be regarded as luxations. According to the plan which I have adopted of disregarding the distinction between fractures, diastases, and dislocations of the sternum, for the reason chiefly that the exact diagnosis is in general impossible, and never of any practical value, these cases referred to by Malgaigne should be included in this enumeration of fractures and diastases.

Boyer believed that the xiphoid cartilage was not susceptible of being permanently displaced backwards, except in aged persons, after it had become ossified, "for," he says, "though violently struck and driven backwards by a blow on what is vulgarly termed the pit of the stomach, yet it restores itself by its own elasticity."²

The following case, however, which has come under my own observation, is conclusive as to the possibility of this accident:

A man, twenty-eight years old, fell forwards, striking the lower end of his sternum upon the top of a candlestick, breaking in the xiphoid cartilage. During two years following the accident he had frequent attacks of vomiting, which were excessively violent and distressing, the paroxysms occurring every five or six days. Both Dr. Green, of Albany, and Dr. White of Cherry Valley, upon whom he called for relief, recommended excision of the cartilage, but the patient would not submit to the operation. Twelve years after the accident, in the year 1848, while he was an inmate of the Buffalo Hospital of the Sisters of Charity, I examined his chest, and found the xiphoid cartilage bent at right angles with the sternum, pointing directly toward the spine. He now suffered no inconvenience from it, except that it hurt him occasionally when he coughed.³

Polaillon relates the case of a woman *æt.* 35, who, being pregnant and wearing a very tight corset, bent herself forwards so as to press the steel of the corset upon the xiphoid cartilage. The cartilage was thrown back and remained in this position, causing for a long time much distress when the stomach was disturbed. The surgeons were unable to reduce the fracture, but eventually it ceased to cause inconvenience.⁴

In Martin's case, mentioned by Malgaigne, the accident was followed by persistent vomiting; which was finally relieved when the surgeon seized the cartilage with his fingers and restored it to place. In Billard's case, referred to also by Malgaigne, the cartilage was restored to its place with a blunt hook, after having made an incision which penetrated the peritoneal cavity.

The direction of these fractures and diastases is generally transverse, or nearly so; occasionally a slight obliquity is found in the direction of the thickness of the bone. In three or four examples upon record, the

¹ Paper read before the St. Louis Medical Society by F. J. Lutz, A. M., M. D. St. Louis Med. and Surg. Journ., July, 1877.

² Boyer, *op. cit.*, p. 59.

³ Buffalo Med. Journ., vol. xii, p. 282, Cases of Fractures of the Sternum.

⁴ Polaillon, Soc. de Chir. du Paris, p. 97, 1876. (Poincot.)

direction of the separation was longitudinal. It is not so unfrequent, however, to find the bone comminuted. Compound fractures are exceedingly rare.

When the line of separation is transverse, the lower fragment is generally displaced forwards, and sometimes it slightly overlaps the upper fragment; in other cases the direction of the displacement is the reverse.

I have seen a remarkable case of separation of the manubrium from the gladiolus, accompanied with a true fracture and other complications.

Louis Wilson, *æt.* 60, was admitted into the Long Island College Hospital, April 4, 1866, having just fallen through the hatchway of a vessel. He had a compound comminuted fracture of the right leg, a fracture of the first four ribs on each side at their necks, a dislocation of the sternum from the cartilages of both second ribs, a dislocation of the left third cartilage from its rib, a dislocation of the first from the second bone of the sternum, and a transverse fracture of the sternum three-quarters of an inch below the top of the gladiolus. The dislocation of the manubrium was complete, and it was thrust behind the upper end of the gladiolus, underlapping it half an inch. The transverse fracture three-quarters of an inch lower down was also complete, and the fragment thus separated was divided into two, namely, an anterior and a posterior fragment, by a transverse splitting; the anterior moiety retaining its attachment to the periosteum below, and not being displaced, while the posterior moiety retained its attachment to the periosteum both above and below, and was pushed downwards by the descent of the manubrium. His mind was clear, but he had paralysis of the bladder, and was breathing with some embarrassment. I had no difficulty in diagnosing the dislocation of the third cartilage, and of the manubrium. There was no swelling or discoloration on the front of the chest, but it was quite tender. His head was not thrown forwards. He complained of some soreness on the back of his head. His general condition was such that I did not attempt reduction. The following day he expectorated blood, and on the third day he died. The autopsy revealed some effusions of blood underneath the pleura, but no lesions of the heart or lungs. The evidence is in this case conclusive that he struck upon his back and head, in fact, that it was a fracture from counter-stroke, by which the head, neck, and three or four upper vertebræ were bent forwards with great force, thus doubling forwards the top of the sternum.

Dr. Robert Watts, Jr., of this city, has reported a very similar case, in which death occurred on the same day. The fragments of the sternum were not displaced, but the ribs had suffered similar lesions.¹

Diagnosis.—In a few cases the patients have felt the bone break at the moment of the accident. When displacement exists, it may generally be easily recognized, and the lower fragment will often be seen to move forwards and backwards at each inspiration and expiration. Crepitus may also be detected in some of these examples. To determine its existence, the hand should be placed over the supposed seat of fracture, while the patient is directed to make forced inspirations and expirations, or the ear may be applied directly to the chest.

¹ Watts, Am. Med. Times, vol. iii, p. 55.

Emphysema has, also, occasionally been noticed, indicating usually that the lungs have been penetrated by the broken fragments.

The frequent occurrence of congenital malformations of the sternum should warn us to exercise great care in our examinations, lest we mistake these natural irregularities for fractures. The point of junction of the first and second portions has also occasionally been observed to be somewhat projected forwards in cases of chronic asthma and emphysema of the lungs. Bransby Cooper mentions a remarkable instance of malformation of the xiphoid cartilage which he at first suspected to be a fracture. It was so much curved backwards that, as Mr. Cooper thinks, its pressure upon the stomach produced a constant disposition to vomit whenever he had taken a full meal, or had taken a draught of water.¹

Prognosis.—In simple fracture or diastasis of this bone, uncomplicated with lesions of the subjacent viscera, and especially when the separation is the result of muscular action or of a counter-stroke, no serious consequences are to be apprehended. The bone unites promptly by osseous or fibrous tissue, even where it is found impossible to bring its edges into apposition. Indeed, generally, where the fragments have been once completely displaced, although it is not difficult to replace them momentarily, a redisplacement soon occurs, and they are found finally to have united by overlapping; but no evil consequences usually result from this malposition. In nearly all of the cases reported in which palpitations, difficult breathing, etc., have been charged to the persistence of the displacement, the injuries were of such a character as to furnish for these unfortunate results other and much more adequate explanations. In one instance only, already mentioned, serious inconveniences followed from a displacement of the cartilage backwards.

In other cases, however, where the fracture is the result of a direct blow, the prognosis is often very grave; a conclusion to which one would naturally arrive from the fact already stated, that the fracture of the sternum thus produced, in itself implies the application of great force.

An abscess occurring in the anterior mediastinum, and caries or necrosis of the bone, are among the most common results of a blow delivered directly upon the sternum; complications which generally end sooner or later in death. Blood may be also extensively effused into the anterior mediastinum.

A remarkable case of recovery after gunshot injury of the sternum is reported by the U. S. Medical Bureau:

Private C. Betts, 26th N. J. Vols., æt. 22, was struck by a three-ounce grapeshot, May 3, 1863, in the charge upon the heights at Fredericksburg, Va. The ball comminuted the sternum, opposite the third rib on the left side, penetrating the costal pleura. The patient removed the ball from the wound himself. On the following day he was admitted to the hospital of the second division of the sixth corps. Through the wound the arch of the aorta was distinctly visible, and its pulsations could be counted. The left lung was collapsed; when sitting up, there was but slight dyspnoea. Several fragments of the sternum were removed. The wound soon began to heal, and he made a complete recovery.²

¹ B. Cooper, *Princ. and Pract. of Surg.*, p. 359.

² Circular No. 6, Washington, D. C., Nov. 1, 1865, p. 23.

Where emphysema is present, we may anticipate inflammation of the pleura and of the lungs.

In several instances, where death has occurred speedily after the injury, the heart has been found penetrated and torn by the fragments. Sanson and Dupuytren have each reported one example of this kind. Duverney has mentioned two, and Samuel Cooper says there is a specimen in the museum of the University College, exhibiting a laceration of the right ventricle of the heart by a portion of fractured sternum. Watson mentions a case in which the pericardium was torn, but the heart was only contused.¹

Treatment.—When the fragments are not displaced, the only indications of treatment are to immobilize the chest, and to allay the inflammation, pain, etc., consequent upon the injury to the viscera of the chest. The first of these indications is accomplished, at least in some degree, by inclosing the body, from the armpits down to the margin of the floating ribs, with a broad cotton or flannel band. A single band, neatly and snugly secured, and made fast with pins, is preferable to, because it is more easily applied than, the roller which surgeons have generally employed; it is also much less liable to become disarranged. It should be pinned while the patient is making a full expiration. To prevent its sliding down, two strips of bandage should be attached to its upper margin, and crossed over the shoulders in the form of suspenders.

Generally the patients prefer the half-sitting posture, with the head and shoulders thrown a little backwards; and this is the position which will be most likely to maintain the fragments in place, and also to secure immobility to the external thoracic muscles, while it leaves the diaphragm and the abdominal muscles free to act.

The second indication may demand the use of the lancet; but more often it will be found necessary to allay the pain and disposition to cough by the use of opium.

If, however, the fragments are displaced, it is proper first to attempt their reduction; which, as I have already intimated, is generally more easy of accomplishment than is the maintenance of them in place until a cure is effected.

The fragments may sometimes be made to resume their natural position by a single full inspiration, but then they usually fall back during expiration; or they may be reduced by straightening the spine forcibly, and at the same time drawing the shoulders back.

Verduc and Petit proposed, in those cases in which it was found impossible to reduce the fragments by these simple means, to cut down and lift the depressed bone. Nélaton suggests the use of a blunt crotchet introduced through a narrow incision; and Malgaigne has thought of another plan, which is, to penetrate the skin with a punch, and directing it to the broken margin, to push the fragment into its place, but which he does not himself regard as a suggestion of much value, since the bone is too soft to afford the necessary resistance; and, moreover, this, in common with all of the other similar methods, is liable, in some degree, to the objection that it may increase the tendency to caries and suppuration, already imminent. If reduced, the fragments will probably imme-

¹ Watson, *New York Journ. of Med.* vol. iii. p. 351.

diately again become displaced; and, more than all, it still remains to be proved conclusively that the mere riding of the fragments is in itself ever a cause of subsequent suffering, or even of inconvenience.

When an abscess has formed in the anterior mediastinum, surgeons have occasionally recommended the use of the trephine. Gibson has twice operated in this manner at the Philadelphia Hospital, but in each case the caries continued to extend, and the patient died; an experience which has inclined him latterly to discountenance the operation.¹

There are other considerations mentioned by Lonsdale, which ought to decide us never to use the trephine in these cases. "For the symptoms denoting the presence of the abscess, when completely confined to the under surface of the bone, will be very uncertain; and when the matter collects in large quantities, it will show itself at the margin of the sternum, between the ribs, when it can be let out by making a puncture with the point of a lancet, without the necessity of removing a portion of the bone."² Ashhurst, referring to the same point, remarks: "The fact that the mediastinal space can be cut into without injury to the pleura is shown by many cases, among others by one which came under my own observation."³

CHAPTER XVIII.

FRACTURES OF THE RIBS AND THEIR CARTILAGES.

§ 1. Fractures of the Ribs.

FRACTURES of the ribs, observed more often than fractures of the sternum, are rare as compared with fractures of other long bones.

In my records, not including fractures from gunshot injuries, only thirty-two patients are reported as having had broken ribs; but, as in several of the cases, two or more ribs were broken at the same time, the total number of fractures is about sixty-five. If, however, I had always accepted the diagnosis made by other surgeons, the number would have been much greater, since I have been repeatedly assured that the ribs were broken when, upon the most careful examination, no evidence, beyond the existence of a severe pain and of difficult respiration, has been presented to me.

Etiology.—The force requisite to break the ribs is scarcely less than what is requisite to break the sternum; and in childhood and infancy it is sometimes almost impossible to break them, so that children and even adults are often crushed and killed outright, where, although the pressure has been directly upon the thorax, the ribs have resumed their positions, and have been found not to be broken. I have met with several examples of this kind.

¹ Gibson, *Institutes and Practice of Surgery*, vol. i. p. 269.

² Lonsdale, *Practical Treatise on Fractures*, London, 1838, p. 242.

³ Ashhurst, *Am. Journ. Med. Sci.*, Jan. and Oct. 1862.

In old age the cartilages ossify, and the ribs themselves suffer a gradual atrophy, which renders them much more liable to break.

The most common causes are direct blows, of very great force, in consequence of which sometimes the fragments are not only broken, but more or less forced inwards; occasionally they are the result of counter-strokes, and then the fragments, if they deviate at all from their natural position, are salient outwards; a species of fracture which I have not met with so often.

Malgaigne has collected eight examples of fractures of the ribs produced by muscular action, by the beating of the heart, etc., all of which occurred upon the left side. In six additional cases collected by M. Paulet, the fractures were upon the right side. Three of these were caused by coughing, and two by a sudden movement of the body. It is believed, however, that in all of these cases the ribs had previously become atrophied, and perhaps undergone other changes in their structure, rendering them liable to fracture from the action of trivial causes. Morselli attributes the frequency of fracture of the ribs in the insane to trophic changes in the structure of the ribs, dependent upon lesions of the nervous centres.¹

Pathology, Seat, etc.—The fourth, fifth, sixth, and seventh ribs are most liable to be broken; the upper ribs, and especially the first rib, being so well protected in various ways as to diminish greatly their liability, while the loose and floating condition of the last two ribs gives them an almost complete exemption.

Malgaigne has noticed, also, contrary to the general opinion of surgeons, that the ribs are most often broken in their anterior thirds, whether the cause has been a direct or a counter blow. My own observations confirm this statement.

The direction of the fracture is generally transverse or slightly oblique; sometimes it is quite oblique. It is often compound; and in a few instances I have found it comminuted or multiple. Where the fracture is compound, it is rendered so generally by the fragments having penetrated the lungs, and not by a tegumentary wound.

Displacement cannot occur in the direction of the axis of the bone unless several ribs are broken at the same time. The fragments are therefore either not at all displaced, or they fall inwards toward the cavity of the chest, or outwards, or very slightly downwards, in the direction of the intercostal spaces. Sometimes the rib rotates a little upon its own axis.

Prognosis.—Death occurs sooner or later in a pretty large minority of the cases in which the ribs have been broken; yet not often as a direct consequence of the fracture, but only as a result of the injury inflicted upon the viscera of the chest, or of other injuries received at the same moment. The violent compression of the heart and lungs has frequently produced death, and sometimes, as I have more than once seen, almost immediately; or the patients have succumbed at a later period to acute pneumonitis, or pleuritis.

Lonsdale saw a case in which, the body of a man having been traversed

¹ Paulet, Morselli, French ed. of this treatise, by Poinot.

by the wheel of a wagon, eight ribs were broken, and, death having followed almost immediately, the autopsy disclosed a rent in the left auricle of the heart, produced by one of the broken ribs.¹ South says there is such a specimen at St. Thomas's Hospital.²

Dupuytren reports a similar case. The same surgeon has also seen several deaths produced by the emphysema, independent of the fracture, two of which are particularly described in his Clinical Lectures.³ Amesbury has seen a case of death from rupture of the intercostal artery, where there was no injury of the lungs.⁴

M. Paulet has studied a series of examples of rupture of this artery in connection with fracture of the ribs, obtained from various sources, and has drawn the following conclusions: First, lesions of the intercostal artery in this class of accidents is much more frequent than is generally supposed. Second, the lesion is always grave, and often mortal. Third, it may occur not only after comminuted fractures, but after simple, and even after incomplete fractures, provided the fracture is on the lower border of the rib.⁵

In several instances observed by me, patients have suffered from pains in the side, occasionally from cough, etc., after the lapse of two or more years, and I suspect it is no uncommon thing for these injuries to entail some such permanent disability, but which is a consequence rather of the injury to the viscera of the chest, than of any condition of the broken ribs themselves.

In general, simple fractures of the ribs unite in from twenty-five to thirty days. Malgaigne has seen one case of non-union; Huguier met with another upon the cadaver, in which a complete false joint existed, furnished with a capsule and lined with synovial membrane;⁶ Eve, of Nashville, Tenn., saw a case of non-union, occasioned, probably, by a caries or necrosis of the bone, since it was accompanied with a discharge of matter, and in which a removal of the ends of the fragments resulted promptly in a cure of the sinus;⁷ and Samuel Cooper says there is a specimen in the Museum of the University College, of a fracture of six ribs where the fragments are only connected by a fibrous or ligamentous tissue.⁸

Barrit, Lisfranc, Trélat, and Demarquay have reported similar examples.⁹

The union generally occurs with only a slight degree of displacement. After the union is completed, even where there is no displacement, a certain amount of ensheathing callus may generally be felt at the point of fracture. Of five cases which I have carefully examined after recovery, in only one instance was I unable to detect any irregularity at this point. I have in my cabinet nine specimens of fractured ribs, in four of which the ensheathing callus is completely formed, but the fragments are in perfect apposition: in one, apposition is preserved, but there is no ensheathing callus; and the remaining four, all occurring in the same

¹ Lonsdale on Fractures, p. 258.

² Dupuytren, op. cit., p. 79.

³ Paulet, Poinsot, op. cit., p. 200.

⁴ Eve, N. Y. Journ. Med., vol. xv. p. 136.

⁵ S. Cooper's Surg., vol. ii. p. 321.

⁶ Chelius's Surgery, by South, vol. i. p. 599.

⁷ Amesbury on Fractures, vol. ii. p. 612.

⁸ Malgaigne, op. cit., p. 435.

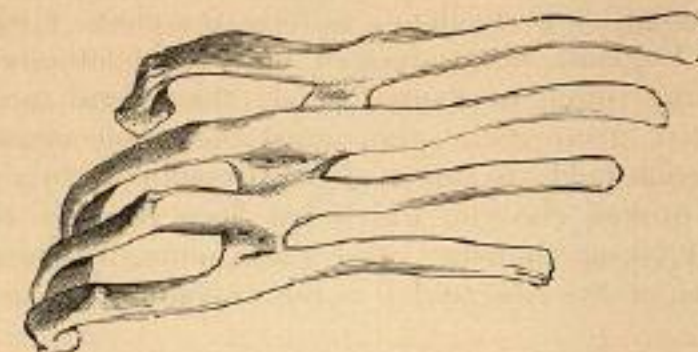
⁹ Poinsot, op. cit., p. 201.

person, are united with displacement, but without a proper ensheathing callus.

In some specimens I have observed sharp spicula, in others broader sheets of bone extending along the course of the intercostal muscles from one rib to the other, forming a species of ankylosis between their adjacent margins.

Symptomatology.—Acute pain, referred especially to the point of fracture, sometimes producing great embarrassment in the respiration, and crepitus, are the most common indications of a fracture. The pain and em-

FIG. 47.



Fractured ribs joined to each other by osseous matter. (From Dr. Gross's cabinet.)

barrassed respiration are, however, far from being diagnostic, since they are often present in an equal degree when the walls of the chest have only been severely contused.

The crepitus, also, is often difficult to detect, owing to the thickness of the muscular coverings, or to the amount of fat upon the body, or to the fracture having occurred perhaps directly underneath the mammae in the female. In three instances, where the presence of emphysema rendered the existence of a fracture quite certain, I have been unable immediately after the accident to discover crepitus.

The crepitus may be discovered sometimes by pressing gently upon the seat of fracture, or by applying the ear or the stethoscope over this point while the patient attempts a full inspiration, or coughs; or we may press upon the front of the chest with one hand, while the fingers of the other hand rest upon the fracture.

Occasionally the patient has felt the bone break, and very often he feels or hears the crepitus after it is broken, and will himself indicate very clearly the point of fracture.

At the same time that we detect crepitus we are able also to discover motion in the fragments, but I have once or twice discovered preternatural mobility without crepitus.

Emphysema, which is almost certainly indicative of a fracture, is present in a pretty large proportion of cases. It has been observed by me in 13 out of 32 cases; generally it did not extend over more than two or three square feet of surface; but in two cases it finally extended over nearly the whole body. It is remarkable, however, that in only four of these thirteen cases did the patients expectorate blood, and then in a very small quantity, and usually not until the second or third day.

Desault observes that emphysema rarely succeeds to fractures of the

ribs; an observation which, as will be seen, my experience does not confirm.

Treatment.—In simple fractures, where there is no displacement, or where the displacement is only moderate, the chest may be inclosed with a broad belt or band, as we have already directed in case of fracture of the sternum; provided always that it is not found to increase instead of diminishing the patient's sufferings. Some patients cannot tolerate this confinement at all; whilst, with a majority, although it is at first uncomfortable and oppressive, after an hour or two it affords great relief from the distressing pain, and they will not consent to have it removed even for a moment. In nearly all cases of comminuted fracture it is inadmissible, on account of its tendency to force the pieces inwards.

Hannay, of England, has suggested the use of adhesive strips as a substitute for the cotton or flannel band; the several successive pieces being imbricated upon each other until the whole chest is covered.¹ The same objection holds to this mode of dressing as to a similar mode of dressing a broken clavicle, which has been recently recommended. It will certainly become loosened after a few hours, by the slight but uninterrupted play of the ribs, and it is not as comfortable as a woollen or cotton band.

The forearm ought also to be brought across the chest at a right angle with the arm, and secured in this position with a moderately tight bandage or sling, so as to prevent any motion in the pectoral muscles.

As to position, the patient generally prefers to sit up, or he chooses a position only partly reclining upon his back; but there is no positive rule to be observed in this matter, except that such a position shall be chosen as shall prove most comfortable to the patient.

If the fragments are salient outwards, the fracture having been produced by a counter-stroke, they may be reduced by pressing gently upon them from without. If, on the contrary, the fragments are salient inwards, they will be found, in a great majority of cases, to have resumed their positions spontaneously or through the natural actions of respiration; but if they have not, it will be exceedingly difficult to restore them. Possibly it may be accomplished by pressing forcibly upon the front of the chest, or upon the anterior extremity of the broken rib; yet if the fragments are comminuted, and the ends are much driven in, this method will avail little or nothing. In such cases several surgeons have recommended that we should cut down to the bone and elevate the fragments, but Rossi alone claims to have actually put the suggestion into practice.

No doubt, if the necessity were urgent, this method might be successfully adopted; or, instead of cutting down to the broken rib, we might even seize the fragment with a hook, as suggested by Malgaigne, or what in some cases might be even more convenient, with a pair of forceps constructed with long teeth, obliquely set upon a firm shaft. Yet the exigency which will demand a resort to any of these measures will be exceedingly rare. In gunshot fractures, which are nearly all compound and comminuted, the loosened or detached fragments should be at once removed.

¹ Amer. Journ. Med. Sci., vol. xxxix. p. 198. From Lond. Med. Gaz., Nov. 1845

In no case do I attach any value or importance to the advice given by Petit, that we shall place a compress upon the front of the chest, underneath the bandage, in order to reduce the fragments, or to retain them in place after reduction. Lisfranc, who advocated this method, claimed that its advantage consisted in the increased length which was thus given to the antero-posterior diameter of the chest, and the consequent accumulation of pressure from the encircling band, in this direction.¹ The mechanical law is no doubt correctly stated, but its value in practice is too inconsiderable to deserve consideration.

The emphysema generally demands no special attention, since it is usually too limited to occasion inconvenience; and when more extensive, it generally disappears spontaneously after a few days, or a few weeks at most. The advice given by some surgeons, that we ought in these cases to cut down to the pleural cavity so as to allow the air to escape freely through the incision, seems thus far to have rested its reputation upon a more than doubtful theory rather than upon any testimony of experience. Abernethy alone, so far as I know, has actually made the experiment, and his patient died.

Dupuytren, in the two cases already alluded to, bled the patients and applied resolvent liquids, with rollers; he also made incisions with the lancet at various points of the body, more or less remote from the seat of fracture, a practice, however, in which he confesses he has no confidence whatever. These patients both died.

Dr. Stedman, of the Massachusetts General Hospital, has reported the case of a man aged sixty-nine, of intemperate habits, who, in addition to a fracture of one of his ribs, had also a dislocation of the outer end of the clavicle. The emphysema commenced immediately, and reached its acme on the twenty-second day. At this time it had extended over his whole body; his eyes were closed, and he breathed with great difficulty; but on the forty-fifth day the emphysema had entirely disappeared, and he was dismissed cured. The treatment consisted chiefly in the free internal use of stimulants, and in the application of bandages; but the bandages soon became disarranged, and after a few days they were entirely laid aside.²

In the case of one of my own patients, where the emphysema was almost equally extensive, the patient recovered after a few weeks, under the use of a simple diet, and without any special medication whatever. The second case of extensive emphysema observed by me was as follows: A man was crushed under a bank of earth Sept. 19, 1860. Two hours after the accident I found him greatly prostrated. Six ribs were broken on the left side near the spine, and one on the right side. In coughing he expectorated some blood. There was emphysema of the face and over the front of the chest. He died at 9 P. M., having survived the accident only about six hours. The autopsy showed the left lung penetrated at two points, and collapsed; about six ounces of blood in the left pleural cavity; lower lobe of right lung crushed and disorganized, but the remainder of the lung not collapsed. The features of the face were

¹ Ranking's Abstract, vol. ii. p. 204, from Gaz. des Hôpitaux, July 8, 1845.

² Stedman, Boston Med. and Surg. Journ., vol. lii. p. 316.

almost obliterated by the emphysema, which had also invaded the mediastinal space, and extended over the body as low as the knees.

§ 2. Fractures of the Cartilages of the Ribs.

Boyer was incorrect when he said that the cartilages of the ribs could not be broken until they were ossified. They are often broken when there is no ossification, at the same time that the ribs themselves are broken. Sometimes they are broken alone. Not unfrequently, also, the separation takes place at the precise point of junction between the cartilage and the bone. G. Puel infers, from experiments upon the cadaver, that the fracture would take place at this point most often.¹

Pyper relates a case in which the sternum was broken in a man aged twenty-five years, and also the cartilages of the sixth, seventh, and eighth ribs of the right side, as was proved by the autopsy, yet the cartilages were not ossified. The vena cava ascendens was also ruptured by the force of the compression.² The reader is referred also to my own and Dr. Watts's cases reported in the chapter on "Fractures of the Sternum." Since the date of the report of these cases I have met with several examples of fracture of the cartilages.

Etiology.—The causes are the same as those which produce fractures of the ribs, yet it is generally understood that it will require greater force, and that consequently the injury done to the viscera of the thorax will be more complicated and intense.

In the reports of the Massachusetts General Hospital an account is given of the case of a man aged thirty, who was crushed by the fall of a heavy weight upon his body, and who died after about sixty hours. An examination after death revealed a fracture of the cartilages of the third and fourth ribs, with a laceration of the intercostal muscles to such an extent that a hernia of the lungs had occurred at this point. This hernia had been discovered and recognized by Dr. Warren soon after the accident occurred; the protrusion being at that time as large as the clenched fist, and regularly rising and falling with each movement of respiration. It was accompanied, also, with a moderate emphysema.

Pathology.—The fracture is clean and vertical, or transverse; never irregular or oblique. The direction of the displacement varies as in fractures of the ribs, but the anterior or sternal fragment is generally found in front of the posterior or spinal.

Union takes place in these fractures, according to the testimony of most pathologists, not through the medium of cartilage, but of bone. Sometimes the new bone is deposited only between the ends of the fragments, in the form of a thin plate; at other times it is formed around the fragments as well as between them. The latter of these two processes has been most frequently observed. The ensheathing callus appears to be supplied by the perichondrium, whilst the experiments of Dr. Redfern render it probable that the intermediate callus may result from a conversion or transformation of the adjacent cartilaginous surfaces. Paget

¹ Puel, *Frac. des cart. cost.* Anvers, 1876.

² Ranking's Abstract, vol. i. p. 147, from the *Lancet*, Oct. 1844.

remarks, also, that the ossification extends to the parts of the cartilage immediately adjacent to the fracture.

According to Poinot, in 1869, H. Peyraud related in his thesis several experiments showing that, in animals, some portions of the costal cartilages nearly four centimetres long having been taken off, they may be entirely reproduced, if care has been taken to save the perichondrium, and a case has been published by Bassereau showing that in man the extremities of a broken cartilage may unite by fibro-cartilaginous tissue. In reference to the experiments of Peyraud, it must be said that we can make no positive inferences as to the process of repair in man from observations made upon other animals.

I have seen one example, in the person of Hiram Leech, æt. 38, which, after the expiration of more than one year, had not united. The fracture had occurred in the united cartilages of the ninth and tenth ribs. The posterior fragment overlapped the anterior, and they played freely upon each other at each act of inspiration and expiration.

I do not know that any observations have been made upon the repair of these cartilages in very early life, and it is possible that the process may differ from this, which has been described as it has been observed in the adult.

Treatment.—The treatment need not differ from that already recommended for fractured ribs.

CHAPTER XIX.

FRACTURES OF THE CLAVICLE.

FOR the sake of convenience, I shall divide fractures of the clavicle into those occurring through the inner, middle, and outer thirds. By the "outer third" is meant all that portion of the clavicle included between its scapular extremity and the internal margin of the conoid ligament. The remaining portion is intended to be divided equally into two separate halves. The peculiarities of these several portions, in respect to anatomical relations, liability to fracture, results, etc., will explain the propriety of the divisions.

Causes.—If we except gunshot fractures, the clavicle is broken, in a large majority of cases, by a counter-stroke, such as a fall, or a blow upon the extremity of the shoulder.

Occasionally it is broken by a direct stroke, as when a blow aimed at the head is received upon the shoulder; it is broken sometimes by the recoil of an overloaded gun, especially when the person lies upon the ground, with the butt of the gun resting against the clavicle.

Gibson has seen a case in which it was broken in a child at birth, by