

GENERAL TREATMENT.—In examples of simple, uncomplicated fracture, "silence, regimen, and a small bleeding" may suffice; but in other cases it may become necessary to introduce a tube into the stomach, to supply the patient with food and drink, since deglutition may be impossible. If, also, suffocation is imminent, there may remain no alternative but a resort to tracheotomy. Indeed this operation ought, we think to be resorted to in all cases in which emphysema is prominent, or in which respiration is interfered with seriously. Dr. William Hunt, of the Pennsylvania Hospital, in his excellent paper on "Fractures of the Larynx and Ruptures of the Trachea," in which he has arranged a tabular synopsis of twenty-nine cases, says that of seventy-seven cases ten recovered and seventeen died. Of eight cases in which tracheotomy was performed, but two died. In the four cases in which recovery took place without an operation, no mention is made of bloody expectoration or of emphysema.¹

As to a "reduction" of the fragments by manipulation, I believe it will be found generally, if not always, impracticable. Whatever displacement exists must be mostly inwards, and we can have no means of forcing them again outwards. Nor, if once replaced, do I see any reason to suppose that they would not become immediately displaced.

Chelius has suggested the propriety, in such cases, of cutting open the coverings of the larynx freely in the median line, and, after stanching the bleeding, proceeding at once to divide the larynx itself in its whole length, and then replacing the broken cartilages.² The procedure has an aspect of severity, but I can well conceive of circumstances which would justify its adoption; not, however, so much for the purpose of replacing the cartilages, as for the purpose of arresting a fatal internal hæmorrhage, and of giving a free admission of air to the lungs. If this operation were to be practised, the wound ought to be left open for a sufficient length of time to allow of the subsidence of the inflammation, and then permitted to close with such precautions as experience teaches are usually necessary after the windpipe has been opened.

Antiphlogistic measures, combined with fomentations to the neck, so far as these latter are found to be agreeable and practicable, are important measures, and not to be overlooked in the general plan of treatment.

My own patient, also, found small pieces of ice, permitted slowly to dissolve in the mouth, very grateful; but he preferred very much, as an external application, the warm fomentations to the cold lotions.

NOTE.—Additional references: Fractures of the Larynx. Gurli, *der Knochen*, vol. 2. Helwig, *Casper's Viertelj.*, 1861, p. 342. Witte, *Archiv für Klin. chir.* Langenbeck, Bd. 21, S. 494-7, 503. Fischer, *Krico-Brf.*, 1 Theil Hets., S. 113. Neudorfer, *Hand-b. der Kniegs*, 2 Hefte, 2 Heft, S. 419. Hénoque, *Gaz. Hebdom.*, Sept. 25 and Oct. 2, 1868. Frodet, *Sur. Frae. du Larynx*, 1868. *Gaz. des Hôp.*, 1868, Nos. 90 and 91. Chailloux, *Thèse de Paris*, 1873. Wales, *Am. Journ. Med. Sci.*, Jan. 1861. Hamilton, *Ibid.*, April, 1867. O'Brian, *Ed. Med. and Surg. Journ.*, v. 18. *Bul. Soc. Anat.*, Dec. 1866. Keiller, *Edin. Med. Journ.*, 1856, pp. 527, 824. *Dublin Quart.*, May, 1860. *Lancet*, 1869, p. 707.

¹ Hunt, *Amer. Journ. Med. Sci.*, April, 1866.

² *System of Surgery*, Philadelphia ed., vol. i. p. 581, 1847.

CHAPTER XVI.

FRACTURES OF THE VERTEBRÆ.

It will be convenient to divide fractures of the vertebræ into fractures of the spinous processes, transverse processes, vertebral arches, and bodies.

§ 1. Fractures of the Spinous Processes.

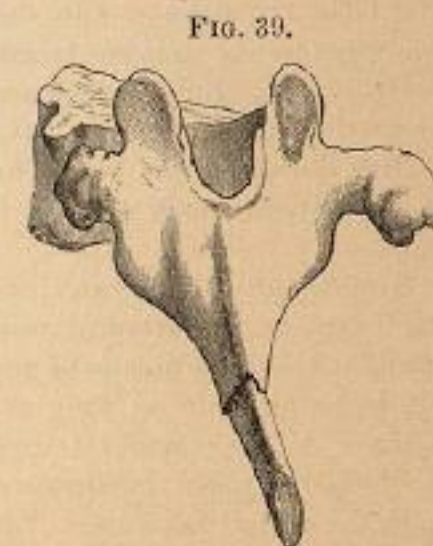
Fractures of the spinous apophyses, independent of a fracture of the arches, may occur at any point of the vertebral column; and they may be occasioned by a blow received upon either side of the spinal column; or by a force directed from above or from below.

Symptoms and Pathology.—These accidents may be recognized by the lively pain at the point of fracture, produced especially when the patient bends forwards, which position renders the skin and muscles tense and drives the fragments into the flesh; by the swelling, tenderness, and discoloration; but chiefly by the lateral displacement of the broken process, and the mobility.

Duverney met with a fracture of two of the processes in the same person, and which could only be recognized by the mobility, since, as the autopsy proved, there was no displacement. Nor would it be surprising if the displacement was absent in a majority of these accidents, inasmuch as the attachment of the ligaments from above and below with the strong and short muscles upon either side, must prevent a deviation in any direction until these tissues are more or less torn. Sir Astley Cooper mentions a case in which, however, such lacerations did occur, and the lateral deformity was quite conspicuous.

A boy had been endeavoring to support a heavy weight upon his shoulders, when he fell, bent double. Immediately he had the appearance of one suffering under a distortion of the spine of long standing. Three or four of the processes were broken off, and the corresponding muscles were detached so as to allow the processes to fall off to the opposite side. There was no paralysis, and he was soon discharged with the free use of his limbs, but the deformity remained.¹

¹ Sir Astley Cooper, *op. cit.*, p. 459.



Fracture of the spinous process.

If the fragment is thrown directly downwards, as it possibly may be, especially in the cervical or lumbar region, yet not without a rupture of the supraspinous ligaments, or of the ligamentum nuchæ, then the displacement will be more difficult to detect, and it may require some more care not to confound it with a fracture of the vertebral arch or of the plates from which the spinous processes arise. The process not being felt in its natural position, nor upon either side, it may seem to have been forced directly forwards, when, in fact, it is only thrown downwards towards its fellow. The danger of error in the diagnosis will be increased when to these conditions is added paralysis of those portions of the body which are below the seat of the fracture, and which, in this case, may be the result of an extravasation of blood or of simply a concussion of the spinal marrow. Nor do I think it would be possible now to determine positively whether it was simply a fracture of a spinous process, of the arch, or of the body itself of the vertebra. In case, however, the paralysis results from concussion, the fact will in most cases soon become apparent by a return of sensation and of the power of motion.

Prognosis.—Hippocrates affirmed that here, as in fractures of other spongy bones, the union took place speedily. It is quite probable that this venerable father of surgery has stated the fact correctly, and yet in the only example known to me where the condition of this process, as proved by dissection, has been carefully stated, the fragment had not united by bone at all. This is the case related by Sir Astley Cooper as having been examined by Mr. Key. A subject was brought into the dissecting-room, in which one of the processes had been broken, and, on dissection, a complete articulation was found between the broken surfaces, which surfaces had become covered with a thin layer of cartilage. The false articulation was surrounded with synovial membrane and capsular ligaments, and contained a fluid like synovia.¹

Ordinarily the displacement continues, whatever treatment may be adopted; but Malgaigne says he has seen one instance in which the twelfth dorsal spine, being broken and displaced laterally, resumed its place spontaneously after a few days. Aurran mentions a similar example.²

Treatment.—If in any case it should be found possible to act upon the fragment, an attempt might be made to press it into place, and to retain it there by means of a compress and bandage; but even this would not be admissible so long as any doubt remained whether it was not a fracture of the vertebral arch, since, if it were, any attempt to restore the bone to place by pressure would be likely to drive it more deeply upon the spinal marrow. Yet what need is there of surgical interference of any kind? If the apophysis remains displaced, it cannot result in any serious, perhaps we may say in any appreciable deformity. The surgeon has therefore only to lay the patient quietly in bed, and in such a position as he finds most comfortable, enjoining upon him perfect rest, and employing such other means as may be proper to combat inflammation.

¹ Sir Astley Cooper, *op. cit.*, p. 459.

² Malgaigne, *op. cit.*, p. 412.

§ 2. Fractures of the Transverse Process.

A fracture of a transverse process can scarcely occur except as a consequence of a gunshot wound. Dupuytren relates a case of this kind in which the ball had penetrated the transverse process of the second cervical vertebra. The man bled very little at the time, and his symptoms progressed favorably for ten days; after which, secondary hæmorrhage occurred, of which he ultimately died. The autopsy showed that the vertebral artery had been injured, and that the inflammation of its coats being followed by a slough, caused his death.¹

I have also elsewhere reported the case of Charles Harkner, of Buffalo, N. Y., who was shot with a pistol on the 21st of January, 1851. I did not see him until the following day. The ball had entered the chin, a little to the left side and below the inferior maxilla, but its place of lodgement could not be discovered. He lay with his face constantly turned to the right. The left side of his neck was swollen and crepitant; the left arm and leg were paralyzed; he slept most of the time, but could be easily aroused, and when aroused he seemed to be conscious, but was unable to speak. By signs he indicated to us that he was suffering no pain. He gradually sank, without hæmorrhage, and died in thirty-six hours from the time of the receipt of the injury.

The autopsy, made four hours after death, enabled us to trace the wound from the chin, through the left ala of the thyroid cartilage, and also through the roots of the transverse process of the fourth cervical vertebra; immediately behind which, lying imbedded in the muscles, was the bullet. The cavity of the tunica arachnoïdes contained considerable serous effusion.

The emphysema in the neck was occasioned, no doubt, by the wound of the larynx, the ball having opened freely into its cavity. This circumstance also explained the aphonia; but the immediate cause of his death seems to have been arachnoid effusion as a result of meningeal inflammation.

The symptoms arising from this accident can only refer to the complications, since a mere fracture of the process is not likely to present any peculiar signs which could be recognized. Concussion or bloody effusion may take place so as to occasion more or less paralysis, or, at a later period, inflammation and its consequent effusions may give rise to the same phenomenon.

In itself considered, and independent of these complications, it is sufficiently trivial, but inasmuch as it has not been known to occur except from gunshot wounds, nor is it likely to occur except from penetrating wounds of some kind, the accident must always be regarded as exceedingly grave, if not actually fatal.

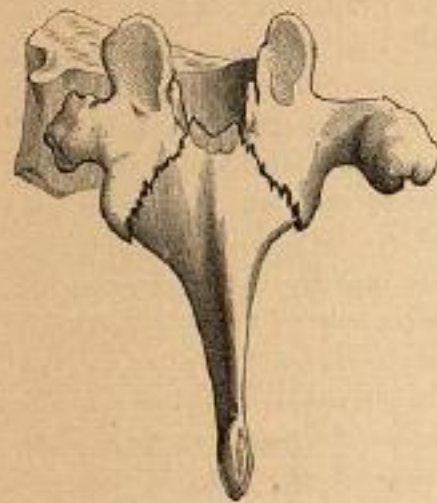
As to the treatment, nothing but strict rest and antiphlogistic remedies can prove of any service.

¹ Dupuytren, *Diseases, etc., of Bones*, Syd. ed., p. 360.

§ 3. Fractures of the Vertebral Arches.

The vertebral arches, upon which both the spinous and transverse processes have their principal support, may be broken at any point of their circumference, by a blow received upon the spinous process; but generally it is the lamellar portion, or the "vertebral plate" which gives way rather than the neck or pedicle of the arch; and in nearly all of the cases recorded the plates have been broken upon both sides. The only exception to this rule, of which the author is informed, is the specimen

FIG. 40.



Fracture of the vertebral arch.

said to be in the museum of Val-de-Grace, and mentioned by M. Lequest.¹

On the first of May, 1851, during a violent storm of wind and rain, a balustrade fell from the top of a high building, striking a man named John Larkin, who was about forty years of age, upon the back of his head and neck. He fell to the ground instantly, and did not again move his feet or legs, although he never lost his consciousness until he died. I found the bladder paralyzed also, and his left arm, but his right arm he could move pretty well. He conversed freely up to the last moment, and said that he was suffering a good deal of pain, which was always greatly aggravated by moving. His death

took place thirty-six hours after the receipt of the injury.

Dr. Hugh B. Vandeventer, who was the attending surgeon, made a dissection on the following day in my presence, which disclosed the fact that the plates of the sixth cervical vertebra were broken upon each side, and that the spinous process, with a small portion of the arch attached, was forced in upon the spinal marrow. There was no blood effused or serum at this point, but about one ounce of serum was found in the cavity of the tunica arachnoides at the base of the brain. The bodies of the vertebrae were not broken. It was our opinion, therefore, that the immediate cause of his death was the direct pressure of the spinous process.

In the case related by Prout, of Alabama, the man having died within forty-eight hours after the receipt of the injury, the arch of the fifth cervical vertebra was found to be broken in three places, and the spinous process was driven in upon the spinal marrow. There was a slight effusion of blood between the sheath of the spinal marrow and the bone, and a considerable effusion between the sheath and the cord. There was no material lesion of the cord or of its membranes, and the body of the bone was neither broken nor dislocated.²

It is probable, also, that in the following example the arch was broken,

¹ M. Lequest, Dic. Encyc., 3d Series, vol. i. p. 446.

² Prout, Amer. Journ. Med. Sci., Nov. 1837, vol. xxi. p. 276, from Western Journ. of Med. and Phys. Sci.

but that the force of the blow having been somewhat oblique, the process was but little if at all thrown in upon the spinal marrow.

R. L., of Erie County, N. Y., aged about forty years, was thrown from a loaded wagon in February of 1851, striking, as he thinks, upon the back of his neck. He was stunned by the injury, and remained insensible several hours; on the return of consciousness, he found that his lower extremities and bladder were paralyzed. During four weeks his bladder had to be emptied by a catheter. Nine months after the injury was received he consulted me, and I found the spinous process of the last cervical vertebra pushed over to the left side. His head was strongly bent forwards, and he was unable to straighten it. He could walk a few steps, but not without great fatigue; and he suffered almost constant pain in his lower extremities, accompanied with excessive restlessness and watchfulness, for which he was obliged to take morphine in large quantities.

In the case related by Alban G. Smith, of Kentucky, to which I shall refer again presently, the deviation was lateral, and so also in Ollivier's case, mentioned by Malgaigne.

Symptoms.—We can imagine a case of fracture of the vertebral arch, with a lateral displacement only, in which the symptoms might not differ essentially from a simple fracture of the spinous process; and it is quite possible that some of the cases which have been supposed to be examples of this latter accident, and in which a speedy recovery has taken place, were really examples of fractures of the arches; yet it must be admitted that such a fortunate result is only possible, since the arches can hardly be broken without communicating a severe concussion to the marrow, nor without lacerations, inflammation, and effusions, which will be most certain to produce compression and paralysis, and probably death.

If, however, it is possible for us to confound a fracture of the process with a fracture of the arches, it is still more possible to confound a fracture of the arches with a fracture of the bodies of the vertebrae. If, as is usually the fact, the process, in case of a fracture of the arch, is less prominent than natural, and that portion of the body receiving its nervous supply from below this point is paralyzed, we may have reasons to believe that the arch is broken and the process is driven in upon the spine; but dissections have shown that in many of these cases, or in most of them, indeed, the bodies of one or more of the vertebrae are broken also, and in still other cases the bodies alone were broken.

If, as in the case mentioned by Ollivier, we can feel the plates move separately, the diagnosis might be made out, so far at least as to determine that the plates were broken; but we would be still unable to say that the bodies of the vertebrae were not broken also.

Something, perhaps, may be inferred from the direction and manner of the blow which has produced the fracture. Thus, a fall upon the top of the head, the feet, or the nates, would most often produce a comminution of the bodies by crushing them together, whilst a blow upon the back could scarcely break one of the vertebrae without breaking the corresponding arch also. We might thus be led to infer, in the first instance, that the arches were not broken; and, in the second instance, if we could

convince ourselves that the arches were not broken, we might rest pretty well assured that the bodies were not.

In the case related by Prout, there was no external mark of injury over the point of fracture, but a distinct crepitus was perceptible on pressure.

Treatment.—If the fragments are not displaced, nothing but rest and a cooling regimen are indicated; but if they are forced in upon the marrow, an important question is presented, and which has received from different surgeons different solutions. Shall an effort be made to reduce the fragments? and, if so, by what means shall the indication be attempted?

It will be remembered that in nearly all of these cases we must remain in doubt, even after the most careful examination, as to the actual condition of the fracture. It may be that what we suppose to be a fracture of the arch is only a fracture of the apophysis, or that, on the other hand, it is a fracture of the body of the bone itself; and if we are expert enough to make out clearly a fracture of the arch, it is not possible for us to say that the body is not broken also, indeed it is quite probable that it is broken. With a diagnosis so uncertain, can we ever find a justification for surgical interference? Mr. Cline and Mr. Cooper thought that we might. According to them, the case presents in no other direction a point of hope or encouragement. Death is inevitable, sooner or later, if the fragment is not lifted, and we can scarcely make the matter any worse by interference. If it proves to be a fracture of the apophysis, as happened to be the case in a patient upon whom Sir Astley operated,¹ our interference was unnecessary, but it has done no harm. If the body of the bone is broken, the operation affords no resources, but the patient is probably beyond suffering damage at our hands. If the diagnosis is correctly made out and the arch only is broken, and if, as was the fact in the case of Larkin already mentioned, there is no bloody effusion, or laceration of the membranes or of the marrow, and if the concussion was not sufficient to determine much inflammation of the cord, then it would seem possible that an operation might save the patient.

Paulus Ægineta first suggested that the compressing fragments ought to be removed by excision; and in 1762 Louis removed from a man who had received a gunshot wound in his back, after the lapse of five days, several loose pieces of bone belonging to the arch of the vertebra, and the patient recovered, but not without a partial paralysis of his lower extremities. Of course, nothing could be more rational or simple than this procedure, adopted by Louis, in any case of an open wound, where the fragments could be easily reached; but the younger Cline was the first, in the year 1814, to put into practice the more ancient suggestion of Paulus Ægineta, namely, to attempt the removal of the fragments in a case of simple fracture. He made an incision upon the depressed bones as the patient was lying upon his face, raised the muscles covering the spinal arch, removing, by means of a circular saw, chisel, mallet, trephine, etc., the spinous processes of the eleventh and twelfth dorsal vertebrae, and the arch of one of the vertebrae. The patient was in no

¹ Chelius's Surgery, Amer. ed., note by South, vol. i. p. 592.

manner relieved, and died on the fourth day after the receipt of the injury and the third after the operation.¹ Mr. Oldknow repeated this operation in 1819 in a case of fracture of the arch of the seventh vertebra. The patient died on the sixth day.² In 1822, Mr. Tyrrell operated at St. Thomas's Hospital on a man who had been injured four days previously, removing the spinous processes of the twelfth dorsal and first lumbar vertebrae. The operation was accomplished with considerable difficulty, and resulted in only a partial return of sensibility. He died on the thirteenth day after the operation.³ In 1827, Tyrrell operated a second time, and death resulted on the eighth day.⁴ On the 30th of August, 1824; Dr. J. Rhea Barton, of Philadelphia, operated upon a man who had been received into the Pennsylvania Hospital twelve days before, with a fracture of the arch of the seventh dorsal vertebra. On the third day he was attacked with a violent chill, and death took place twelve hours after. The dissection showed about half a gallon of blood in the posterior mediastinum, and bloody effusion existed along the whole length of the spinal canal.⁵ The patient whom Laugier trephined at the base of the spinous process of the ninth dorsal vertebra, died on the fourth day.⁶ The operation has been repeated unsuccessfully by Wickham, Attenburrow, Holcher, Heine, and Roux.⁷

February 5, 1834, Dr. David L. Rogers, of New York, operated upon a man who had fallen two days before, breaking the arch of the first lumbar vertebra, and forcing the spinous process upon the cord. This man died on the eighth day.⁸

In 1854 Dr. Blackman, of Cincinnati, operated, his patient dying on the fourth day. During the same year, also, Dr. B. removed a portion of the sacrum for an injury of four years' standing, with no benefit.⁹ In 1858 Dr. Stephen Smith, of Bellevue, removed the arch of the tenth dorsal vertebra, death occurring soon after.¹⁰ December 29, 1857, ten days after the receipt of the injury, Dr. J. C. Hutchison, of Brooklyn, operated upon a man at the City Hospital, Brooklyn, removing the spinous processes of the eighth, ninth, and tenth dorsal vertebrae, with the posterior arch of the latter. The patient survived the operation ten days.¹¹ Ballingall says Dr. Blair is reported in the Essays of Dr. Monro, Secundus, as having operated successfully, but no particulars are given by Ballingall.¹²

Dr. H. A. Potter, of Geneva, N. Y., informs us that he has operated three times. In the first case he states that he removed the posterior portion of the three lower cervical vertebrae. The patient died on the

¹ Cline, Chelius's Surgery, Amer. ed., vol. i. p. 590.

² Oldknow, Sir A. Cooper on Disloc. and Frac., Amer. ed., 1851, p. 479.

³ Sir A. Cooper's Lectures, by Tyrrell, 3d Amer. ed., 1831, vol. ii. p. 17.

⁴ Tyrrell, Med.-Chir. Rev., vol. x. p. 601.

⁵ Barton, Goodman's ed. of Sir A. Cooper on Disloc., etc., p. 421.

⁶ Malgaigne, Amer. ed., p. 341.

⁷ Chelius's Surgery, Amer. ed., vol. i. p. 590. Also, Velpeau's Op. Surgery, 1st Amer. ed., vol. ii. p. 737.

⁸ Rogers, Amer. Journ. Med. Sci., May, 1835.

⁹ Velpeau's Surgery, Blackman's ed., vol. ii. p. 392.

¹⁰ Smith, New York Journ. Med., 1859, p. 87.

¹¹ Hutchison, Trans. N. Y. Med. Soc., 1861, p. 93.

¹² Blair, Ballingall's Military Surg., 5th Edinburgh ed., p. 321.

fourth day. In the second case the doctor removed the spinous processes of the fifth and sixth cervical vertebræ, and the entire posterior arch of the fifth. The sheath was not broken, "but the cord was much injured." There was almost complete paralysis of the extremities, and this condition was not remedied by the operation. Three years later, the patient being still alive, but only a very slight improvement having taken place, Dr. Potter "removed the fourth, sixth, and seventh cervical vertebræ." (We presume he intends to say the "posterior arches.") At the time of the report, January, 1863, there was no further improvement. Finally the doctor reports a completely successful case. The injury was of "five months' standing."¹ Packard says, in a note to his translation of Malgaigne, that Dr. Potter operated on a case of three months' standing, and the patient died on the eighteenth day. I suppose this to be the same case. Lucke operated on the eleventh dorsal vertebra, and the patient died three months later.

In 1867 M. Denucé, of Bordeaux, operated, the day following the accident, upon a man aged twenty-four years, who had a fracture of the last dorsal arch. The arches of the last dorsal and first lumbar were elevated. The spinal marrow did not appear to be contused, although he had complete paralysis of the lower extremities. The man died two days later.²

These are all of the cases of which the author has any information in which this operation had been made, and they have all, excepting the two cases reported by Potter and the one by Blair, terminated fatally in a very short time. The case reported by Alban G. Smith, of Kentucky, is not related in such a manner as to enable us to make use of it safely, nor is it stated how long the patient survived the operation; Gibson says it gave no permanent relief. The example mentioned by an English writer is equally unreliable, inasmuch as it is given only upon rumor, and but a "few months" had elapsed since the operation was performed. It was said to have been made in the year 1838, by a surgeon of the name of Edwards, in South Wales; and it was affirmed that the compression was relieved and that the patient "did well."³ So unique a case would certainly have found before this an ample confirmation. Indeed, I must say that none of the cases reported as successful give any evidence of authenticity.

Experience, then, seems to have shown that we have little or nothing to expect from this surgical expedient; and, notwithstanding the strong hope expressed by Sir Astley Cooper that Mr. Cline's operation might hereafter prove a valuable resource, and contrary to the conclusions which I in common with many other surgeons had drawn from the anatomical relations of these parts, I am compelled reluctantly to declare that the expedient is scarcely worthy of a trial. To the same conclusion, also, many of the most distinguished surgeons have arrived, among whom we may mention, as especially entitled to confidence, Brodie, Liston, Alexander Shaw, Malgaigne, and Gibson.

"Chédevergne, after analyzing the previous papers of MacDonnel and of Félizet, has collected 25 cases of trephining of the spine, which give

¹ Amer. Med. Times, Jan. 10, 1863.

² Lucke, Denucé, French ed. of this treatise, p. 167. Poinot.

³ Edwards, British and Foreign Med. Rev., 1838, p. 162.

the following results: 12 operations performed in the dorso-lumbar region show 10 deaths, 1 cure, and 1 unknown result; out of 13 operations performed in the cervical region, there were 9 deaths and 4 recoveries; making a total of 25 operations, with 19 deaths and 5 recoveries. This ratio of successful cases, as Chédevergne says, might possibly be smaller than that furnished when the cases are left to themselves."¹

What more can be said of the attempt to raise the depressed bone by seizing the spinous process with the fingers, or with a pair of strong hooked forceps passed through the skin, or finally, if this cannot be done, by laying bare both sides of the process and seizing upon it with a pair of firm tenacula? This is the alternative presented to Malgaigne, and which he ventures to recommend as deserving a trial. In the absence, however, of any testimony in its favor, beyond the mere rational argument adduced by this distinguished writer, we must waive any further consideration of the subject; only expressing our conviction that it will be found, after a fair trial, as useless and as inexpedient as the more severe operations of Cline.

Jeffries Wyman, of Boston, has met with eleven specimens of old united fractures of the vertebral arches occurring in the fourth or fifth lumbar vertebræ between the lower articulating and the transverse processes. He has also met with the same fracture once in the third lumbar vertebra. The frequency of this peculiar form of fracture in this region, Dr. Wyman ascribes to the fact that the upper and lower articulating processes are widely separated from each other, and connected only by a narrow neck, in which respect they contrast very strongly with the dorsal vertebræ; and he supposes that the fractures may be caused by either a forcible bending of the body backwards, or by the shock resulting from a fall from a height in which the force of the concussion is conveyed downwards through the pelvis. In no case has the existence of this fracture been recognized during life, nor is it probable that its occurrence would cause any marked symptoms unless it had been caused by a blow directly from behind.²

As to the therapeutical treatment of the various symptoms belonging to these accidents, and in relation to the prognosis, the remarks which we shall make will be found equally applicable to fractures of the bodies of the vertebræ, and we shall reserve the consideration of these topics for the following section.

§ 4. Fractures of the Bodies of the Vertebræ.

The same causes which produce fractures of the arches may produce also fractures of the bodies of the vertebræ, that is, blows received directly upon the extremities of the spinous processes; but in these cases the arches are generally broken at the same time.

In other cases the bodies of the vertebræ are broken by falls upon the top of the head, by which the vertebræ are not only driven forcibly together, but often doubled forwards upon each other; or the patient may have alighted upon his feet or upon his sacrum.

¹ Chédevergne, Poinot, op. cit., p. 167.

² Wyman, Boston Med. and Surg. Journ., Aug. 12, 1863.

Reveillon has reported a case of fracture of the fifth cervical vertebra from muscular action, which occurred in diving. The man was taken out of the water unconscious, and died in a few hours, having declared before death that his head did not strike the bottom, although he had jumped from a height of seven or eight feet, and the water was only three feet deep.¹ The statement of the sufferer, under such circumstances, could not really possess much value, and we think we see good reason to suppose that he was mistaken. South also relates a case of fracture of the fourth and fifth cervical vertebræ occasioned by diving, in which it was supposed that the fracture was caused by the concussion of the head upon the water.²

Malgaigne says the spine bends at three principal points; comprised, the first between the third and seventh cervical vertebræ, the second between the eleventh dorsal and second lumbar, the third between the fourth lumbar and the sacrum; and that a majority of the fractures of the vertebræ occur at these points of flexion. He makes an argument from this also that these fractures "are generally the result of counter-strokes, as the effect of forcible flexion of the column either forwards or backwards." Malgaigne observes, moreover, that dislocations follow the same rule.

M. Chédevergne thinks that indirect fractures are much more frequent than direct, and he makes of these two varieties, namely, those caused by tearing and those caused by crushing, the former being the result of forced flexion forwards or backwards, the lesion being usually at the twelfth dorsal or first lumbar. By experiment on the cadaver, M. Chédevergne has determined that in flexion forwards the apophysis of the twelfth dorsal vertebra is broken off, the great supraspinous ligament torn, and finally the body of the vertebra is separated into two parts, of which the superior is the smallest. In flexion backwards the primary lesion takes place in front.³

The direction of the line of fracture varies greatly in the different examples which we have seen; some are crushed, and more or less comminuted. In some cases a narrow piece is chipped from the margin, others are broken transversely, and others obliquely. In oblique fractures the line of the fracture is generally from behind forwards, and from above downwards. Malgaigne thinks that a crushing or comminution can only occur from a forcible flexion forwards; but I have seen at least one example in which this was not the fact; the patient having fallen so as to strike with the back of his neck upon an iron bar. This was the case of the sailor, to which I shall again refer more particularly.

The upper fragment is almost always that which suffers displacement; sometimes being simply driven downwards, and thus made to penetrate more or less the lower fragment; at other times, as in certain transverse fractures, it is only displaced forwards, and in still other examples, where the fracture is oblique, the upper fragment is displaced both downwards and forwards.

¹ Reveillon, *Chelius's Surg.*, note by South, vol. i. p. 584.

² South, *ibid.*, p. 588.

³ Chédevergne, *Mem. de l'Acad. de Méd., Paris*, 1869-70, tom. 29, p. 73.

In the first and last of these examples the spine becomes bent forwards at the point of fracture, producing an angle of which the most salient point posteriorly is represented by the extremity of the spinous process belonging to the broken vertebra; in the second example the spinous process of the broken vertebra is depressed, and the process of the vertebra next below is relatively prominent.

In a pretty large proportion of cases also the fracture of the body of the vertebra is complicated, as we have already stated, with a fracture of the arches, in some instances with a fracture of the oblique processes, and with a dislocation.

Symptoms.—Severe pain at the seat of fracture, felt especially when the part is touched or the body is moved, tenderness, swelling, ecchymosis, occasionally crepitus, a slight angular distortion of the spine, or simply a trifling irregularity in the position of the processes, and paralysis of all the parts whose nerves take their origin below the fracture, are the usual signs of the accident.

The paralysis may be due to the mere pressure of the displaced fragments, but it is much more often due to a severe and irreparable lesion of the cord itself. I have, in one instance, seen the cord almost completely separated at the point of fracture, although the displacement of the fragments was inconsiderable.

Accompanying the paralysis of the bladder, there has been generally observed an alkaline state of the urine, and subacute inflammation of the coats of the bladder. Priapism is present in a certain proportion of cases.

Those who die immediately seem to be asphyxiated; while those who die later wear out from general irritation, this condition being frequently accompanied with an obstinate diarrhœa and vomiting. A few become comatose before death.

It will be seen, moreover, that a certain proportion finally recover; but scarcely ever are all the functions of the limbs and of the body completely restored.

We shall render this part of our description of these accidents more intelligible if we regard them as they occur in the various portions of the spinal column, since the symptoms, prognosis, and treatment have reference mainly to the point at which the fracture has occurred.

1. *Fractures of the Bodies of the Lumbar Vertebræ.*

The spinal cord terminates, in the adult, at the lower border of the first lumbar vertebra, but in the child at birth it extends as low as the third lumbar vertebra. The remainder of the vertebral canal is occupied by the leash of terminal nerves, called collectively the cauda equina.

The nerves which emerge from the intervertebral foramina below the fourth and fifth lumbar vertebræ, unite with the sacral nerves to form a

FIG. 41.



Oblique fracture of the body of a vertebra.

plexus which supplies the sphincter and levator ani, the perineal muscles, the detrusor and accelerator urinæ, the urethra, the glans penis, and a great proportion of the lower extremities. It will be apparent, therefore, that a fracture, with displacement, of even the last vertebra of the column, involves the possibility of more or less paralysis of all those parts supplied by this plexus, and that in proportion as the fracture is higher in the vertebral column, will the probability of additional complications be increased. In other words, in addition to the more or less complete loss of function in the organs supplied by the ilio-sacral plexus, there will probably be associated loss of function in other organs, supplied from sources above this point of the vertebral canal.

A fracture, however, of the bodies of the fourth or fifth lumbar vertebra, produced by a direct blow, is exceedingly rare, owing to the protection which it receives from the alæ of the pelvis.

Dr. Alexander Shaw has reported four cases of fracture below the second lumbar vertebra, which were unaccompanied with any degree of paralysis, and which were followed by speedy recovery,¹ a circumstance which he ascribes to the fact that the cauda equina is composed of nerves possessing considerable firmness, and suspended loosely together; for this reason they escape pressure by slipping among themselves, and suffer less injury from the same amount of compression than the medulla spinalis.

FIG. 42.



Key's case of fracture of the first lumbar vertebra.

In the two following cases the results were less fortunate, yet recoveries seem to have taken place.

A boy was admitted into St. George's Hospital, in September, 1827, with a fracture and considerable displacement of the third and fourth lumbar vertebrae, the displacement being sufficient to cause a manifest alteration in the figure of his spine. His lower limbs were paralyzed. An attempt was made to restore the displaced vertebrae, but it was attended with only partial success. At the end of a month he had slight involuntary motions of the lower extremities, and at the same time he began to recover the power of using them voluntarily. Three or four months

after the receipt of the injury he left the hospital, and the history of his case was interrupted at this date.²

Dr. Thompson, of Goshen, N. Y., reports also a fracture of either the third or fourth lumbar vertebra, followed by recovery. The patient fell from the roof of a house, striking first upon his feet and then upon his buttocks. This occurred in October, 1853. The usual signs of a fracture were present, such as paralysis, etc. A bed sore formed above the top of the sacrum, and a piece of bone exfoliated, which seemed to belong to the last lumbar vertebra. He was confined to his bed seven months.

¹ Shaw, London Med. Gaz., vol. xvii.

² Brodie, Sir Ast. Cooper on Disloc., op. cit., p. 471.

After eighteen months he began to use crutches. At the end of about three years all improvement ceased, at which time he could not quite stand alone; yet, with the aid of apparatus, he was able to get about the country and vend books, prints, etc. This was also his condition one year later.¹

A patient in Guy's Hospital, under Mr. Key, with a fracture of the first lumbar vertebra, lived one year and two days. On examination after death, it was ascertained that bony union had occurred between the fragments, and that the spinal marrow was completely separated at the point of fracture.²

Mr. Harrold relates a case of fracture of the first and second lumbar vertebrae, in which the patient survived the accident one year, lacking nine days; death having resulted finally from a sore on the tuberosity of the ischium and disease of the bone. After death it was ascertained that the fracture had united by bone, and that the spinal marrow was almost completely cut in two, the divided extremities being enlarged and separated nearly an inch from each other.³

2. Fractures of the Bodies of the Dorsal Vertebrae.

In these examples the same organs are paralyzed as in the fractures lower down, in addition to which there is generally considerable disturbance of the functions of respiration, irregular action of the heart, indigestion, accompanied with a tympanitic state of the bowels.

Dupuytren, who reports several examples of fractures of the dorsal vertebrae, has not taken the pains to record the length of time they survived the accident except in two instances, both of which were fractures of the eleventh vertebra. One died of suffocation on the tenth day, and the other on the thirty-second. In Sir Astley Cooper's cases, mention is made of a fracture of the twelfth dorsal vertebra, which the patient survived fifty-two days, one of the tenth dorsal, which terminated fatally in six days, and another of the ninth dorsal, which did not result in death until after nine weeks.

In 1853 Dr. Parkman presented to the Boston Society for Medical Improvement a specimen of fracture of the fifth dorsal vertebra, the bodies of the third and fourth being also displaced forwards, in which position they had become firmly ossified. The spinal cord had been completely separated, yet the patient survived the accident two months.⁴

Dupuytren has related also two examples of fractures, one of the tenth and the other of the last dorsal vertebra, from which the patients completely recovered after from two to four months' confinement.⁵ A similar case is related by Lente, of New York. Barney McGuire, having fallen a distance of twelve or fifteen feet upon his back, was found with nearly complete paralysis of his lower extremities and of his bladder. Swelling existed over the lower dorsal vertebrae, and this point was very tender.

¹ Thompson, Amer. Journ. Med. Sci., Oct. 1857. Lente's paper.

² Key, A. Cooper on Disloc., etc., op. cit., p. 467.

³ Harrold, A. Cooper, op. cit., p. 464.

⁴ Parkman, New York Journ. Med., March, 1853, p. 286.

⁵ Dupuytren, op. cit., pp. 356-7.

Subsequently, when the swelling subsided, the prominence of the spinous processes of the tenth and eleventh dorsal vertebræ put the question of a fracture beyond doubt. Gradually, under the use of cups, strychnia, mineral acids, laxatives, buchu, and electricity, his symptoms improved. In six months he was able to walk about the streets, and four years after the accident he was employed in a foundry under regular wages, being able to stand fifteen or twenty minutes at a time, and to walk half a mile without resting. At this time there remained no tenderness in the spine, but the projection of the process was the same as at first.¹

3. *Fractures of the Bodies of the five lower Cervical Vertebræ.*

We shall now have added to the symptoms already enumerated, paralysis of the upper extremities, greater embarrassment of the respiration with diminished action of the heart, and more complete loss of sensation and volition in the lower part of the body. In general, also, the eyes and face look congested, owing to the imperfect arterialization of the blood, and death is more speedy and inevitable than in examples of fracture occurring lower down.

In ten recorded examples of fractures of the five lower cervical vertebræ which I have been able to collect, one died within twenty-four hours, four in about forty-eight hours, one in eleven days, and one lived fifteen weeks and six days, one about four months, one fifteen months, and one, reported by Hilton, survived fourteen years.² The most common period of death seems, therefore, to be about forty-eight hours after the receipt of the injury.

The example of the patient who survived the accident fifteen weeks and six days, is recorded by Mr. Greenwood, of England. A woman, Mary Vincent, æt. 47, was injured by a blow on the back of her neck, but she was not seen by Mr. Greenwood until after eleven days, at which time she was breathing with difficulty, occasioned by paralysis of the intercostal muscles, respiration being carried on by the diaphragm and abdominal muscles alone. This was the extent of the paralysis. There seemed to be a depression opposite the fourth and fifth cervical vertebræ, and pressure at this point occasioned universal paralysis, as did also the action of coughing and sneezing. About three weeks after the accident, she attempted for the first time to move in order to have her clothes changed, when she was immediately seized with paralysis in the right arm and hand. After this she lost her appetite, had frequent attacks of purging, and thus she gradually wore out.³

The patient who survived about four months was admitted into Hôtel Dieu, under the care of Dupuytren, in 1825, on account of a fracture of the fourth cervical vertebra, caused by a fall on the back of his neck, and suffering from paralysis of the bladder and extremities. After two months and a half of entire rest, he was convalescent, and quitted the hospital, with only slight weakness in his left leg, and with his head a

¹ Lente, Amer. Journ. Med. Sci., Oct. 1857, p. 361.

² Hilton, Lond. Lancet, Oct. 27, 1860.

³ Greenwood, Sir A. Cooper on Disloc., p. 472.

little bowed forwards. In returning from a long walk he fell paralyzed, and remained in the open air all night. From this time he continued to fail, and died thirty-four days after the second fall. On examination after death, the body of the vertebra was found to be broken, and also the processes of the fifth, allowing the fourth to slip forwards and compress the cord. A true callus existed in front of these bones, which looked as if recently broken. The cord itself exhibited an annular constriction, which Dupuytren conceived to be the seat of the original lesion narrowed by cicatrization.¹

The following example furnishes a fair illustration of the usual phenomena which accompany fractures of the third or fourth cervical vertebra.

On the 25th of July, 1857, a sailor fell backwards from the wharf, striking with the nape of his neck upon a bar of iron. I saw him on the following day, in consultation with his attending physician, Dr. Edwards. He was lying upon his back, breathing rapidly. His lower extremities were completely paralyzed; legs and feet swollen and purple; right arm completely paralyzed, and his left partially; from a point below the line of the second rib, there was no sensation whatever; his bowels had not moved, although he had already taken active cathartics; the urine had been drawn with a catheter; the pulse was slower than natural, and irregular. He was constantly vomiting. In reply to questions, he said that he felt well, articulating distinctly, and with a good voice. His eyes and face were somewhat congested, but with this exception his countenance did not betray the least physical disturbance. He lived in this condition about forty hours, only breathing shorter and shorter, and his consciousness remaining to the last moment.

In proceeding to examine the spine a few hours after death, and before any incision was made, we were unable, upon the most minute examination, to detect any irregularity of the processes of the cervical vertebræ, or any crepitus; but, on dissecting the neck, we found that the arches of the third and fourth vertebræ were broken, and the spinous processes slightly depressed upon the cord. The bodies of the corresponding vertebræ were comminuted, and the vertebræ above were driven down upon them, carrying the processes in the same direction. The theca and the spinal marrow were almost completely severed upon a level with the fourth vertebra.

A man residing in Erie Co., N. Y., was thrown backwards suddenly from the back end of a wagon, alighting upon the top of his head. Dr. Mixer having requested me to see this patient with him, I found the symptoms almost an exact counterpart of those which belonged to the case which I have just described, except that a crepitus and a mobility of the fragments could be distinctly felt in the upper and back part of his neck. His death occurred in very much the same manner after about forty-eight hours. No autopsy was allowed. We noticed in this case, also, that whenever he was turned over upon his face, respiration almost entirely ceased, but it was immediately restored by laying him

¹ Dupuytren, op. cit., p. 358.

again on his back. Many other similar examples have from time to time come under my notice.

Strains of the Ligaments and Muscles.—Dupuytren, Sir Astley Cooper, South, and other surgeons have related cases simulating fracture, but which proved to be strains of the ligaments uniting the cervical vertebrae, accompanied with more or less injury to the spinal marrow. In one instance, I have met with what has seemed to be a strain of the ligaments and muscles of the neck, but which presented no symptoms of serious injury to the spinal marrow.

John Neuman, of Canada West, æt. 25, fell headforemost from a height of fourteen feet, striking upon the top of his head. He was taken up insensible, and remained in this condition six hours. When consciousness returned, his head was very much drawn backwards, and it was impossible to move it from this position. There was no lack of sensibility or of the power of motion in his limbs, and all the functions of his body were in their natural state; but he has suffered with occasional severe pains in his arms ever since. The accident happened on the twenty-fourth of November, 1857, and he called upon me eight months after. His head was then forcibly bent forwards instead of backwards, into which position it had gradually changed. In the morning he generally was able to erect his head completely, but after a few hours it was constantly drawn forwards, as when I saw him. There was no tenderness or irregularity over the cervical vertebrae, and he was so well as to be regularly employed as a day-laborer.

Concussion.—Sir Astley Cooper has collected four examples of what he terms "concussion of the spinal marrow," all of which recovered after periods ranging from a few weeks to many months; but in only one case is it stated that the recovery was complete.¹ Boyer also enumerates three cases of concussion which came under his own observation, all of which terminated fatally in a short time. In the first example mentioned by Boyer, the autopsy disclosed neither lesion nor effusion of any kind; in the second case, it does not appear that any autopsy was made. The third is related as follows: "A builder fell from a height of fourteen feet, and remained for some time senseless; and, on recovering from that situation, found that he had lost the use of his inferior extremities. He had at the same time a retention of urine, an involuntary discharge of the feces, and some disorder in the function of respiration. Death followed on the twelfth day after the accident. The body was opened, and the vertebral canal was found to contain a sanguineous serum, the quantity of which was sufficient to fill a little more than its lower half."² No doubt some of the cases reported as concussion were only examples of paralysis from extravasation of blood, a circumstance which is peculiarly likely to happen as a result of the rupture of one of those numerous large vessels which surround the vertebrae outside of the thecae. It is seldom that the vessels of the cord itself give out sufficient blood in these cases to cause compression. Possibly examples of compression as a result of extravasation of blood may sometimes be recognized by the fact of the gradual approach of the paralysis after the lapse of several hours, as has occurred recently in a

¹ Sir A. Cooper, *op. cit.*, p. 454.

² Boyer, *Lecture on Diseases of the Bones*, Amer. ed., 1805, p. 55.

case brought to my notice at the Bellevue Hospital, and in which recovery finally took place.

4. *Treatment of Fractures of the Bodies of the Vertebrae when the fracture occurs in any portion of the column below the Second Cervical.*

In a few instances, I have noticed among the recorded examples of fractures of the bodies of the vertebrae, that surgeons have made some slight attempt to reduce the fracture, or rather to rectify the spinal distortion, generally by the application of moderate extension to the limbs, and by laying the patient horizontally upon a hard mattress. But I have not been able to discover that in any case the patients have derived benefit from the attempt, although it has been said occasionally, by the gentleman making the report, that the deformity was slightly diminished. Nor am I aware that in any instance the patient has suffered any damage from the attempt; at least the reporter has in no case thought it necessary to make this observation. I am confident, however, that such manipulation can seldom serve any useful purpose, and I very much fear that it has been frequently a source of mischief; although in cases so generally fatal, it might be very difficult to estimate with much accuracy the amount of injury done. If by any possibility the fragments could be replaced, I know of no means by which they could be kept in place; and in truth we are much more likely to increase the penetration of the spinal cord and the general disturbance, than to diminish it, by extension or pressure. Moreover, it usually inflicts upon the unfortunate sufferer great pain, and for these reasons it ought generally to be discouraged.

I have, however, met with two cases of fracture of the lumbar vertebrae, in which relief was afforded by permanent extension. When the fracture is below the middle of the vertebral column, extension, if employed, should be made by adhesive straps, weights, and a pulley, as will hereafter be directed in fractures of the femur; the counter-extension being made by the weight of the body. It will be understood, however, that when paralysis exists the ligation of a limb with bandages will expose the patient to great danger of ulceration and sloughing at and below the points of pressure, and the amount of extension must be very moderate.

When treating of fractures of the arches of the vertebrae, I took occasion to call attention to Mr. Cline's operation, occasionally recommended and practised in such cases. I was not ignorant, however, that Mr. Cline, and several other of the advocates of this operation, had recommended it especially for fractures of the bodies of the vertebrae when accompanied with displacement. Even Malgaigne has preferred to consider the merits of this operation in its relations to these latter fractures; but whilst I am prepared to admit the propriety of an argument as to the value of Cline's operation considered in reference to fractures of the arches, I cannot admit its propriety in reference to fractures of the bodies of the vertebrae. The proposition appears to me too absurd to be entertained for a moment.

The treatment, then, ought to be, in a great measure, expectant. The patient should be laid in such a position as he finds most comfortable, and, as far as possible, the spine should be kept at rest, since the most trivial disturbance of the fragments, and even that which may cause no pain to

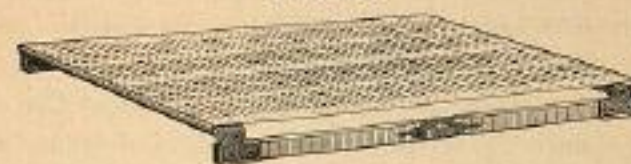
the patient, is liable to increase the injury to the spine, and prevent the formation of a bony callus. Especially ought the surgeon to be careful, while making the examination, not to turn the patient upon his face, in which position the spine loses its support and a fatal pressure may be produced. The urine should be drawn very soon after the accident, and at least twice daily for the next few weeks. Indeed, it is a better rule to draw the urine as often as its accumulation becomes a source of inconvenience, or whenever the bladder fills, which will in some cases be as often as every four or six hours. It is especially necessary to attend to those urgent demands of the patient during the first few weeks, when the paralysis is most complete generally, and the mucous surface of the bladder, already irritated and inflamed by the excessively alkaline urine, suffers additional injury from any degree of painful distention of its walls. It is unnecessary to say that the frequent introduction of the catheter may itself prove a source of irritation, unless it is managed carefully and skilfully. This duty ought never to be intrusted to an inexperienced operator.

I do not see what advantage the surgeon can expect to derive from the administration of drastic purgatives, such as full doses of jalap, castor oil, or spirits of turpentine, at any period. If in the first instance the bowels are so completely paralyzed that they seem to demand such violent measures to arouse them to action, we may be quite certain that the spinal cord is suffering from a pressure, or from some lesion, which these agents have no power to remedy. The bowels may possibly be made to act, but it would be difficult to show how this is to relieve the suffering cord. So far from affording relief, these measures add directly to the nervous irritation and prostration, and provoke vomiting and general restlessness. It is not desirable, we think, to obtain a movement of the bowels, during the first few days by any means, however gentle. The effort to defecate, and the consequent motion, will probably do much more harm than the evacuation can do good; and especially, for the same reason, ought we to avoid putting into the stomach anything which will occasion nausea and vomiting.

After the lapse of a few days, if reasonable hopes begin to be entertained of a recovery, it will become important to establish regular evacuations of the bowels, either by a judicious management of the diet, by gentle laxatives, or by enemata. At a still later period, when the inflammatory stage is past, and the nerves remain inactive or paralyzed, nothing could be more rational than the employment of strychnia in doses varying from the one-twelfth to the one-eighth of a grain three times daily. Nor do I think that any single remedy has more often proved useful in my own practice, or in the practice of other surgeons with whom I am acquainted. In order, however, to derive benefit from this or any other remedy, it must be continued for a long time; perhaps for a year or more. Electricity, setons, issues, and blisters are no doubt also sometimes useful. Care must be taken that setons, etc., do not produce bedsores. Passive motion and frictions, good fresh air, and nourishing diet, become at last essential to recovery. From an early period, and during the whole course of the treatment, great attention should be paid to the prevention of bedsores, by supporting all those parts of the

body upon which the pressure is considerable. For this purpose we may employ circular cushions, air-cushions, and air-beds; but water-beds are very much to be preferred to air-beds as a means of preventing bedsores. Water-beds must be filled with water at the temperature of 68° Fahrenheit, and they must be secured in position by side boards, or a kind of shallow box, the sides of which are elevated six or seven inches. Permanent extension can be employed upon these beds as well as upon ordinary beds. Sometimes a section of a bed, three feet square, is found quite as serviceable as an entire bed, inasmuch as the back and nates are the only parts which are liable to bedsores. They may be obtained from the manufacturers, Hodgman & Co., corner of Nassau Street and Maiden Lane, New York City, at prices ranging from \$15 to \$25. Of late I have found the wire-beds, manufactured at 59 Pearl Street, Hart-

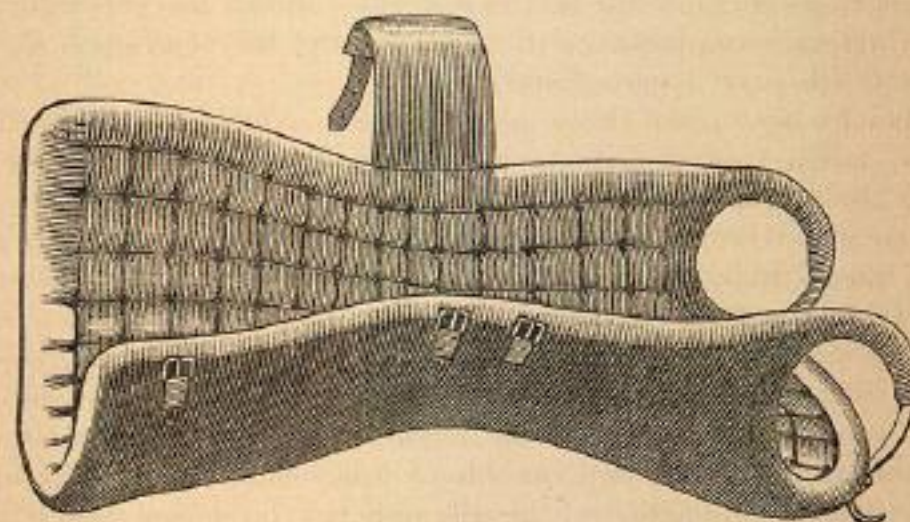
FIG. 43.



Wire-bed.

ford, Conn., excellent substitutes for water-beds. They are less expensive, more easily managed, more durable, and admit of a much better regulation of the temperature. Whether they are quite as efficient in the prevention of bedsores as water-beds, I cannot say positively, but they have been much used under my observation at Bellevue and in the

FIG. 44.



Bonnet's vertebral gutter.

Hospital for Ruptured and Cripples, and I have seen no bedsores occur where they were in use. In a few cases it may be found useful to support the back, including the neck and nates, with a wire cuirass, well padded; and especially where the confinement is greatly prolonged.

When sores have formed, they should be treated, if sloughing, with yeast poultices, or the resin ointment. I find also the resin ointment an

excellent dressing for the sores after the sloughs have separated. In case the surface is only slightly abraded, simple cerate forms the best application.

§ 5. Fractures of the Axis.

The phrenic nerve is derived chiefly from the third and fourth cervical nerves. If, therefore, the second cervical vertebra is broken, and considerably depressed upon the spinal cord, respiration ceases immediately, and the patient dies at once, or survives only a few minutes. In such examples of fracture of this bone as have not been attended with these results, the displacement and consequent compression have been inconsiderable, or there has been no displacement at all.

Mr. Else, of St. Thomas's Hospital, says that a woman in the venereal ward, and who was then under a mercurial course, while sitting in bed, eating her dinner, was seen to fall suddenly forwards; and the patients, hastening to her, found that she was dead. Upon examination of her body, it was discovered that the processus dentatus of the axis was broken off, and that the head in falling forwards had driven the process backwards upon the spinal marrow so as to cause her death.¹

Sir Astley Cooper also relates the case of a man who was shot by a pistol through the neck, breaking and driving in upon the spinal marrow both the "lamina and the transverse process" of the axis. He died on the fourth day.²

Malgaigne has collected three cases of fracture of the odontoid apophysis, all of which were accompanied with displacement of the atlas. The first, reported by Richet, died on the seventeenth day; the second, reported by Palletta, died after one month and six days; and the third, by Costes, lived four months and two weeks. Swan has reported a case, also, of fracture accompanied with dislocation of the head upon the atlas, in which death ensued immediately.³

Rokitansky says that there is a specimen contained in the Vienna Museum, taken from a patient who survived the accident some time, although the fragments never united.

M. Denucé, of Bordeaux, has seen a case of *incomplete* fracture of this process, caused by a gunshot, the ball having lodged in the body of the bone. The patient survived four weeks.⁴

The following case is reported by Parker:

"The patient, Mr. G. B. Spencer, was a man forty years of age, a milkman by occupation, of medium height, nervo-sanguine temperament, of active business habits, and capable of great endurance. His life was one of constant excitement, and he was addicted to the free use of liquors. He suffered, however, from no other form of disease than occasional attacks of rheumatism, for which he was accustomed to take remedies of his own prescribing, which were generally mercurials, followed by liberal doses of iodide of potassium, 'to work it all out of the system.'

"On the 12th of August, 1852, while driving a 'fast horse' at the top of his speed on the plank road near Bushwick, L. I., he was thrown violently from his carriage by the wheel striking against the toll-gate. He alighted upon his head and face about fifteen feet from his carriage. Upon rising to his feet he declared himself uninjured, but soon after complained of feeling faint; after drinking a glass of brandy he felt better, got into his carriage with a friend, and drove home to Rivington Street in this city, a distance of more than two miles. There was so little apparent danger in this case that no physician was called that night. Early on the morning of the following day, Dr. B. was called to visit him. He found his patient reclining in his chair, in a restless state, and learned that he had suffered considerable pain in the back part of his head and neck during the night. He was entirely incapacitated to rotate the head, which led to the suspicion of some injury to the articulations of the upper cervical vertebræ; but so great a degree of swelling existed about the neck as to prevent efficient examination. There was no paralysis of any portion of the body, his pulse was about 90, and his general system but little disturbed. Warm fomentations were applied to the neck, and a mild cathartic administered. On the following day there was no particular change in his symptoms, but as there existed considerable nervous irritability, tinct. hyoscyami was prescribed as an anodyne, and fomentations of hops applied locally. On the third day leeches were applied to the neck, and after this the swelling so much subsided that on the fifth day an irregularity was discovered to exist in the region of the axis and atlas, which had many of the features of a partial luxation of these vertebræ.

"At this time he began to walk about the room, having previously remained quiet on account of the pain he suffered on moving. He persisted in helping himself, and almost constantly supported his head with one hand applied to the occiput. He often remarked, if he could be relieved of the pain in his head and neck, he should feel well. He began to relish his food, and the swelling nearly disappeared at the end of a week, leaving a protuberance just below the base of the occiput, to the left of the central line of the spinal column, with a corresponding indentation. Notwithstanding strict orders to remain quietly at home, on the ninth day after the accident he rode out, and in a day or two after returned as actively as ever to his former occupation of distributing milk throughout the city to his old customers. During the following four months no material change took place in his symptoms, although he constantly complained of pain in his head. For this period he did not omit a single day his round of duties as a milkman, which occupied him constantly and actively from five o'clock in the morning to nearly noon. On the first of November, Prof. Watts examined him, and inclined to the opinion that there was a luxation of the upper cervical vertebræ.

"About the 1st of January, 1853, the pains, from which he had been a constant sufferer, became more severe, and he was heard to complain that he could not live in his present condition; he remarked, also, that he had heard a snapping in his neck. After going his daily round on the 11th of January, he complained of feeling cold, and afterwards of numbness in his limbs. In the evening he had a chill, and complained

¹ Else, Sir A. Cooper on Disloc., etc., op. cit., p. 462.

² Sir A. Cooper on Disloc., etc., op. cit., p. 476.

³ Swan, Boston Med. and Surg. Journ., 1877, vol. i. p. 226.

⁴ Denucé, Nouv. Dic. de Med. et de Chir. Prat., t. iii. p. 810.

of a pain in his bowels. He passed a restless night, and arose on the following morning about six o'clock; he was obliged to have assistance in dressing himself, and experienced a numbness of his left, and afterwards of his right side. He attempted to walk, but could not without help, and it was observed that he dragged his feet. He sat down in a chair and almost instantly expired, at eight o'clock, A. M., on the 12th of January, precisely five months from the receipt of the injury.

"The autopsy was made thirty hours after death, by Dr. C. E. Isaacs, in presence of several medical gentlemen. Muscular development uncommonly fine. An unusual prominence discovered in the region of the axis and atlas. On making an incision from the occiput along the spines of the cervical vertebræ, the parts were found to be very vascular. These vertebræ were removed *en masse*, and a careful examination instituted. The transverse, the odontoid (ligamenta moderatoria), as also all the ligaments of this region, excepting the occipito-axoideum, were in a state of perfect integrity; this latter was partially destroyed. A considerable amount of coagulated blood was found effused between the fractured surfaces, some of it apparently recent, but much of it was thought to have occurred at the time of the accident, and afterwards to have prevented the union of the bones. The spinal cord exhibited no

FIG. 45.



Fracture of the odontoid process of the axis. Parker's case. a. Broken surface. b. Odontoid process.

appearances of any lesion. The odontoid process was found in the position well represented in the accompanying illustration, completely fractured off, and its lower extremity inclining backwards toward the cord. Death finally took place, doubtless, from the displacement of the process during some unfortunate movement of the head, by which pressure was made upon the cord. The destruction of the occipito-axoid ligament, which would otherwise have protected the contents of the spinal cavity, must have favored this result."¹

Vander Poel, of New York, has reported the case of a man æt. twenty-one, who had fallen from a carriage upon the back of his head. The symptoms which ensued led his surgeons to believe that he had experienced a fracture of the fourth cervical vertebra. His condition subsequently improved to such a degree that he was able to perform light labor; but after six months they became aggravated, and he died six months and a half after the accident, of apnoea. The autopsy revealed a transverse fracture of the odontoid process, the transverse ligament being uninjured. There was no other fracture of the vertebræ.²

Dr. Philip Bevan presented to the Surgical Society of Ireland, in 1862, a specimen obtained from the dead-room, and which was supposed to be an epiphyseal separation of the odontoid process, occurring in early life. The history of the case is not known, although the woman was

¹ Bigelow, New York Journ. Med., March, 1853, p. 164.
² Vander Poel, Arch. Clin. Surg., vol. ii. p. 116.

forty years old when she died. It does not appear very clear to us whether this was really an epiphyseal separation, or the result of some morbid process.¹

At the meeting of the New York Pathological Society, Nov. 12, 1868, Dr. Austin Flint presented a case of separation of the odontoid process of the axis.

Dr. W. Bayard, of St. John, N. B., has, however, reported a case of separation of the odontoid process in a child, followed by complete recovery. In August, 1864, Charlotte Magee, of St. John, æt. 6 years, previously in excellent health, fell five feet, striking on her head and neck, causing an immediate immobility of the head, which continued about two years and a half, when an abscess formed in the back of the pharynx, and the bone was spontaneously discharged. "Since then she has been able to move the head freely, and her recovery may be said to be complete."² The specimen was subsequently presented to the New York Pathological Society, and no doubt remains that the entire process was thrown off.

Dr. Stephen Smith, who has written a very instructive paper on this subject, has collected 23 cases of separation of the odontoid process, at least 20 of which must be regarded as fractures. The ages of the patients range from three years to sixty-eight. Eight of this number were spontaneous, the separation being apparently due to some progressive disease or atrophy of the bone. Two of these recovered after the formation of abscesses in the pharynx and the extrusion of the bone. In four cases the fractures were gunshot, and one died. The remainder, so far as ascertained, were in consequence of blows upon the head; and of these only the girl Charlotte Magee recovered. Of the whole number, 23, three were without history, two of them being dissecting-room cases.³

Symptoms.—These will depend much upon the cause and complications of the accident. In all cases there will be more or less inability to support the head in the erect posture, and if displacement exists, or if the products of inflammation press upon the cord, a proportionate impairment of its functions must ensue.

Treatment.—The treatment consists in absolute quietude, with moderate extension, effected by means of suitable apparatus.

§ 6. Fractures of the Atlas.

I have been able to find only one example of a fracture of the atlas alone, and this is the case related by Sir Astley Cooper as having come under the observation of Mr. Cline.

A boy, about three years old, injured his neck in a severe fall; in consequence of which he was obliged to walk carefully upright, as persons do when carrying a weight on the head; and when he wished to examine any object beneath him, he supported his chin upon his hand,

¹ Bevan, Amer. Journ. Med. Sci., April, 1864. From Dublin Med. Press, Feb. 18, 1863.

² Bayard, Canada Med. Journ., Dec. 1869.

³ Smith, Amer. Journ. Med. Sci., Oct. 1871, p. 338.

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. 233.
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.

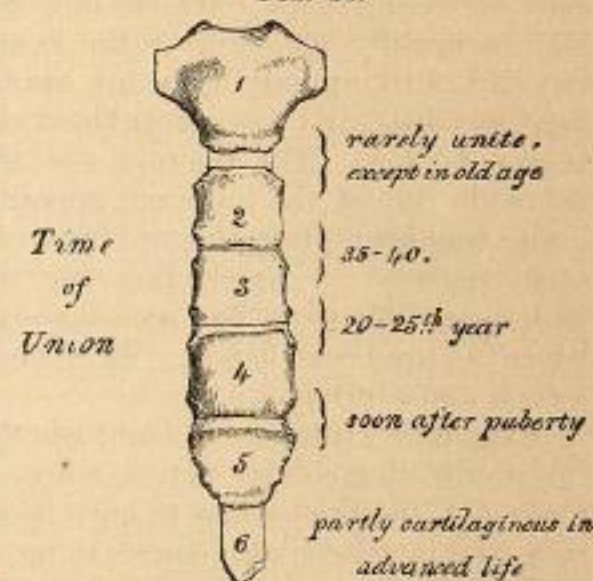
FRACTURES AND DIASTASES OF THE STERNUM.

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.