

TRAUMATIC LESIONS OF THE ATLAS AND AXIS.

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THERE exists much lack of knowledge concerning the subject of non-fatal injuries to the upper two cervical vertebræ. The matter was first called to our attention by the observation of a rather remarkable case and the interest thus aroused has led to the discovery of others and to a review of the literature. By considering the production of the injury and by describing the immediate and subsequent symptoms we hope to make their diagnosis more easy and their rational treatment and intelligent prognosis more clear.

Literature.—At least three important articles on the subject of injuries to the upper cervical vertebræ have appeared in recent years. The first is by Walton, in the *Boston Medical and Surgical Journal* in 1903, on “Cervical Dislocations and Their Reduction”; the second by Corner in the *ANNALS OF SURGERY* in 1907, on “Rotary Dislocations of the Atlas,” and the third by Van Assen in the twenty-first volume of the “*Zeitschrift für orthopädische Chirurgie.*”

Walton's article is the first clear description which we have found of the cervical dislocations and the rational method of their reduction. He believes them to be far commoner than has been supposed. They are usually unilateral and consist of a rotary displacement, the upper vertebræ on the side of the lesion slipping forward and either catching on the apex of

the articular process below or slipping over it into the intervertebral notch. These lesions are non-fatal, do not cause symptoms of compression of the cord, and are capable of reduction after long periods by proper manipulation.

Corner's article on "Rotary Dislocation of the Atlas" is comprehensive and attempts to cover the reported cases of fatal and non-fatal injuries to the atlas and axis. He calls attention to the fact that in order to allow the free motions of the head the ligaments are all lax, that the head therefore must be held firm by muscular action alone,—and that if for any reason this muscular support is lacking, any blow has, to use his words, a "flying start" in the production of the dislocation or its complicating fracture. From his cases it is evident that the most important point to determine as well as often the most difficult is the fracture or integrity of the odontoid process. In 6 of the 8 fatal cases of Corner the odontoid was broken. In the 10 non-fatal cases only once. It also is suggestive to realize that of his 8 fatal cases in only 2 did death or paralytic symptoms follow soon after the injury, periods varying from twenty-three days to several years elapsing in all the others, and that the cause of death at this time was either injudicious movements made by the patient or his physician or the development of a myelitis.

The last article which we shall review is one by Van Assen, from Joachimsthal's clinic, and primarily the report of a case of fracture of the posterior arch of the atlas and of the odontoid process with a probable accompanying rotary dislocation of the atlas on the axis. It is more than this, however, for he too attempts a review of the literature and brings out certain important facts. He reports a collection of 136 cases of spinal injury made by Wagner and Stolper, who found among these only 1 of injury to the atlas and axis. Out of 19 cases of injury to the atlas collected by Van Assen only 1 was diagnosed in the living and many of them were associated with lesions of other vertebræ. He states that only 6 authentic cases have been recorded of isolated fracture of the atlas. In the 12 reported cases of fracture of the axis 9 times the odon-

toid only was broken. It is seen, therefore, that reports of injury to the atlas alone are very rare, and that injuries to the axis alone or in conjunction with the atlas are not often recognized in the living.

Production of the Injury.—In general these lesions result from violence of some sort. Falls from a height or down stairs are commonest causes. In these cases the blow is received on the fore part of the head and from above downwards. In Dr. Wilson's case, reported in the ANNALS OF SURGERY, April, 1907, there is reason to believe that at least the final displacement was accomplished by an osteopath, who exerted in one of his manipulations quick forcible pressure on the top of the subject's head while he was standing. The patient immediately fell to the floor, but afterwards recovered.

In a case reported by Lambotte, a sudden movement of the head was made by a young woman while sewing. Stiffness of the neck and pain in the head followed, but not until a year later did paralytic symptoms ensue. The postmortem showed the odontoid to be fractured across its base transversely and repaired by some fibrous tissue. There was a rotary dislocation of the atlas on the right. The transverse and check ligaments were intact.

The case resembles in many ways one which has been described by Dr. F. H. Albee ("Case Teaching in Orthopedic Surgery," Case VII) (see Case IV, end of article) in which the symptoms followed a jerk of the head secondary to a sudden push of the body.

It is evident then that while violence is the common cause of dislocation and fracture of the upper two cervical vertebræ we must recognize that severe lesions may occur from surprisingly slight traumatisms,—indeed, if we accept Lambotte's case, from muscular action alone.

The More Common Types of Lesion.—We have outlined above the commonest lesion of all, as pointed out by Walton, namely, a unilateral sUBLUXATION or true dislocation unassociated with fracture. The rotary dislocation of the atlas on

the axis as described by Corner belongs in this class and is illustrated by the outline drawing in Fig. 1.

The next most common type is the fracture of the odontoid, usually accompanied by rotary dislocations. Skiagraphs of this lesion when compared with the normal lateral skiagraph (Fig. 2) demonstrate very clearly this lesion (*cf.* Figs. 3, 7, and 10). Four of the cases referred to in this article where this displacement has occurred are still living and have had no symptoms of cord compression. This fact is certainly interesting and to the writers has been surprising.

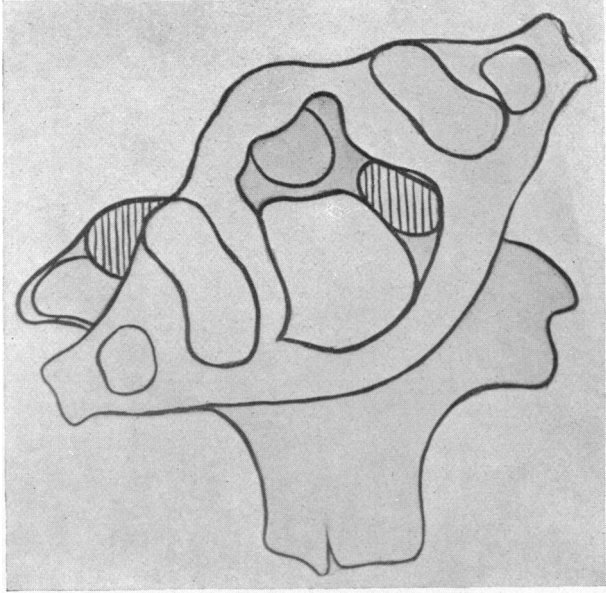
The third and far less common forms of lesion are those in which the arches or lateral masses of atlas or axis have been fractured with or without accompanying dislocations and fractures of the odontoid. Two of the cases which have been observed by the writers illustrate this type (Case II; see page 202. Case VII; see page 205), as does also Van Assen's case (Case III; see page 202).

Immediate Symptoms.—The immediate symptoms which follow these injuries vary from almost instant death to an almost entire absence of all symptoms except neck rigidity and asymmetrical head position. The striking phenomenon is the frequency with which only comparatively slight symptoms result. Severe occipital neuralgias and neck rigidity with increase of pain on any attempted active or passive movement of the head are nearly always present and should lead one to suspect bony lesion.

Subsequent Symptoms.—The rigidity and as a rule the occipital neuralgia persist. Sudden movements or attempts at reduction are often followed by immediately fatal consequences, but the most important end result as shown by many cases reported by Corner has been the gradual onset of a myelitis apparently caused by the irritation of the long-continued abnormal position, or in case of fractures by callus formation (*cf.* Case VI).

Diagnosis.—We need hardly emphasize the importance of the X-ray in making the diagnosis. Lateral X-rays of the neck represent no special technical difficulties, and show well

FIG. 1.



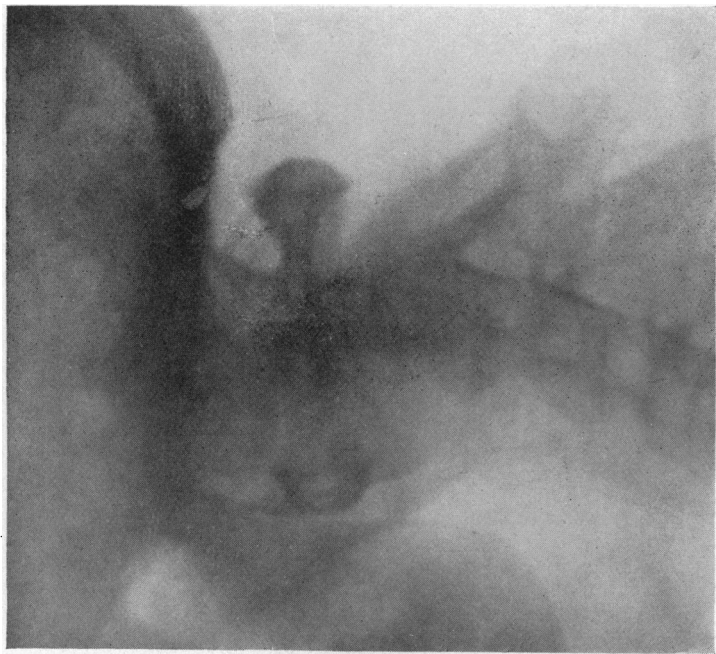
Diagrammatic representation of rotary dislocation of the atlas—and occiput—on the axis. (Corner.)

FIG. 2.



Lateral skiagraph of normal cervical spine.

FIG. 3.



Lateral skiagraph of Case I. Cf. Fig. 2 and note different relations of atlas and axis.

any anteroposterior abnormality and often suggest a lateral asymmetry in a dislocation (*cf.* Fig. 8) (Case V, page 204). The ordinary anteroposterior X-ray of the neck is valueless as far as the atlas and axis are concerned, the mental prominence and teeth entirely obscuring any clear view. If the patient can open his mouth, however, most important information may be had by a skiagraph taken through this wide open aperture (*cf.* Fig. 9) (Case V, see page 204). Odontoid fractures may be seen and any lateral displacement demonstrated.

When good X-rays are not available much may be determined by inspection and palpation. Inspection reveals the probable displacement if one reasons out the lesion necessary to produce the individual asymmetry. By palpation one may discover many things. The line of the spinous processes and their relative anteroposterior position should be first determined. If the spine of the axis is abnormally prominent a fracture of the odontoid is to be suspected. Normally the transverse process of the atlas can be felt half way between the tip of the mastoid process and the angle of the jaw. The location of these processes is, therefore, significant and must be studied. The value of the examination of the pharynx by palpation, preferably under anaesthesia, can hardly be overestimated.

As Corner has originally pointed out, in the rotary dislocations of the atlas two abnormal prominences may be made out, one due to the forwardly displaced transverse process and lateral mass of the atlas on the side of the marked dislocation and the other on the opposite side and a little lower, corresponding to that portion of the axis which is made more evident by the slipping backwards of the atlas.

In spite of the helpfulness of all these signs it is difficult to determine positively the integrity of the odontoid. The importance of this determination is, however, made apparent by several cases in which the penalty for what proved unintelligent manipulation has been the life of the patient.

Treatment.—If one can convince himself that a simple

unilateral rotary dislocation of the atlas or axis has occurred intelligent manipulation offers every hope of cure. Dr. E. W. Ryerson of Chicago and one of the writers have even reduced cases of six months' standing. Walton has called attention to the fact that extension alone, or accompanied by rotation, is an inefficient and somewhat dangerous procedure. If one considers the anatomy of the lesion it is evident that his method is the only rational one.

This consists of first freeing the dislocated articular facet of the upper vertebræ from its position. Whether this upper articular process has simply caught on the apex of the process of the vertebræ below or actually slipped forward into the anterior notch is a difference only of degree. It should be first lifted free and then rotated into place by the manipulation of dorsi lateral flexion followed by rotation. For example, if the left inferior articular process of the axis has slipped forward and we suppose the patient to be facing North, we should first bend the head without traction to the East and South, *i.e.*, to the right and backward, possibly rotating a trifle in the direction of the deformity to better free the process. We should then rotate toward the West and North, *i.e.*, turning the head to the left and bending it forward. This uses the undislocated joint as a powerful fulcrum which is lost if traction be employed as well. It is helpful to remember that the chin will point to the side opposite the main lesion. In a doubtful case where the exact nature of the lesion is not clear and where we may be dealing with a fractured odontoid, we advise support and fixation by means of apparatus such as the Thomas collar, or a plaster helmet, until a definite diagnosis can be made. Corner believes that in cases where the odontoid seems probably to have been broken that the patient should be kept in bed with the head immobilized for at least three weeks; that then an anæsthetic should be given, and with an examining finger in the pharynx an attempt at reduction should be made.

None of the authors consider operative procedures possible. The writers, in conclusion, wish to report an unusual

case, with as far as is known an original operation. In light of the apparent frequency of odontoid fractures which are not immediately fatal and the common subsequent occurrence of myelitis, from the irritation caused by the abnormal mobility it seems possible that this operative procedure may have a wider range of usefulness than we had anticipated.

CASE I.—R. M., age 15, was sent to one of us in July, 1906, by Dr. Maurice H. Richardson for an opinion as to cervical dislocation.

In brief, the history is that five weeks previous he had fallen from a tree, striking his head against a limb on the way to the ground. Immediate pain and stiffness of the neck followed with the appearance of a swelling on the left side high up. The condition had not materially changed since the accident. There had been no paralytic symptoms, though there had been acute paroxysms of pain during which the boy asked to be killed. The pain radiated over the head and down the shoulder and arm.

Examination showed a thin, sick-looking boy, with a tender prominence on the left side of the neck corresponding to a forwardly displaced transverse process of the atlas. This prominence could be felt on the posterior wall of the pharynx. Several X-rays taken at this time and soon after revealed no lesion which could be accurately interpreted.

All motions of the head were restricted and painful. The chin pointed to the right. The left tonsil was enlarged. The temperature was 100° F. Further general examination was negative.

A rotary dislocation of the atlas or possibly the axis was supposed. The boy was sent to the Massachusetts General Hospital, and under an anæsthetic the head was gently manipulated by Dr. Richardson, with an apparent return to normal conditions and almost complete flexibility. This condition remained for a few days. The boy was taken home against advice, but old conditions returned very soon. Six months after the accident the boy was again seen, and as conditions were almost intolerable on account of the severe occipital neuralgia, he was again sent to the hospital and a second manipulation was performed by one of the writers. The same flexibility and apparent reduction were present after this manipulation. More X-rays failed to suggest the real lesion, and in a complete plaster helmet the symptoms were relieved for

one month. The helmet was then removed and a high Thomas collar applied. In a week the symptoms had recurred with added severity and at this examination the spines of the axis and third cervical vertebræ were evidently much more prominent than before. A fracture of the odontoid was for the first time suspected and confirmed by X-rays taken laterally (Fig. 3) and through the mouth.

The symptoms were evidently caused by the slipping forward of the atlas. The odontoid evidently showed no tendency to unite. The boy reentered the hospital on Dr. Mixter's service and was put to bed with head extension. A leather cuirass in two pieces (Fig. 4) was made from an accurate cast taken by laying the patient in a bed of soft plaster and then making the anterior half by pouring over the chest and neck thin plaster cream.

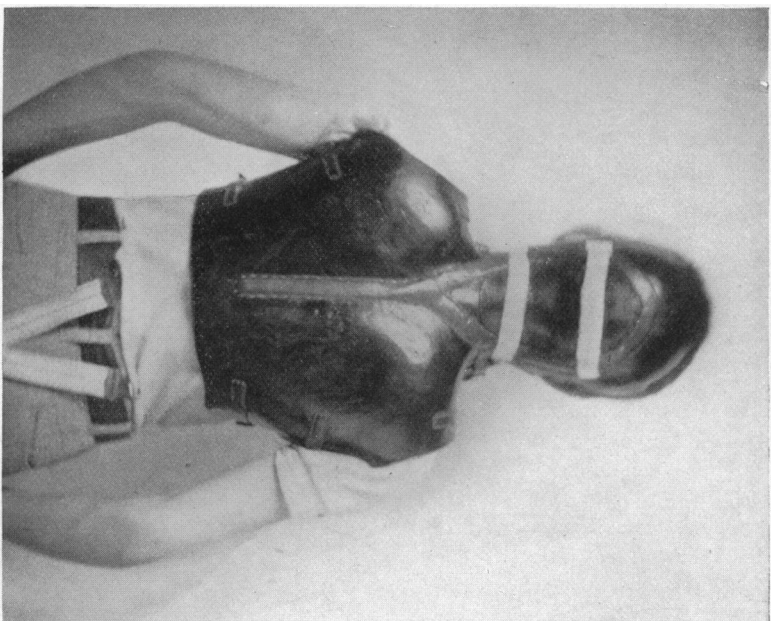
When this accurately fitting apparatus was ready the following operation was performed. The boy was placed in the ventral position, the head being supported manually over the end of the table. A linear four-inch incision was made in the median line of the neck and carried down until the hooked spine of the axis was defined. Next the posterior arch of the atlas forwardly displaced was sought and exposed. With an aneurism needle a stout braided silk soaked in compound tincture of benzoin was passed about this posterior arch between it and the spinal cord. While forward pressure on the anterior arch was exerted through the pharynx, traction was made on the posterior arch. There was firm resistance to replacement and only a slight amount of reposition was accomplished. This was maintained, however, and the atlas firmly anchored by tying the silk band about the hooked spinous process of the axis. The wound was closed with deep silkworm gut sutures, and the leather cuirass applied and strapped tight (Fig. 4, *a* and *b*). The wound was dressed through a posterior window. There was first intention and the boy made an uneventful convalescence, with no paralytic symptoms and an absence of pain. The apparatus was worn for two months, gradually omitted, and up to the present time he has remained well, without symptoms other than slight stiffness of the neck, and has led an active life.

It is now somewhat over two years since the operation and his present appearance is seen in Fig. 5.

FIG. 4a.



FIG. 4b.



Case I. in apparatus applied immediately after operation.

FIG. 5.



Case I.—Present appearance.

FIG. 6a.



FIG. 6b.



Case II.—Rotary dislocation of atlas on axis. Probable fracture of the anterior arch of the atlas.

FIG. 7.



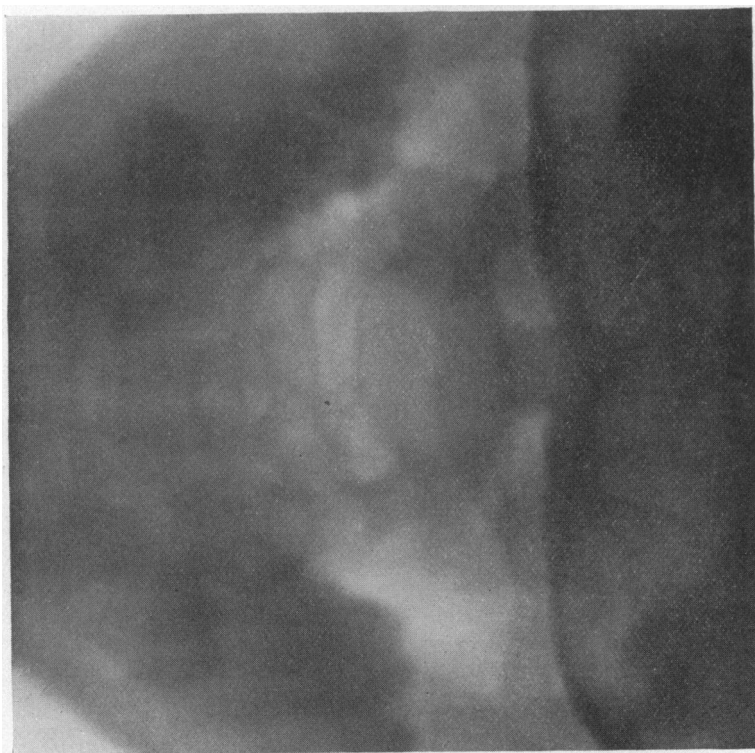
**Probable disease of the atlo-axoid joint, with marked forward displacement of the atlas.
No symptoms of cord compression.**

FIG. 8.



Lateral skiagraph of Case V. Note the apparent slight forward displacement of the atlas, due to the rotary dislocation. (Skiagraph by Dr. G. S. Johnston, of Pittsburg.)

FIG. 9.



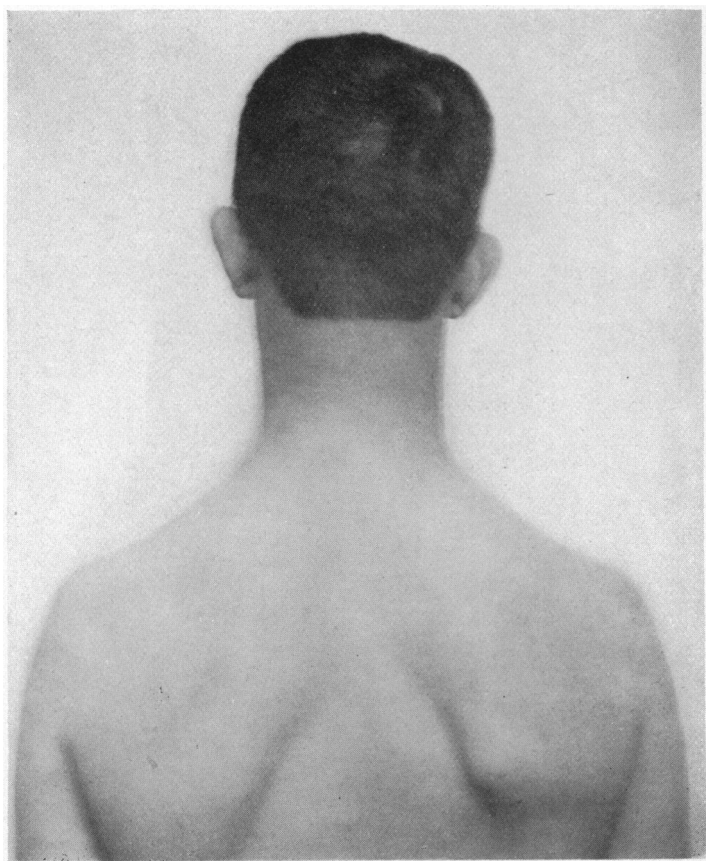
Anteroposterior skiagraph of Case V. Note the clear view of the unbroken odontoid process and the asymmetry of the two alto-axoid joints (rotary dislocation of the atlas). (Skiagraph, by Dr. G. S. Johnston, of Pittsburg.)

FIG. 10.



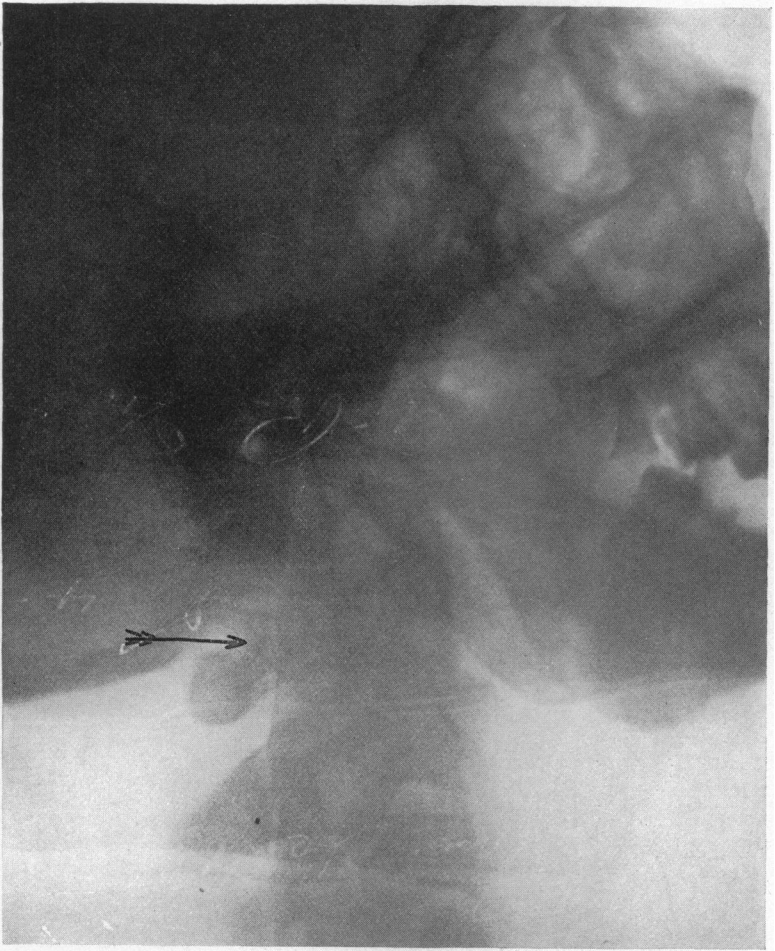
Lateral outlined skiagraph of Case VII, showing marked forward displacement of the atlas.

FIG. 11.



Back view of Case VII. Head held slightly inclined to right.

FIG. 12.



Lateral skiagraph of upper cervical spine of Case VII. Arrow points to fracture of posterior arch of atlas, shown well in the negative but indistinct in the reproduction, appearing like an exostosis.

CASE II.—C. F., age 58; female (Fig. 6, *a* and *b*). Ten weeks before being seen, while groping about during the night to find the bathroom, she became confused and fell down a flight of thirteen stairs, striking head and neck and shoulders. She felt a distinct "crack" in the neck, referred to just below occiput. Not unconscious, she was picked up, but could not open mouth well; immediate pain referred to the right side, and stiffness of the neck; no other noticeable disturbance of motion or sensation. She remained two days in bed and was able during this time to walk to the bathroom. She was unable to lift right upper lid after the accident; no swelling or ecchymosis of eye. In three days she was able to travel several miles in electric cars and climb three flights of stairs. Pain in the head, neck, and shoulders was so severe that she was unable to sleep, and was removed to a hospital. Under ice pack, electricity, and massage, neck pain and severe headaches continued. Shoulder and arm pain disappeared. She left hospital three weeks before being seen, because unrelieved.

Pain was referred to the occipital region and streamed up over the head. On any attempted motion of the head the pain shot through the right shoulder and down the arm. Coughing or sneezing caused excruciating pain.

Physical Examination.—A well-developed woman, standing with a slight deviation of the head to the right and a slight compensatory curve in the cervicodorsal region. All active and passive motions of the head were restricted and painful. A few degrees of rotation remain. The line of the spinous processes can be palpated until the axis is reached, which seems farther forward than normal. On the right side of the neck in the region of the atlo-axoid articulation there is somewhat more resistance than on the left. Pressure over this point and the corresponding region on the left causes pain. The spinal motions below the cervical are apparently normal; no paralysis; no disturbances of sensation; reflexes normal. Inspection of the mouth showed enlarged tonsils, but no inflammatory signs. Palpation of the posterior pharyngeal wall through the mouth showed a greater prominence on the right side.

From the lateral skiagraph no definite lesion could accurately be diagnosed. The anteroposterior skiagraph taken through the

open mouth showed an asymmetry of the two atlo-axoid joints (rotary dislocation on the right) and an apparent fracture of the anterior arch of the atlas.

Treatment.—A Thomas collar was applied, with almost instant temporary relief. High frequency currents were given to relieve the pain, together with gentle massage, etc.

Diagnosis.—Fracture of the atlas; rotary dislocation of the atlas on the axis on the right.

Result.—One year after the accident patient has resumed her occupation as a seamstress, wearing collar much of the time, since it relieves symptoms.

CASE III. (Case of J. VAN ASSEN).—Male, 55 years of age. Since 12, occasional attacks of convulsions and loss of consciousness. Method of injury: One month before being seen slipped from a ladder, struck an open door, and fell about twelve feet on to an asphalt floor; unconscious for only a few minutes.

Immediate Symptoms.—A scalp wound demanded stitches. He remained fourteen days in bed. When the bandages were removed and he attempted to sit up he had immediate pain and stiffness in his neck. This had not been noticed in bed. In spite of massage the pain and stiffness increased. There were drawing pains also in the sides of his neck and on the sides of his occiput. There was no interference with walking or weight-bearing and no difficulty in swallowing. The head was slightly inclined to the right and fixed in slight forward bending; no visual disturbance. Mouth can be opened and tongue motions normal. In the cervicodorsal region of spine is a left convex scoliosis. At the occipito-atloid joint there is a localized deviation. The line of the spinous process is not broken. The mid-line of the face does not correspond to the mid-line of the body, but seems pushed to the right. Pain referred to the vertebral prominence and all through the neck is elicited on all active and passive attempts to lift the head from its slightly forward, bent position. Active turning of the head was impossible and passive attempts were painful. There was a little lateral motion, but accompanied by pain. There was no paralysis. The reflexes were normal and the general examination of heart, lungs, and nasopharynx was negative. There is no record of pharyngeal palpation. The lateral skiagraph showed a fracture of the posterior arch of the atlas. The anteroposterior skiagraph taken through the mouth

showed the mass of the atlas higher on the right than on the left and an apparent fracture of the odontoid process.

Treatment.—Protection of the neck by means of a supportive collar apparatus.

Result.—Final relief of symptoms as long as support was worn (?).

Diagnosis.—Fracture of the posterior arch of the atlas. Probable fracture of the odontoid process. Probable rotary dislocation of the atlas on the axis on the right.

CASE IV. (Case of Dr. F. H. ALBEE, New York).—Miss S., 18 years of age. Two brothers died of tuberculosis. Six weeks before being seen patient caught a severe cold and had a stiff and painful neck. Continued at work for three weeks. On returning from work a man rushing for a car bumped into her, giving her neck a severe twist. The blow did not knock patient down, but she was immediately seized with severe pain in neck and shoulders, and her head had to be supported on her hands all the way home. She was in bed three weeks, then transferred to the Hospital for the Ruptured and Crippled, in the service of Dr. W. R. Townsend, where the following notes were made.

Patient is obliged to hold the head with her hands when sitting or standing. While lying down she usually steadies head with hand. Cervical spine held carefully and rigidly. The head is inclined forward. The cervical spine has lost its normal contour. The forward curve is much exaggerated at its upper part. Neck is tender.

A skiagraph taken soon after entrance shows an apparent separation of the atlas from the axis, the latter bone presenting no sign of an odontoid process. The atlas is more anterior than normal and there is in the skiagraph a clear space of nearly a centimetre between the bones.

Treatment.—Plaster "Minerva" jacket was applied. Later a Taylor spinal brace and chin support was fitted and in this the patient left the hospital.

Result.—Eleven months after accident still wearing apparatus and free from pain. She cannot hold the head up without some support. The spine is less sensitive to passive movements. A prominence can be felt on the posterior pharyngeal wall. Skiagraph at this time shows no open space between atlas and axis

but a still existing marked forward displacement of atlas. No shadow of the odontoid process is seen.

Diagnosis.—Forward displacement of the atlas. Question of tubercular disease.

Case illustrates that the atlas can be displaced far forward without symptoms of cord pressure.

CASE V. (Case of Dr. DAVID SILVER, Pittsburg, Pa.)—S. F., age 9 years. Thirteen months before being seen one of the boy's playmates "bumped" S. F.'s head against a stone wall. Immediate soreness in the neck with some swelling on the right side ensued. Head had to be lifted from the pillow with his hands and patient would scream if not moved carefully. Pain extended up over right occiput and down the right shoulder. Improvement gradual.

Physical Examination.—Chin held slightly to the right with head tilted to the left. Movements of the cervical spine good except right lateral bending, which is moderately limited. On the right side in a spot corresponding to the position of the transverse process of the atlas a distinct bony prominence can be felt. Lateral radiograms essentially negative, except that the atlas casts a shadow more anterior than normal. Anteroposterior radiogram taken through the mouth showed a rotary dislocation of the atlas on the axis. Odontoid apparently intact. Cutaneous test for tuberculosis negative.

Treatment.—At first extension in recumbency. Later Thomas collar. Now wearing no apparatus (two years, eight months since accident).

Diagnosis.—Rotary dislocation of the atlas on the axis.

Result.—Improved position of head and freer movement. Still present (June, 1909) a slight tendency to hold the head to the left.

CASE VI.—D. F., Massachusetts General Hospital, W. Surg. Records, vol. 447, p. 101. September 8, 1903 (entrance). Five and a half months before entrance was in a railroad accident, sustaining severe scalds about shoulders and arms, and scalp wounds. The sight of right eye was destroyed. After accident head was found to be thrust slightly forward and immovable; no paralysis. Two months after accident, while head was being bandaged, something slipped, and could move head more freely. Ever since accident there has been difficulty in swallowing owing to a "ledge" in the back of his throat.

Physical Examination.—Head thrust forward and attitude like that of a stork; slight sideways and rotary motion. X-ray shows a dislocation of the atlas on the axis forward and downward, with possible fracture of the articular processes (see Fig. 10).

September 9: Manipulation under ether with head traction and rotation. Adhesions gave way, click felt, and head in more normal position; plaster helmet for one month. Head could at end of this time better be supported without apparatus. "Ledge" had disappeared from posterior pharynx, but second cervical spinous process was displaced to the left. Sent out with new plaster helmet, October 8, 1903.

Re-entry, January 25, 1904. Well up to one month ago when neck began to grow stiff and sore, and three weeks ago prickly sensation began in right hand. Two weeks ago right foot affected. At entrance loss of power in both hands and both feet and spastic condition of upper and lower limbs. Examination of pharynx shows no recurrence of "ledge."

Operation, January 29, Dr. Mixter.—Laminectomy of third and fourth cervical vertebræ. Arches of atlas, and axis found ankylosed and depressed, pressing into cord apparently from callus formation. These pressing protuberances removed. Fixed on Bradford frame. Improvement in pressure symptoms in both arms and legs continued for about four weeks.

On the night of February 26 sneezed; felt something give way in his neck and became completely paralyzed. Head traction employed without effect. Died March 1. Temperature 107.5°. No postmortem allowed.

Diagnosis.—Complete dislocation of atlas on axis. Fracture of arches of atlas and axis.

CASE VII.—J. J. C., single, laborer. The patient fell from a staging about sixty feet, striking on the right shoulder and side of the head and the neck; taken to a hospital; unconscious for sixteen hours; in bed three weeks. Head was stiff; pain on the right side of the head running over occiput, and the neck very much ecchymosed and swollen. There was difficulty in raising both arms, especially the right; no other signs of paralysis or paresis. No X-ray was taken and he returned to his home in three weeks. Pain continued; unable to be up more than for a few hours. One month ago reported at the Massachusetts

General Hospital. No definite lesion was at that time made out.

Seen by the writer seven weeks after accident. Stands with head to the right, chin to the left, with slight but distinct asymmetry (cf. Fig. 11); reflexes normal; pupils equal and react to light and distance; motions of the spine and other joints normal. The line of the spinous processes is apparently straight, not well defined in the upper part of the neck, where there is some spasm of the muscles. Voluntary forward and back motions of the head most markedly restricted. The rotation to the right is the most marked limitation of all motions. Lateral motions are quite free. All motions are painful when carried to the limits of muscular resistance. On palpation a mass can be felt between the mastoid process and the angle of the jaw on the left, more prominent than on the right. Inspection of the thorax negative, but palpation shows a greater bony prominence on the right side. Anteroposterior X-ray taken through the mouth shows no fracture of the odontoid but simply asymmetry of the two lateral masses of the atlas. Lateral X-ray shows an apparent fracture of the posterior arch of the atlas (Fig. 12).

Diagnosis.—Fracture of the posterior arch of atlas on the right. Rotary dislocation of the atlas on axis.

Treatment.—Hydrotherapy. High frequency. Thomas collar.

Result.—Gradual disappearance of pain and increase in mobility of head.

BIBLIOGRAPHY.

- v. Assen (J.): Zeitschr. f. Orth. Chir., Bd. xxi, 1-3, p. 117.
 Bacon: University Med. Magazine, 1891, iii, 182.
 Bayard: Boston Med. and Surg. Jour., 1870, N. S., v, xliii.
 Berndt: Deut. Zeitschr. f. Chir., 1893, Bd. xxxv.
 Bernstein: Deutsche Zeitschr. f. Chir., lxx, 174.
 Billot de Picque: Bull. et Mém. de la Soc. de Chir. de Paris, 1900, xxvi, 23.
 Broca: Bulletin de la Soc. de Chir., 1863, 3rd series, 549.
 Buisson: Bulletin de l'Académie de Méd. de Paris, 1852-1853, xviii, 102.
 Corner: Chir. Soc. Trans., London, 1905. ANNALS OF SURGERY, Jan., 1907, p. 9.
 Cortes: Malgaigne's Fractures, 1907, 329.
 David: Bulletin de la Société Anatomique de Paris, 1888, lxiii, 910.
 Delbert: Bul. et Mém. de la Soc. de Chir. de Paris, Jan. 17, 1900.
 Dupont: Bulletin de la Société Médicale de la Suisse, 1876, x, 65.
 Eberman: Am. Jour. of Med. Sciences, Phila., 1879, N. S. vol. lxxviii, p. 590.
 Gibson: Lancet, 1885, ii, 429.

- Gurlt: Handb. u. Leh. v. d. Kochenbrüchn, 1862, Bd. ii.
Hamilton: Quarterly Journal, Dublin, 1872, vol. i, S. 459.
Hesse: Beiträge zur klin. Chir., 1895, xiii, 93
Keate: Med. Gazette, London, 1835, vol. xvi,
Kissinger: Zentralbl. f. Chir., 1900, Bd. xxvii, S. 933.
Kocher: Mittel. a. d. Grenzgebieten d. Med. u. Chir., 1896, Bd. i.
Küster: Arch. f. klin. Chir., Bd. xxxi, S. 218.
Lannelongue: Compt. Rend. de l'Academie des Science, Paris, 1904,
cxxxix, 495-6.
Legg: Lancet, 1893, ii, 1382.
Lloyd: Am. Jour. Med. Sciences, 1904, vol. cxxviii.
May: Am. Jour. Med. Sciences, 1876, vol. lxxii.
McCarthy: Trans. Path. Soc., London, 1874, vol. xxv.
Montreal General Hospital Report, 1880, p. 141.
Morestin: Bull. et Mem. de la Soc. Anat., Paris, vol. x.
Romm: Beitr. z. klin. Chir., Bd. xlvii, S. 626.
Scott: Brit. Med. Jour., 1904, vol. i, S. 247.
Stokes: Brit. Med. Jour., 1871, vol. ii.
Unde (Hagemann) and Boettger: Archiv. f. klin. Chir., 1878, xxii, 217.
Wade: Medico-Chirurgical Transactions, Royal Med. and Chir. Soc., Lon-
don, 1849, vol. xxxii.
Wagner: Arch. f. klin. Chir., Bd. xxxi, S. 192.
Wagner and Stolper: Deutsch. Chir., Leifg. xl.
Walton: Boston Med. and Surg. Jour., vol. cxlix, No. 17, Oct. 15, 1903,
p. 445.
Wilson: ANNALS OF SURGERY, April, 1907, p. 632.
Wittek: Arch. f. Orth., 1906, vol. iv, No. 4.