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FRACTURES AND SUBLUXATIONS OF THE ATLAS AND AXIS

A Follow-up Study of 20 Patients

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Since Crutchfield, in 1933, introduced cranial traction, the results of treating fractures of the atlas and axis have changed. Prior to that time, Osgood & Lund (1928) had reported a mortality of about 50 per cent, but during recent years it has declined to less than 10 per cent (Amyes & Anderson 1956, Rogers 1961, Schmidt & Lohr 1969).

In the literature there is a marked difference of opinion as to whether the primary treatment should be conservative or operative. Conservative immobilization in fractures of the odontoid process of the axis is preferred by several authors (Amyes & Anderson 1956, Blockey & Purser 1956, Böhler 1965, Hambly 1944, Nachemson 1960), who claim that this treatment results in union of the fracture, provided that an early diagnosis is made and provided that reduction and immobilization are sufficient. Others (Alexander et al. 1958, Cone & Turner 1937, Wilson 1963) have found the risk of re-dislocation to be so great that primary operative treatment is invariably indicated.

Ramadier & Bombart (1963) found that among 152 fractures of the cervical spine, one-third affect the uppermost two vertebrae. The most common type of atlanto-axial fracture is that of the odontoid process (Böhler 1965, Osgood & Lund 1928, Ramadier & Bombart 1963, Wilson 1963) the mechanism of which is hyperflexion or hyperextension of the upper part of the cervical spine. Frequently, the fracture is accompanied by a forward or backward dislocation of the odontoid process and the atlas. Other fractures involving the 1st and 2nd cervical vertebrae are fractures of the atlantal arch, of the axial arch, and of the axial body.

The purpose of the present study was to try to assess the late

results of conservative *versus* operative treatment in cases of fractures and/or subluxations of the atlas and axis.

M A T E R I A L

During the period 1960–1968 a total of 29 primarily surviving patients (8 females and 21 males) with traumatic fractures and/or subluxations of the atlas and axis were treated in the Orthopaedic Hospital and in the Neurosurgical Department, Bispebjerg Hospital, Copenhagen. Among these 29 patients 4 had died at follow-up and 5 failed to present themselves in spite of repeated requests. The material, then, comprises 20 patients. One female and 7 males, average age 31 years (range 6–64) had been treated operatively, whereas 4 females and 8 males, average age 51 years (range 26–80), had had conservative treatment. All had a clinical and all but one a radiological follow-up examination. The follow-up period ranged from 1–9 years, average 4½ years, after the accident. The X-ray examination included ordinary anteroposterior and lateral views as well as views in extreme flexion and in extreme extension of the cervical spine. In addition, sagittal and frontal tomography was obtained of all fractures involving the odontoid process.

All the patients had primarily had neck pain, a fixed posture of the head, and restricted mobility of the cervical spine. In connection with the trauma one patient developed tetraplegia, whereas the others did not exhibit acute neurological signs.

In 14 of the 20 cases the fracture was diagnosed on the day of the accident, in 2 cases 3 and 5 days later, while in 2 cases, 4 weeks and in another 2 patients, 4 and 5 months elapsed before the diagnosis was confirmed.

A total of 12 fractures involved the odontoid process. One of these was accompanied by fracture of another cervical vertebra. The atlas and odontoid process were dislocated in 6 cases, backward in 2 and forward in 4. In 4 cases there was a forward dislocation of the atlas without an associated fracture of the odontoid process. One of these patients had an odontoid ossicle, one had rheumatoid arthritis, and one was a child aged 6 years. In the latter patient there was no explanation why the atlas could get subluxated without an associated fracture of the odontoid process.

As is apparent from Table 1, all patients with fractures of the odontoid process without displacement had been treated conservatively by immobilization in Camp's collar for 10 to 36 weeks, average 20 weeks. One patient aged 80, with chronic bronchitis and respiratory embarrassment, was immobilized for only 4 weeks.

Surgical treatment had been preferred in 7 of the 10 cases of dislocation of the atlas with or without odontoid fracture. Five were primarily treated by fusion. One of the remaining 2 did not have the operation until 5½ months after the trauma, when he developed signs of cord compression. In the other one the fusion was done because of non-union of the odontoid process not diagnosed until 5 months after the accident. The remaining 3 patients of these groups were treated conservatively. In one case, this was done because the dislocation of the atlas was so slight that operative fixation was not believed to be indicated. In another case there was contra-indication in the form of a co-existing disease. The third patient was treated in a department in which the attitude to these fractures was conservative. Two of the patients were treated with Camp's collar for 3 and 6 months

Table 1. Shows the type of fracture and treatment.

| Type of fracture | No. of patients | Treatment | |
|---|-----------------|-----------|--------------|
| | | Surgical | Conservative |
| Fracture of the odontoid without displacement | 6 | 0 | 6 |
| Displacement of the atlas with fracture-dislocation of the odontoid | 6 | 4 | 2 |
| Displacement of the atlas without fracture of the odontoid | 4 | 3 | 1 |
| Fracture of the arch of atlas without dislocation | 1 | 0 | 1 |
| Fracture of the arch of axis without dislocation | 2 | 0 | 2 |
| Fracture of the arch of axis with dislocation | 1 | 1 | 0 |
| Total | 20 | 8 | 12 |

respectively, the third one by cranial traction for 3 months followed by Camp's collar for 3 months.

All patients with fractures of the atlantal arch or axial arch without displacement (3 in all) were treated conservatively (Camp's collar for 6-12 weeks). The only one of these fractures which was displaced was treated by fusion.

Out of the surgically treated patients 5 had had posterior fusion of the 1st and 2nd cervical vertebrae, whereas 3 had had posterior fusion of the 1st, 2nd, and 3rd cervical vertebrae. The operation had been performed after the fracture had been reduced by a week or two of cranial traction and the subluxation of the atlas had been reduced. Fixation was secured by steel wires around the vertebral arches, splitting of the bony surfaces, and insertion of bone chips or bone grafts from a bone bank.

RESULTS

Table 2 shows that at follow-up 3 patients complained of neck pain. However, in all cases the pain was intermittent and so mild that analgesics were rarely required.

As might be expected, the 8 operated patients had a more marked restriction of mobility than the unoperated patients. They had mild subjective complaints, but all were working in their old jobs. Within the group of unoperated patients, 5 out of 12 had restriction of rotation to less than half the normal. However, 4 of these patients were over 72 years of age and showed signs of cervical spondylosis deformans. Only one patient had signs of cord damage at follow-up.

Table 2. Symptoms of patients treated surgically or conservatively at time of follow-up.

| Symptoms | Neck pain | Loss of rotation (more than 50 %) | Spinal cord symptoms | Vascular symptoms |
|--|-----------|-----------------------------------|----------------------|-------------------|
| Surgical treatment (total 8 patients) | 1 | 8 | 0 | 2 |
| Conservative treatment (total 12 patients) | 2 | 5 | 1 | 0 |

This was the patient with rheumatoid arthritis who still had weakness of all limbs and hyperreflexia. However, the pareses were less severe than prior to the treatment. Two of the operated patients complained of dizziness on bending the head backward, one also of associated headache. Possibly, these symptoms were vascular, although the odontoid process and atlas had been accurately reduced and the fusion was firm.

Out of the 20 patients 19 were X-rayed at follow-up. From Table 3 it is apparent that the odontoid fracture had united in 3 of the 4 operated patients. The patient with the ununited odontoid fracture had not had the fusion operation until the non-union had been recognized 5 months after the trauma. Among the conservatively treated patients 7 showed non-union of the odontoid process. Two of them exhibited instability of the atlas on X-rays taken during extreme flexion and extreme extension of the cervical spine. Table 4 shows that yet another patient had an unstable atlas, viz. the conservatively treated patient with rheumatoid arthritis. In this patient the atlas slid 10 mm forward during maximum forward flexion. X-rays of the cervical spine during extreme flexion and extreme extension in the

Table 3. The result of the surgical and conservative treatment of fractures of the odontoid estimated by routine roentgenograms supplemented by tomograms of the odontoid process.

| Treatment | Healing of the fracture Number of patients | Pseudarthrosis of the odontoid process Number of patients |
|---------------------------------|---|---|
| Surgical (total 4 patients) | 3 | 1 (see text) |
| Conservative (total 7 patients) | 3 | 4 |

Table 4. The result of the roentgenograms of patients with fracture dislocation of the odontoid process and atlas or atlas dislocation during extreme flexion and extension.

| Treatment | Stability of atlas Number of patients | Instability of atlas Number of patients |
|---------------------------------|--|--|
| Surgical (total 7 patients) | 7 | 0 |
| Conservative (total 8 patients) | 5 | 3 |

surgically treated patients confirmed that the fusion was firm in all cases. The uppermost cervical vertebrae moved *en bloc*. All the fractures of the atlantal and axial arches had united.

Radiography showed incipient development of spondylosis deformans in two out of the 8 operated patients at follow-up. The spondylosis affected the segments immediately below the fusion. In both cases the atlas was displaced 10 mm forward, so that the normal lordosis of the cervical spine had been replaced by kyphosis. Therefore, the development of spondylosis deformans in these two cases must be presumed to have been induced by the altered load on the underlying vertebrae and discs. In the remaining 6 operated patients, in whom there were no signs of spondylosis deformans, the odontoid process and atlas had been reduced to the normal anatomical position.

At follow-up one of the 12 conservatively treated patients had developed unilateral osteoarthritis of the atlanto-axial joint, whereas 4 patients exhibited increasing degeneration of the intervertebral discs and spondylosis deformans. The apparent higher frequency of spondylosis deformans among the conservatively treated patients must be taken with reservation, as the average age of this group was 51 years against 31 years in the operated group. (Four of the conservatively treated patients developing spondylosis deformans were all past 70 years of age.)

Four patients, aged 61–86 years, had died at the time of follow-up. Three had had odontoid fractures with dislocation, and one had had a fracture of the axial arch with forward dislocation of the axial body. All these patients had been treated by conservative measures. The death certificates were inspected. It is striking that 2 of the 4 patients had been found dead and that in these 2 cases the actual cause of death was not established. The other two had died of bronchopneumonia. According to the death certificate, one of them had developed quadriplegia after discharge.

DISCUSSION

The diagnosis of fracture of the first and second cervical vertebrae may be difficult, if the symptoms and signs are slight. However, this possibility should be borne in mind when patients complain of neck pain and restricted rotation in the neck after a head injury. If routine X-rays do not reveal a fracture, they should be supplemented by tomography and oblique views. Fracture and/or subluxation of the atlas had primarily been overlooked for more than four weeks in 4 of the present cases (X-rays of the cervical spine had not been obtained primarily).

Manifestations of cord damage were found in 2 patients of the material. These manifestations are reported to be rare in cases of atlantal and axial fractures in which the patient survives. The explanation may be the good spatial conditions in the spinal canal at the level of these vertebrae (Böhler 1965, Schmitt & Lohr 1969) and the fact that if a cord injury occurs in this site the outcome is usually fatal. It is not possible to decide how often death after head injuries is due to overlooked fractures of the first two cervical vertebrae, as there are often other major injuries which are immediately interpreted as the cause of death.

At follow-up non-union of the odontoid process was found in 4 out of 7 conservatively treated patients. In 2 of these 4 cases the non-union was associated with instability of the atlas. None of the patients had symptoms. However, the risk of developing secondary manifestations of cord damage must be considered great in cases where the non-union is associated with radiologically demonstrable instability of the atlas. A patient who had been primarily treated by conservative measures developed signs of cord compression 5½ months after the accident. At this time, X-ray examination showed non-union and instability of the atlas. (After a fusion operation the patient was free of symptoms at follow-up.) A patient who had died at the time of follow-up had developed quadriplegia after discharge. This patient also had radiologically demonstrable non-union (but was not subjected to operation because of advanced age). Lastly, it cannot be ruled out that in one or more of the other deceased patients death may have been caused by acute dislocation of the atlas. Several authors have pointed out the same risk of developing secondary myelopathy (Crutchfield 1933, Dunbar & Bronson 1961, Rogers 1961).

All the osteosynthesis-fusions healed primarily. After the operation

rotation in the cervical spine was less than half the normal rotation. This restriction caused minor complaints, but did not interfere with the patients' daily activities or work and had not in any case necessitated a change of occupation.

Judging by the present material, early operative treatment of unstable atlantal and axial fractures is preferable, as all the fused cases healed without major sequelae, whereas several of the conservatively treated patients have already developed cord symptoms, or it is feared that they will do so. Moreover, the operatively treated patients can be mobilized more quickly and can return to work sooner.

SUMMARY

The result of a follow-up study of 20 patients with fracture and/or subluxation of the atlas and axis is submitted. Twelve patients had been treated by conservative measures and 8 by operation. Apart from a clinical examination, the follow-up included conventional X-ray examination supplemented by tomography and by X-ray studies during extreme flexion and extreme extension. Surgical treatment consisted of posterior fusion of the 1st-2nd or 1st-3rd cervical vertebrae. All healed by primary intention and did not give rise to major complaints. The postoperative course had always been uncomplicated. Out of 8 conservatively treated patients with fractures of the odontoid process of the axis, 4 exhibited non-union (asymptomatic). One patient, who had not undergone operation until 5 months after the injury, had cord symptoms which responded to the operation. Four of the conservatively treated patients had died at the time of follow-up. One of them had developed quadriplegia and two had been found dead. At the X-ray studies done during extreme flexion and extreme extension, instability of the atlas was found in 3 out of the 12 conservatively treated patients but in none of the operated ones.

It is concluded that early operative treatment of unstable atlantal and axial fractures is preferable to conservative treatment which involves a risk of non-union and cord symptoms.

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