FRACTURES OF THE ODONTOID PROCESS CONSERVATIVE AND OPERATIVE TREATMENT PROGNOSTIC FACTORS

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In a retrospective study 33 fractures of the dens were analyzed. Nonoperative treatment was successful in types I and III, but unsuccessful in 48.5% of type II fractures. In addition to the poor outcome factors of Schatzker (7), the classification of Roy-Camille (6) is a valuable prognostic factor.

Keywords : fracture of the dens ; analysis.
Mots-clés : fracture de l'odontoïde ; analyse.

INTRODUCTION

The treatment of fractures of the odontoid process remains controversial. Such fractures have been the subject of many investigations concerning neurologic complications, nonunion rates, best method of treatment, and prognostic factors, among others.

To guide the treatment and predict the prognosis Anderson and D'Alonzo proposed a classification that divided the fractures of the dens into 3 categories (1) (fig. 1). Type I fractures (fractures through the upper part of the odontoid process) are rare and are treated by simple immobilization. Type II fractures (at the junction of the odontoid process with the vertebral body of C2) are common ; they have a high rate of nonunion and their treatment remains controversial. Type III fractures (through the vertebral body of C3) unite with halo-immobilization. Union in type III fractures is not a problem because of the large cancellous fracture surface.

Proponents of both conservative and surgical management can be found, especially in the treatment of type II fractures. No single method of treatment has become universally accepted. Failure may result in nonunion with subsequent instability and cervical myelopathy. Prognostic variables for union include the direction and magnitude of

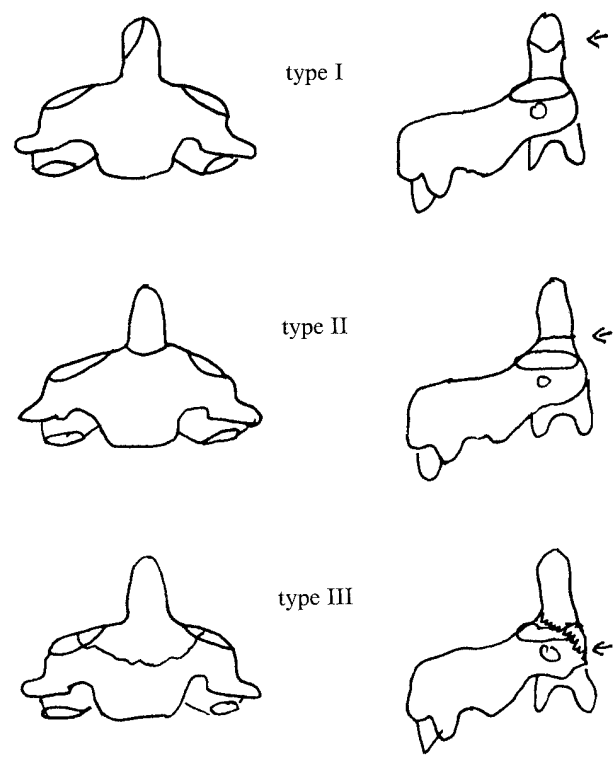

Fig. 1. — Types of Anderson and D'Alonzo.

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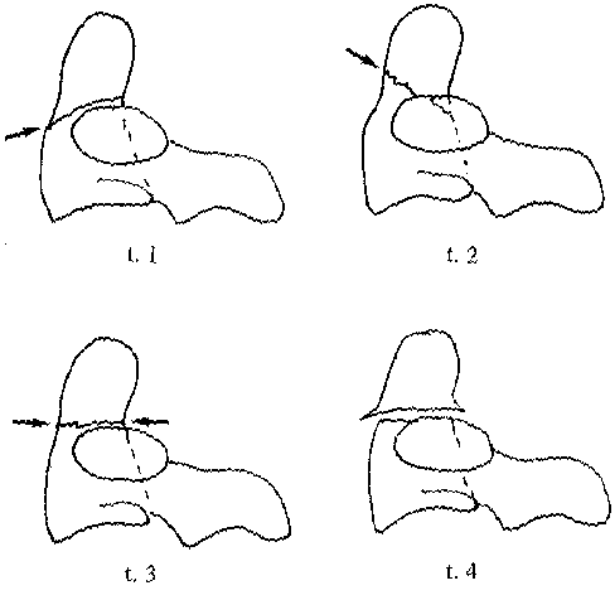
the fracture displacement, initial treatment, patient age, and delay in diagnosis. Delay in diagnosis is common ; the patient is often unconscious or has associated head trauma. Neurological damage is infrequent, ranging from tetraplegia to irritation of the greater occipital nerve.

MATERIALS AND METHODS

A retrospective study of 33 patients with fractures of the odontoid process treated at the orthopedic department of the University Hospital, Leuven, Belgium, from 1960 to 1987 was undertaken. The charts and roentgenograms of the 33 patients were reviewed. The charts were analyzed for demographic data, mechanism of injury, associated trauma, neurologic deficit, other spinal fractures, treatment and end results. Radiographs were examined to determine the type and displacement of the fracture. Fractures of the odontoid process were classified according to the method of Anderson and D'Alonzo (1). A subclassification for type II fractures had been used (6) (fig. 2).

Patients were contacted for clinical review and radiographic dynamic study. Fifteen patients could be examined ; the others were lost to follow-up and one had died. Three patients could be contacted by phone.



Type 1 — fracture line inclined forwards
Type 2 — fracture line inclined backwards
Type 3 — horizontal fracture
Type 4 — fracture "English policeman's hat"

Fig. 2. — Subtype of Roy-Camille.

All patients in this study had a complete radiographical dossier with tomograms, dynamic radiographs and radiographs until follow-up time. With these documents the union rate or established pseudarthrosis could be easily observed in both examined patients and patients who could not been reached. Rates of union or non-union were uniformly distributed in both groups.

RESULTS

There were 27 male and 6 female patients with an average age of 37.9 years (range 1 to 75). There was one type I fracture, 28 type II fractures and 4 type III fractures. One case of a type II fracture as reported by M. N. Hadley (4) (type II fracture with comminution of the base of the dens) was discovered by tomograms (fig. 3). Follow-up time averaged 8.3 years ranging from 2 to 17 years. One patient died from a hip fracture 2 years after consolidation of his dens fracture.

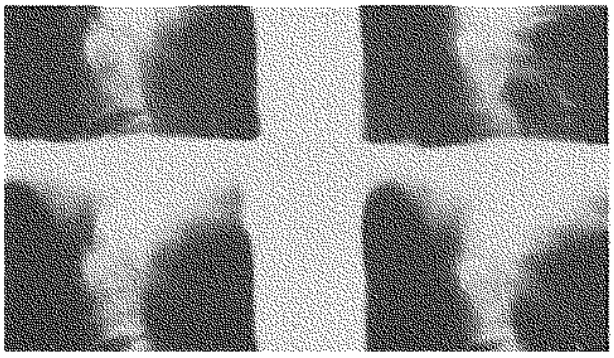


Fig. 3. — Fracture of Hadley.

In 15 of our cases the dens fracture was the result of a fall on the head ; a car accident was the cause in 18 others. Delay in diagnosis was noted in 12 cases with an average time of 9.4 weeks with two extreme cases (one fracture was discovered after one year of intermittent neck pain, another was diagnosed after 10 months). It was impossible to determine the exact mechanism of injury in our patients. Associated injuries were noted in 21 patients (table I). Closed head injury was the most commonly associated injury and occurred in 7 patients ; 6 patients had other cervical fractures. Eleven patients had cord symp-

toms related to the fracture at the time of injury (table II). Some minor degree of neurological involvement was noted in 10 others.

All patients were placed initially in halo traction and subsequent halo jacket or Minerva cast for an average of 3.9 months until union or second treatment (posterior fusion). Our 4 cases of type III fractures and our one case of type I dens fracture achieved primary healing with a Minerva cast.

Finally union was determined by the presence of trabecular union on tomograms (in 24 cases). Stability was tested by flexion-extension films (in 22 patients) or dynamic radioscopy (in 15 cases). Stability of the atlantoaxial joint and of the odontoid process was analyzed. There was no atlantoaxial instability. In 6 cases a partially fibrous, partially osseous union was present. One instability of the posterior fusion mass was discovered (in our 13 operated cases), as well as two asymptomatic stable nonunions (probably partially fibrous unions) and one unstable and asymptomatic fibrous union in our nonoperated patients.

Displacement in both sagittal and frontal planes was examined on radiographs at the time of injury and at follow-up time and was noted in 17 cases. Angulation was noted in 13 patents (7 of which resulted in nonunion ; there was an average angulation of 20% compared to 15% of the union group).

Problems arose with type II dens fractures (table III). Fusion was done in 13 patients. Fusion was performed posteriorly with autologous iliac crest bone without instrumentation. Postoperatively a halo jacket was applied for 3 months and changed for a cervical collar until the patients were free of symptoms. In 4 cases a C1-C2 fusion was done, in 5 cases a C0-C2 fusion and in another 4 patients a C0-C3 fusion. The fusion was considered solid after an average time of 18 weeks.

Table I. — Injuries associated with fractures of the dens

	Number of cases
Closed head injury	7
Scalp laceration	3
Atlas fracture	5
C4 fracture	1
Skull fracture	2
Ankle fracture	1
Metacarpal fracture	1
Metatarsal fracture	1
Scapula fracture	1
Rib fracture	1
Luxation C1-C2	2
Thoracic spine fracture	1
Pulmonary contusion	1
Nasal fracture	1

(Combination of two or more injuries in one patient possible)

Table II. — Neurologic injuries associated with fractures of the dens

	Number of cases
Transiente paralysis	3
Occipital neuralgia	4
Pyramidal syndrome	5
Ulnar paresthesia	2
C5 paresthesia	1
Central cord syndrome	1
Hemiparesis	2
Deltoid paralysis	2
Nystagmus	1

Table III. — Analysis of subtypes of Roy-Camille in Type II of Anderson and D'Alonzo (N = 28)

		Delayed union	Non-union	Unstable fibrous union	Fusion
Type 1	2	2			2
Type 2	11	1	6	1	7
Type 3	14	2	3		3
Type 4	1		1		1

In the fused group one brain abscess developed through an infected halo pin, but the patient recovered without problems. At follow-up one pseudarthrosis of a fusion mass and 4 occipital neuralgias were diagnosed.

DISCUSSION

A review of the literature reveals a variety of opinions as to the treatment of odontoid fractures. This variety is caused by high rates of nonunions

following conservative treatment (range 4-64%) (table IV), (3). There is a tendency in the neurosurgical literature to consider surgical fusion in the initial treatment of all types of odontoid fractures ; whereas orthopedic surgeons seem to be more conservative.

Table IV. — Review of results in literature (Fuji, 1988)

Rate of nonunion of conservatively treated odontoid fractures				
		No. of cases	No. of nonunions	Rate (%)
Amyes	1956	53	2	4
Schweigel	1979	22	1	5
Bohler	1965	36	2	6
Schiess	1982	18	2	11
Roberts	1973	40	8	20
Wang	1984	25	5	20
Fuji	1988	22	5	23
Anderson	1974	37	9	24
Apuzzo	1978	40	13	33
Nachemson	1960	18	8	44
Our study	1990	33	16	48,5
Althoff	1979	47	23	49
Schatzker	1971	22	14	64

Apuzzo *et al.* (2) advised that all fractures displaced more than 4 mm or occurring in patients over 40 years of age should be operated on primarily. Anderson and D'Alonzo (1) recommended primary fusion for all type II fractures because of the high nonunion rate after conservative treatment. Schatzker *et al.* (7) suggested that the high rate of nonunion might be explained by backward displacement and extensive displacement.

All our nonunions had at least one of the poor outcome factors of Schatzker (older than 40 years, type II fracture, displacement of more than 4 mm). In contrast we noted predominantly anterior displacement rather than a posterior displacement.

The type II fracture reported by M. N. Hadley (4) is a comminuted type II fracture with associated free fracture fragments. Because this fracture is quite unstable and cannot be realigned, early surgical fusion is advocated, as we did in our case.

Types I and III fractures of the odontoid generally enjoy a good prognosis for union when treated with immobilization. We had one type I fracture and 4 type III fractures that healed with an average of 3.5 months of immobilization.

As stated by R. Roy-Camille *et al.* (6) the prognosis of the fractures of the odontoid process could be based on an evaluation of the direction of the frature line : instability is found in cases of comminution or with an oblique fracture line (fig. 2). An anteriorly orientated fracture line (type 1 according to the classification of R. Roy-Camille) permits the fracture to displace anteriorly. In fractures with a posteriorly oriented fracture line (type 2 fractures) the displacement is more serious and the risk for nonunion high (of the 11 subtype 2 fractures, 7 were fused). In one type 2 fracture without secondary treatment an unstable asymptomatic fibrous union developed. A horizontal fracture line (type 3) was noted in 14 cases ; only 3 needed posterior fusion. One of these fused patients had an asymptomatic pseudarthrosis of the fusion mass. Finally type 4 fractures are fractures with a comminuted base, like an "English policeman's hat" (R. Roy-Camille (6)). They are very unstable and require surgical treatment. We had one type 4 fracture that was fused. The overall nonunion rate was 48.5% ; which is quite high compared to other studies (table V), but which is partially explained by the high referral rate (18 cases out of 33 cases with delayed diagnosis or delayed union) to our university hospital.

Posterior fusion is a suitable technique for nonunion or delayed union of the odontoid fractures. Of the 13 patients with a posterior fusion 12 were successful (success rate of 92%, which can be compared with the 90% union rate of Ramadier *et al.* (5)). The procedure is less dangerous than posterior wiring or anterior screwing. However it restricts atlantoaxial motion, which was a major finding in our fused patients. Rotation was grossly restricted in all fused patients.

CONCLUSION

Type I and III odontoid process fractures have a good prognosis for union when treated with the halo device. Type II fractures had a nonunion rate of 48.5% owing to several factors (delay in diag-

nosis and treatment, subtype 1 and 2 of Roy-Camille). They can be treated simply with posterior fusion with good results (92% union rate).

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SAMENVATTING

E. VAN HOLSBEECK, D. STOFFELEN en G. FABRY. Densfrakturen. Conservatieve en heelkundige behandeling. Prognostische factoren.

Retrospectief werden 33 densfrakturen geanalyzeerd. Conservatieve behandeling was succesvol in types I en III, doch niet in 48.5% van de types II frakturen. De classificatie van Roy-Camille geeft tesamen met de criteria van Schatzker mogelijke prognostische informatie.

RÉSUMÉ

E. VAN HOLSBEECK, D. STOFFELEN et G. FABRY. Fractures de l'apophyse odontoïde. Traitement conservateur et chirurgical, facteurs pronostiques.

Trente-trois fractures de l'odontoïde ont été revues. Le traitement conservateur a donné de bons résultats dans les types I et III, mais était insuffisant dans les types II. La classification de Roy-Camille ainsi que les critères de Schatzker ont une valeur pronostique.