Treatment of type-two odontoid fractures in halo thoracic vests

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We treated 22 patients with type-two odontoid fractures in halo thoracic vests for six to eight weeks followed by a Philadelphia collar for four weeks. Eighteen patients were reviewed by questionnaire and radiography at a mean of 40 months after injury. We assessed union, fracture position, the degree of permanent pain and stiffness, satisfaction with the treatment and the outcome.

The overall union rate was 82%. Posterior malunion with residual posterior displacement or angulation was associated with a higher incidence of persisting pain. The position at union did not correlate with the residual cervical stiffness. Fractures failed to unite in four patients (18%) none of whom had late neurological sequelae, although they had more late pain. There were associations between the development of nonunion and an extension-type injury, age over 65 years and delay in diagnosis.

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Fractures of the odontoid process are relatively rare, comprising 7% to 19% of those involving the cervical spine.¹⁻⁵ They are classified into types 1, 2 and 3 according to the position of the fracture in the dens.⁶ Type-2 fractures occur in the narrow portion where the bone is mostly cortical and account for 46% to 92% of odontoid fractures.^{1,2,6-8}

The choice of the best treatment for type-2 fractures is difficult. Nonunion is common ranging from 11% to 63%.^{1,2,6,7,9-11} Factors predisposing to nonunion include old age,^{11,12} posterior displacement of the fracture,¹¹⁻¹³ fracture distraction,^{14,15} lateral displacement on the antero-posterior radiograph,¹⁵ displacement greater than 4 mm^{11,13} and delay in treatment.^{9,15}

Type-2 odontoid fractures can be treated non-operatively with skull tongs, a halo thoracic device or with an extended cervical brace.¹⁶ More recently, internal fixation has been advocated for treatment of both fresh injuries and non-union.^{6,13,17,18} There is still some controversy about the choice of the best treatment, and it is reported that patients over 60 years of age have high rates of nonunion after non-operative treatment.^{2,11,12,19,20}

Past studies of the treatment of type-2 odontoid fractures have used union as a successful outcome and nonunion to describe an unsatisfactory result. We have investigated the influence of nonunion and malunion on the long-term disability, and have also considered the temporary disability experienced by elderly patients on halo thoracic brace treatment.

Patients and Methods

From January 1990 to December 1996, we treated 43 patients with fractures of the odontoid. The fracture was type 2 in 28; there were 19 men and nine women (Table I). The mechanism of injury was a motor-vehicle accident in 11 patients (39%), a fall at ground level in nine (32%), a bicycle accident in three (11%), a fall from a horse in two, a fall from a height in two and a rugby tackle in one.

Of the 28 patients, 22 had treatment in a halo thoracic vest (HTV) of whom 18 were available for follow-up. Nine attended for clinical review and radiography and completed a questionnaire. The other nine had a telephone questionnaire and a radiograph was arranged by their local practitioner. Questions were asked about residual stiffness (none, mild, moderate and severe), level of residual pain (none, mild, moderate and severe) and the frequency of pain (none, occasional, frequent and constant). Patients rated their satisfaction and outcome using a scale of very satisfied, satisfied, non-committal and not satisfied. Three of the four patients who could not be followed had died from unrelated causes and the fourth had emigrated. According to hospital records the fractures had united in all four.

The halo thoracic devices were applied in the treatment room of the hospital ward with the patient lying supine. The halo pins were inserted under local anaesthesia (lignocaine 1%) and the halo was connected to the chest piece of the device with the neck held in a neutral position.

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Table 1. Details of 28 patients with type-2 odontoid fractures

Case	Age (yr)	Mechanism of injury	Position at injury†	Classification at injury†	Position in halo vest†	Delay in diagnosis (days)	Treatment	Length of immobilisation (days)	Problems during treatment	Follow-up (mth)	Outcome
1	20	MVA*	35° E/2 mm P	E	35° E/U	-	HTV	50	-	12	Union
2	42	MVA	37° E/7 mm P	E	N/U	-	HTV	72	-	41	Union
3	54	Fall	15° E/2 mm P	E	25° E/6 mm P	49	HTV	119	-	58	Nonunion
4	56	MVA	N/2 mm P	E	N/2 mm P	-	HTV	48	-	68	Union
5	72	Bicycle	N/8 mm A	E	25° E/2 mm P	34	HTV	41	-	23	Nonunion
6	73	Fall	20° E/3 mm P	E	25° E/3 mm P	-	HTV	61	-	41	Union
7	79	Fall	35° E/U	E	20° E/3 mm P	3	HTV	48	-	37	Nonunion
8	79	Fall	15° E/4 mm P	E	15° E/4 mm P	5	HTV	54	-	12	Nonunion
9	80	Fall	32° E/6 mm P	E	35° E/3 mm P	-	HTV	49	-	76	Union
10	81	Fall	30° E/6 mm P	E	30° E/6 mm P	-	HTV	56	-	15	Union
11	84	Height	25° E/2 mm P	E	20° E/6 mm P	-	HTV	44	-	49	Union
12	29	Sport	N/4 mm A	F	N/U	-	HTV	58	-	36	Union
13	42	MVA	10° E/4 mm A	F	N/3 mm A	7	HTV	43	-	19	Union
14	47	Fall	N/5 mm A	F	15° E/7 mm A	25	HTV	22	Fall. Halo removed	71	Union
15	70	MVA	N/9 mm A	F	N/U	3	HTV	36	Pin-site infection	42	Union
16	18	MVA	N/U	Anat	N/U	-	HTV	57	-	70	Union
17	47	MVA	N/U	Anat	N/U	-	HTV	32	Fall. Halo removed	19	Union
18	51	Bicycle	N/U	Anat	N/U	-	HTV	61	-	34	Union
19	25	Horse	N/3 mm A	F	FNA	-	HTV	58	Two readjustments	-	Union. Lost to follow-up
20	59	MVA	FNA	FNA	FNA	4	HTV	56	-	-	Union/deceased
21	71	Fall	30° E/7 mm P	E	10° E/3 mm P	1	HTV	92	One readjustment	-	Union/deceased
22	82	Fall	N/10 mm P	E	FNA	2	HTV	93	-	-	Union/deceased
23	23	MVA	N/U	Anat	N/U	-	Philadelphia collar	13	-	-	Union
24	56	Height	15° E/2 mm P	E	-	-	Odontoid screws	-	Loss of position	-	Union
25	16	MVA	N/U	Anat	N/U	-	HTV/halo traction	3 HTV 40 traction	Loss of position	-	Union
26	60	Bicycle	25° E/3 mm P	E	Deceased	-	-	-	-	-	Deceased (early)
27	66	Horse	FNA	FNA	Deceased	-	-	-	-	-	Deceased (early)
28	90	MVA	N/7 mm P	E	FNA	-	Post-fusion	-	Loss of position	-	Union/deceased

* motor-vehicle accident
† A, anterior; P, posterior; U, undisplaced; F, flexion; E, extension; N, neutral; FNA, films not available; Anat, anatomical

Fig. 1a

Fig. 1b

Fig. 1c

Flexion (a), extension (b) and open-mouth AP (c) radiographs of 59-year-old man at five years after a type-2 fracture of the odontoid treated in a halothoracic device for eight weeks and Philadelphia collar for four weeks. There is persistent nonunion with slight instability. The patient had mild cervical pain but no cervical stiffness, and no neurological abnormalities.

Check radiographs were taken and the device adjusted until the reduction was satisfactory.

Six patients did not complete HTV treatment; two with associated Jefferson fractures died from the complications of high cervical cord injury. One other patient required an early posterior fusion at C1-C2 for loss of position while in the HTV. One patient presented late and had odontoid screw fixation. In one the halothoracic device was removed after three days because the fracture could not be reduced in the vest; he completed treatment in halo traction. The sixth patient had multiple injuries including a burst fracture of T6 with associated paraplegia; the HTV was removed after 13 days and treatment was completed in a Philadelphia collar.

From the initial radiographs the fracture was classified in terms of the degree of displacement and whether it was in flexion or extension. Fractures with the odontoid either angulated or displaced posteriorly were designated extension-type fractures and those with either anterior angulation or displacement were recorded as flexion fractures. In a third group the fractures were undisplaced on the initial views. Follow-up radiographs were examined for the existence of bony union, malunion or nonunion. Fourteen of the 28 patients had additional spinal fractures. The mean follow-up in the 18 patients was 40 months (12 to 76).

Results

The mean period in the HTV was 53 days (22 to 119). In three patients this was removed early because of complications (Table I), but all three fractures united.

Radiological review. Four extension fractures failed to unite (Fig. 1). These patients were advised to have posterior cervical fusion at the C1-C2 level but all refused operation. Their average age was 71 years, all were retired and none developed neurological complications. The fractures which

failed to unite showed displacement of at least 3 mm or at least 20° of angulation on the initial radiographs.

A delay in diagnosis of more than three days was also associated with nonunion. In eight patients with delay in diagnosis this ranged from three to 49 days: four of them had nonunion.

Clinical review. Four (22%) patients were very satisfied with the outcome of their treatment, 12 (67%) were satisfied and two (11%) were non-committal. Nearly all the patients whose fractures had united were either very satisfied or satisfied (89%) and no patient was dissatisfied with their outcome. Many patients complained of some discomfort and three out of those with nonunion had troublesome pain.

The position at the time of final union was correlated with pain and stiffness. Fractures were described as united in flexion, in extension or in the anatomical position. No patient whose fracture had united in the anatomical position complained of significant pain. Of those whose fractures had united with significant posterior displacement and angulation 75% had moderate to severe long-term pain.

Approximately 40% of patients had moderate to severe limitation of movement and we found no correlation between fracture union, the length of time in the HTV, the final position of the fracture, and the degree of stiffness.

Nine patients had already retired at the time of the injury, and eight of the nine who were working returned to work. The remaining patient also had sustained a head injury at the time of the accident.

Discussion

Our results show that conservative treatment with a HTV is effective for type-2 fractures of the odontoid with an 82% rate of union, and confirm previous findings that extension fractures are more likely to have nonunion;^{6-8,13} 36% of

extension fractures failed to unite compared with 100% union for undisplaced and flexion fractures. Incomplete reduction of extension fractures predisposes to nonunion, and although our numbers were small it seems that more than 20° of dorsal angulation, or posterior displacement of 3 mm both increase the risk of nonunion. Delay in diagnosis and treatment also correlated with an increased rate of nonunion.^{9,15} four patients who developed this had delays in treatment ranging from three to 49 days. None of the seven patients with united extension injuries had experienced a delay in diagnosis.

Few studies have looked in detail at long-term functional results after odontoid fractures.^{1,9,13} We found that late pain was more common in elderly patients after prolonged treatment in a HTV, and about 40% of patients had considerable permanent stiffness.

Elderly patients have received particular attention in regard to odontoid fractures, and are considered to be more likely to suffer nonunion even although the injury is usually due to low-velocity trauma in this group compared with younger patients.^{3,9} All our patients with nonunion were older than 56 years, and three were over 72 years. All of them had extension fractures, making the relative contribution of these two factors difficult to separate.

Nonunion may be associated with the delayed onset of quadriplegia, paraplegia or myelopathy.²¹ None of our patients developed late neurological sequelae, perhaps because the period of moderately rigid immobilisation allowed fibrous union of sufficient strength to protect against the progressive deformity which may lead to neurological damage.

Treatment in a HTV for six to eight weeks followed by four weeks in a Philadelphia collar is satisfactory for type-2 odontoid fractures, especially for flexion fractures, undisplaced fractures and extension fractures which have been fully reduced. If extension fractures cannot be reduced and held adequately in a halothoracic device, then early internal fixation or C1-C2 cervical fusion should be advised.

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