Eur Spine J (2000) 9:56–60

ORIGINAL ARTICLE

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Odontoid fractures: high complication rate associated with anterior screw fixation in the elderly

Received: 28 November 1998
Revised: 15 September 1999
Accepted: 25 September 1999

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Abstract This study is a retrospective analysis of patients older than 65 years with odontoid fractures. The series consisted of 29 consecutive patients with odontoid fractures (18 women, mean age 78, range 66–99 years). Twenty-six patients were neurologically intact, Frankel E, whereas three had neurological symptoms: two Frankel D and one Frankel C. Eleven patients were treated with anterior screw fixation according to Böhler, seven with a posterior C1–C2 fusion. Ten patients with either minimally displaced fractures or with complicating medical conditions were treated conservatively. At follow-up, 7/7 patients with posterior fusion had healed without any problems, whereas 8/11 patients treated with anterior screw fixation, and 7/10 conservatively treated patients were either failures or had healed, but after a complicated course of events. We conclude that anterior screw fixation according to Böhler is associated with an unacceptably high rate of problems in the elderly. Probable causes may be osteoporosis with comminution at the fracture site, or stiffness of the cervical spine preventing ideal positioning of the screws. As non-operative treatment also often fails, the method of choice seems to be posterior C1–C2 fusion.

Key words Cervical spine fractures · Anterior screw repair · Posterior fusion · Conservative treatment

Introduction

Fractures of the odontoid process of the axis have been the subject of many investigations, but most articles do not consider the biological impact of age. Few publications cover the subject in the elderly population, although odontoid fractures are the most common fractures of the cervical spine in this age group. There is still a lack of agreement on the best method of treatment among patients over 65 years of age. Conservative treatment carries a high risk of developing non-union [15, 19] as does halo-vest treatment [8]. Posterior C1–C2 fusion according to Gallie has long been the method of choice. The Gallie technique, however, is not biomechanically optimal and has a failure rate of 1/5 [9]. By adding transarticular screws the mechanical situation was improved [14, 16]. Recently, the anterior screw technique according to Böhler [6] has gained increased popularity. In most reports, younger and older patients have been grouped together. Few publications have examined the results explicitly in the elderly population. Berlemann and Schwarzenbach [5] advocated the anterior screw technique in the elderly.

The present study is a review of a consecutive series of odontoid fractures in patients over 65 years of age treated at our department between 1988 and 1994. The results of anterior screw fixation, posterior C1–C2 fusion, and conservative treatment are compared.

Materials and methods

The series consists of 29 consecutive patients (18 women) with a mean age of 78 (66–99) years with odontoid fractures treated at our department between 1988 and 1994. Patient demographics and results are presented in the Table 1. Twenty-four of the fractures were

Table 1 Patient demographics and results (*ASA* American Society for Anesthesiologists)

	Intention to treat[a]		
	Conservative	Direct screw repair	Posterior C1-C2 fusion
Gender			
Female	6	7	5
Male	5	4	2
Trauma grade			
High energy	5	2	3
Low energy	6	9	4
Fracture class (Anderson and D'Alonso)			
II	7	10	7
III	4	1	0
C1 arch fracture			
No	9	11	6
Yes	2	0	1
Neurology (Frankel grade)			
E	10	9	7
D	1	1	0
C	0	1	0
Preinjury morbidity (ASA class)			
1	1	3	0
2	9	6	5
3	1	2	2
Reoperation	2	2 (+2 Abandoned technique perop.)	0
Osseous healing at follow-up			
Healed	2	8	6
Not healed but no healing disturbance	2	1	1
Non-union	6	1	0
Complications			
Abandoned technique perop.	0	2	0
Loosening of screws	0	2	0
Redisplacement	0	1	0
Cardiac failure	0	0	1
Skin blisters from collar	0	1	0
Local neck pain	0	1	0

[a] Indicates the treatment that was initially decided for the patient, not the actual treatment (i.e. after a change of technique during surgery or a reoperation)

type II and five type III according to Anderson and D'Alonzo [3]. In addition, three patients also had ring fractures of C1.

High-energy trauma, defined as anything more forceful than a fall at the same level, was the cause in ten of the patients. Neurological symptoms were present in three: two Frankel D and one Frankel C [12].

Treatment

The fractures were treated in three different ways. In 11 patients (ten with type II fractures) an anterior screw fixation according to Böhler was chosen [6], whereas a posterior C1–C2 fusion was performed in seven (all with type II fractures). Eleven patients were treated conservatively (seven with type II fractures). This group was treated with a firm neck support (Philadelphia collar), or a halo vest (in one patient). The series was not randomized between the treatment groups; the allocation to one of the two operative techniques was according to the preference of the attending surgeon.

Follow-up

Follow up was done on average 51 (range 24–89) months after the injury and consisted of a review of notes and radiographs. A questionnaire was answered by 14 and a clinical examination was performed in five of the 19 patients still alive. Bony union was evaluated on the latest available lateral radiograph according to a three-point scale: definitely healed (bone trabeculae bridging the fracture or fusion area), not healed but without signs of healing disturbances (bone trabeculae could not be seen bridging the fracture or fusion area but no signs of mechanical failure of the fixation were present), and established non-union (the fracture line still visible or a radiolucent zone across the fusion mass, a radiolucent zone around a screw, implant failure, or change in alignment or signs indicating non-union). Due to the retrospective nature of the review no flexion-extension films were obtained.

The outcome was dichotomized as either positive or negative for the applied treatment modality. A positive outcome consisted of an uneventful healing period resulting in a pain-free situation with union of the fracture or the fusion in a good position. Non-union, secondary displacement, or loss of fixation was considered a negative outcome, even if the clinical situation was satisfactory. A clinically unsatisfactory situation was considered a negative outcome. In two patients an anterior screw fixation was initially attempted, but had to be abandoned due to technical problems during the operation; these two patients were also considered a negative outcome with respect to the intended technique.

Results

There were no peroperative deaths. Ten patients died from unrelated causes during the follow-up period; the deaths were evenly distributed during the follow-up period from 6 to 73 months after the injury.

The outcome differed between the treatment groups. In the anterior screw fixation group one patient could not be evaluated because of missing radiographs. Two of ten were considered to have achieved a positive outcome, whereas eight were considered to have achieved a negative outcome. In two patients the intention had been to perform an anterior screw fixation, but the technique had to be converted to a posterior fusion due to technical problems during the operation. The reason in both cases was inability to gain access to the dens while keeping the fracture reduced. In two patients, the fractures were healed, but the screws had obviously loosened from the proximal fragment and started to back out. In one patient a redisplacement occurred. Two patients developed non-unions

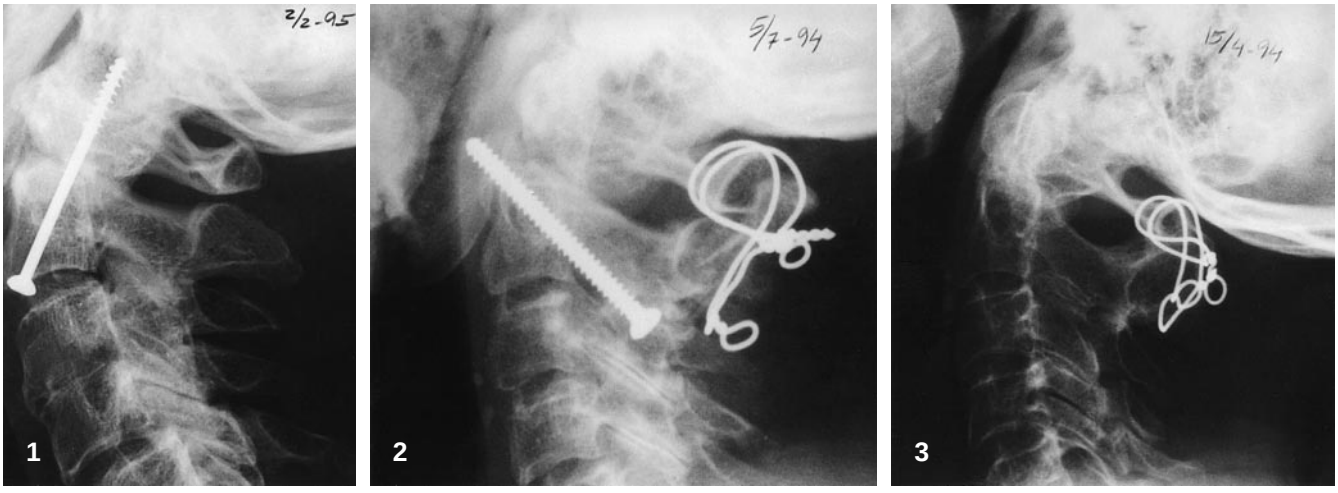

Fig. 1 A follow-up radiograph of a patient with an Anderson and D'Alonzo type II fracture treated with direct screw repair with an obvious non-union

Fig. 2 A patient with an Anderson and D'Alonzo type II fracture treated with transarticular screws and a posterior Gallie fusion. The fracture of the dens may still be un-united, but the fusion is solidly healed

Fig. 3 In this patient both the fracture and the fusion are solidly healed

(Fig. 1), and one patient had healed, but suffered from severe motion pain from C1–C2 articulation.

In the posterior C1–C2 fusion group all seven patients were considered to have achieved a positive outcome; six were definitely healed (Figs. 2, 3), and one was not healed but showed no signs of healing disturbances.

In the conservatively treated group, one patient could not be evaluated because of missing radiographs. Six of ten patients developed non-union whereas two were definitely healed and two showed no healing disturbance. Of the patients with non-unions, two underwent subsequent surgery, one with posterior C1–C2 fusion, the other with a direct anterior screw fixation. Both patients failed to heal; in the patient who underwent posterior fusion, both the fusion and the dens fracture remained un-united. In the patient that underwent direct repair of the dens non-union, this failed to unite. However, the clinical situation did not motivate additional surgery.

Too few patients participated in the clinical part of the investigation to allow a detailed analysis of these results. However, the obtained information is included in Table 1.

Discussion

Interest in spinal fractures among the elderly is rising, possibly because the population is getting older and this type of fracture is becoming more frequent. It has been shown that the rates of non-union, morbidity, and mortality are high in elderly patients with spinal fractures [15, 17, 19]. Prolonged bed rest and conservative treatment seem to be risk factors [15, 19]. Mortality seems to be higher in patients treated conservatively [4, 5, 15, 17]. The authors agree that there are few patients with neurological symptoms and that the fractures usually are caused by low-energy trauma, i.e. falls [4, 5, 15, 17, 19].

The indications for various forms of treatment for odontoid fractures in the elderly remain controversial. Some authors suggest that conservative treatment is adequate in elderly people [17], although this will result in a high rate of non-union. Others, on the other hand, recommend surgical stabilization, because of the risk of residual C1–C2 instability that may cause pain and late myelopathy [2, 3, 8, 15, 19]. Age and concomitant illness do not seem to be contraindications to surgery, which can decrease and eliminate in-hospital mortality in odontoid fracture [4]. Non-union is, however, not equivalent to a bad result, and "fibrous union", grade 1 according to Lind et al. [18], is definitely compatible with symptom-free normal function. The clinical dilemma is to decide which non-unions will become potentially dangerous with a tendency to develop myelopathy and which will become stable, symptom-free and, thus, harmless.

Halo-vest treatment may be an alternative [18]. However, we have chosen not to use this treatment for two main reasons. Firstly, the frequency of non-union is unacceptably high, especially in the elderly population, where 25–30% may develop non-union [13, 20]. Secondly, elderly people tolerate the halo vest poorly [13, 19].

Unstable fractures can be managed in two ways, either with anterior screw fixation [6] or posterior C1–C2 fusion [16, 20]. Authors who recommend the anterior approach argue that this method is easy to perform and saves neck motion. Good results have been shown in young patients [1, 10], and some authors claim equivalent results compared to posterior C1–C2 fusion [6, 11]. Results of the anterior approach in elderly patients have only been covered in one report that we have come across [5]. The authors

found a high rate of union and recommended the technique. However, not all fractures are suited to the anterior approach; location of the fracture line, bone quality, and the ability to extend the neck are factors to consider. Arguments for the posterior approach, on the other hand, are its high success rate, few complications, and the relative tolerance of the resulting limitation in range-of-motion in the neck among older patients [4, 7, 8, 19].

The difference between our results and those of Berlemann and Schwarzenbach [5] requires a special analysis. In the present study, we found an unacceptably high rate of negative outcome in patients treated with the anterior approach, whereas they reported only a few. One reason may be that they only looked at the patients who had been treated with the technique whereas we looked at all the patients in whom the technique had been attempted. In our group there were two patients where the anterior technique had to be abandoned during the procedure. We also considered the two patients who had healed, but where the screws had backed out, to be failures, in spite of bony union and a clinically satisfactory outcome. One may argue that this is incorrect, but we believe that screw loosening indicates fixation failure, at least for a period of time.

The conservatively treated group in our study does not lend itself to comparison with the two surgically treated groups. The choice between the two surgical methods was partly by chance, though a proper randomization was not performed. The conservatively treated patients, on the other hand, differed; the attending surgeon may have chosen not to operate because of the patient's general condition or because the fracture was undisplaced. The failure rate in the conservative group in the present series may seem high, but corresponds to most other conservatively treated series.

Conclusions

Our experience of direct fracture repair according to Böhler [6] in odontoid fractures in patients over 65 years of age is not very encouraging, as we saw a high incidence of technical problems and healing disturbances. Posterior C1–C2 fusion, on the other hand, led to a high frequency of bony union with few complications. The inadvertent limitation in range of motion did not seem to be a major problem in this age group. In the present series, non-operative treatment resulted in a high incidence of non-union.

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Anterior screw fixation of the dens has changed the treatment of dens fractures type II. Minerva-casts or halo-braces no longer are needed. This technique of direct anterior screw fixation of dens fractures, however, has shown to be very demanding and unsafe in certain instances, for example in the presence of very osteoporotic bone. This paper illustrates these difficulties which in some instances may be due to technical problems, in other to the osteoporotic bone itself. In the elderly patient, the anterior cortical shell of C2 may be so weak that the screw must pass through the anterior part of the annulus fibrosus of C2/3 to have enough purchase in the caudal fragment. It is our experience also that a posterior fusion C1/C2 using transarticular screw fixation is a sounder fixation technique than anterior screw fixation of the dens in elderly patients presenting with a dens fracture and marked osteoporosis. Both techniques, however, need a thorough anatomical knowledge and a perfect operative technique. Therefore, these techniques should only be used by very experienced spine surgeons.

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