Efficacy of anterior odontoid screw fixation in elderly patients with Type II odontoid fractures

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Object. Type II odontoid fractures are the most common trauma-related dens fracture. Although Type III odontoid fractures have a high union rate when external immobilization is applied, Type II fractures are associated with high rates of nonunion, particularly in elderly patients and those with posteriorly displaced fractures or fractures displaced by more than 6 mm. Because elderly patients may not also tolerate external immobilization in a halo vest, alternative techniques should be explored to identify a method for managing these higher-risk patients. In this study the authors examine the efficacy of anterior odontoid screw fixation in a high-risk group of 10 elderly patients (> 65 years of age) treated for Type II odontoid fractures.

Methods. A retrospective review of all patients with Type II odontoid fractures treated at two institutions between September 1997 and March 2000 was performed. Demographic data, neurological examination, fracture type and degree of displacement, treatment method, and outcome data were examined at discharge. Ten patients older than 65 years who had sustained a trauma-related odontoid fracture and had undergone an anterior odontoid screw placement procedure were retrospectively reviewed. Fracture displacement (mean 6.6 mm) was observed in all but one patient, and in seven there were posteriorly displaced fractures. Seven were successfully treated with anterior screw fixation and external orthosis alone; in one patient in whom poor intraoperative screw purchase had been observed, the fracture healed after undergoing halo vest therapy. Only one patient was shown to develop a nonunion requiring a subsequent posterior fusion procedure.

Conclusions. Odontoid screw fixation can be safely performed in elderly patients, and frequent bone union is demonstrated. However, osteopenia may preclude adequate screw fixation in some patients.

KEY WORDS • odontoid fracture • anterior cervical fusion • screw fixation
toid screw fixation were identified. One additional patient was treated by one of our surgeons at the Cayuga Medical Center. There were four men and six women ranging in age from 67 to 92 years (mean age 80 years). The hospital and office records as well as admission and subsequent radiographs obtained in the patients who underwent placement of anterior odontoid screws were individually examined. Several parameters were recorded including patient age, mechanism of injury, fracture type, degree of displacement, associated fractures, postoperative immobilization, neurological status, medical comorbidities, presence of osteopenia, and complications. Successful bone union was determined on dynamic radiographs that demonstrated ankylosis across the fracture line and no movement of the dens.

**RESULTS**

Ten patients older than 65 years of age with Type II odontoid fractures were treated with anterior odontoid screw fixation (Table 1). Falls were the most common mechanism of injury (eight of 10 cases), whereas one patient sustained the fracture in a motor vehicle accident and the other in a diving accident. All but one patient had sustained a displaced Type II odontoid fracture (mean displacement 6.6 mm, range 3–10 mm), with seven posteriorly (Fig. 1) and two anteriorly displaced. In only one patient was a neurological injury demonstrated; this patient had sustained a C-2 fracture that caused complete tetraplegia (American Spinal Injury Association A) in a diving accident. Associated fractures included four cases of C-1 fractures, three of long bone fractures (humerus, ulna, and radius, respectively), and one case of a C-6 fracture. Six patients suffered from osteopenia. Five patients underwent traction to reduce the fracture, followed by early odontoid screw placement (Fig. 2). Four patients were initially treated with rigid external immobilization. After stabilization of medical comorbidities was achieved, the patients underwent odontoid screw placement within 1 week of the original accident. In one patient bone union had not occurred after 5 months of halo immobilization, and this patient then underwent screw placement. In eight patients one screw was placed, in one two screws were placed, and in one patient the screw was removed intraoperatively because adequate bone purchase could not be obtained. In this patient, the dens was very osteopenic, with fragmentation of the cancellous bone and a weak cortical surface. To achieve initial structural integrity, we injected the cavity within the dens with the bone substitute Norian (Synthes, Paoli, PA), and the patient was immobilized postoperatively in a halo vest.

All patients were placed in a rigid external orthosis (five halos and five collars) after surgery. One patient was treated postoperatively for pneumonia and a nonfatal myocardial infarction, and one patient died of pneumonia that developed 3 weeks after surgery. Three patients were discharged directly to home, four underwent rehabilitation

**TABLE 1**

Summary of data obtained in 10 patients in whom odontoid screws were placed*

<table>
<thead>
<tr>
<th>Age (yrs), Sex, Mechanism of Injury</th>
<th>Neurological Exam</th>
<th>Disp (mm)</th>
<th>Assc Fx</th>
<th>Immobilization &amp; Therapy</th>
<th>Fusion</th>
<th>Follow Up (mos)</th>
</tr>
</thead>
<tbody>
<tr>
<td>67, M dive</td>
<td>C-2 ASIA A</td>
<td>4 post</td>
<td>C-1, C-6, ulnar</td>
<td>GWT &amp; halo</td>
<td>stable</td>
<td>12</td>
</tr>
<tr>
<td>83, F fall</td>
<td>intact</td>
<td>8 post</td>
<td>C-1</td>
<td>GWT &amp; halo</td>
<td>stable</td>
<td>3</td>
</tr>
<tr>
<td>86, F fall</td>
<td>intact</td>
<td>10 post</td>
<td>C-1, radius</td>
<td>GWT &amp; collar</td>
<td>dead</td>
<td>1</td>
</tr>
<tr>
<td>86, F fall</td>
<td>intact</td>
<td>10 post</td>
<td>C-1</td>
<td>GWT &amp; collar</td>
<td>nonunion</td>
<td>8</td>
</tr>
<tr>
<td>67, M fall</td>
<td>intact</td>
<td>3 post</td>
<td>humerus</td>
<td>GWT &amp; collar</td>
<td>stable</td>
<td>18</td>
</tr>
<tr>
<td>82, F fall</td>
<td>intact</td>
<td>9 post</td>
<td>C-1</td>
<td>GWT (intraop screw)</td>
<td>stable</td>
<td>5</td>
</tr>
<tr>
<td>85, F MVA</td>
<td>intact</td>
<td>5 ant</td>
<td></td>
<td>GWT &amp; halo</td>
<td>stable</td>
<td>3</td>
</tr>
<tr>
<td>67, F fall</td>
<td>intact</td>
<td>4 ant</td>
<td></td>
<td>collar &amp; halo</td>
<td>stable</td>
<td>3</td>
</tr>
<tr>
<td>87, M fall</td>
<td>intact</td>
<td>6 post</td>
<td></td>
<td>GWT &amp; collar</td>
<td>stable</td>
<td>4</td>
</tr>
<tr>
<td>92, M fall</td>
<td>intact</td>
<td>0</td>
<td></td>
<td>halo (5 mos) &amp; collar</td>
<td>stable</td>
<td>6</td>
</tr>
</tbody>
</table>

* Disp = displacement of odontoid fragment and direction (post = posteriorly; ant = anteriorly); Assc Fx = associated fractures; GWT = Gardner–Wells traction.
Type II fracture in the elderly

Prior to discharge, and three were admitted to nursing care facilities. Nine patients were alive at 4 to 18 months postoperatively (mean 10 months). Dynamic radiographs demonstrated a stable fusion in all but one surviving patient between 3 to 6 months after surgery (mean 4.3 months), including the patient in whom the screw was removed intraoperatively. However, in one patient a nonunion was diagnosed 8 months after surgery. Intraoperatively, incomplete reduction of a distracted odontoid fragment was achieved, despite manual manipulation and use of a lag screw. To facilitate healing, Norian bone substitute was injected into the defect site to provide immediate structural support and to allow gradual replacement by native bone ingrowth. Although bridging of the bone was observed anteriorly on polytomography at 5 months, this patient had fallen and was suffering persistent neck pain. Dynamic radiographs revealed anteriorly displaced fracture in flexion. Consequently, a posterior atlantoaxial fusion procedure was performed in which sublaminar wiring was placed.

DISCUSSION

Odontoid fractures represent 10 to 15% of all cervical spine fractures, of which Type II odontoid fractures are the most common.22 Historically, a high mortality rate has been associated with atlantoaxial instability in cases of untreated odontoid fractures; Jefferson23 described 13 of 15 patients who died of odontoid fracture–related instability. Consequently, treatments to prevent subluxation have been advocated, including external immobilization and/or subsequent surgical fusion. However, the reported incidence of nonunion is 4 to 63% when external halo vest immobilization is applied.2,9,11,12,19,20 Moreover, skeletal traction for reduction of posteriorly displaced fractures has been associated with cases of respiratory arrest.24 Although posterior atlantoaxial fusion with wiring and/or posterior transarticular screw fixation achieves a high rate of bone union, the range of motion of the atlantoaxial joint is markedly reduced.7,10,17 White and Panjabi31 have described a reduction of 47° of axial rotation and 10° of flexion–extension after performing atlantoaxial fusion. Moreover, exclusive use of wiring techniques requires an intact atlantal ring, which may be fractured in approximately 16% of patients with odontoid fractures.7 In contrast, anterior odontoid screw fixation achieves a similarly high rate of fusion (84–96%).1,5,6,8,13,21,25,26,30 without reducing the range of motion.14,15,26 For example, Henry, et al.,21 reported that in 56 of 61 patients bone union was demonstrated, with only six of 49 patients having a greater than 25% reduction in their range of motion. Moreover, in biomechanical studies the investigators have only demonstrated minimal biomechanical advantage associated with the placement of a second screw, at the expense of reducing the surface area for fusion.8,15

Fracture displacement, particularly posteriorly,11,12,29 has also been associated with a higher incidence of nonunion.12,16,18,20,28 For example, Greene, et al.,16 have reported that fractures that are displaced by more than 6 mm had an 86% nonunion rate, whereas those displaced by fewer than 6 mm had only an 18% nonunion rate. In addition, a higher incidence of nonunion (50–86%) is observed in older patients.11,12,20,28,29 Ryan and Taylor,28 for example, have described 30 patients over 60 years of age in whom the rate of fusion was only 23%. Moreover, Hanigan, et al.,20 have reported a 26% mortality rate and a 50% nonunion rate in 19 patients greater than 80 years of age. In contrast, Berlemann and Schwartzenzach7 have reported successful bone union after 6 months in 16 of 19 elderly patients treated with anterior odontoid fixation.

In the elderly patients we report here, there are multiple risk factors for nonunion, including advanced age (mean age 80 years), frequent posterior displacement (as found in seven of 10 cases), and increased fracture displacement (mean 6.6 mm). Despite these nonunion-related increased risk factors, a stable bone union was observed in all but one surviving patient. Early surgical treatment in most patients was not associated with significant perioperative morbidity except respiratory complications in two cases. The patients were also mobilized more rapidly, after only a few weeks of rigid collar immobilization in five of 10 patients. As a result, only three patients were discharged to a nursing care facility, whereas four were discharged to a rehabilitation facility initially, and three were able to return home directly.

CONCLUSIONS

Odontoid screw fixation in the elderly population is safe and effective. The use of anterior screw fixation as an alternative to posterior fusion facilitates maintenance of a normal range of motion while achieving a comparable rate of bone fusion. In addition, the need for postoperative...
external orthosis immobilization can be reduced without compromising the fusion rate. Based on the report of Berlemann and Schwarzenbach and the present series of patients, we recommend that anterior odontoid screw fixation be considered as a reasonable option in the management of elderly patients with Type II odontoid fractures.

References


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