ELSEVIER

Spine

CERVICAL SPINE FRACTURES IN THE ELDERLY

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BACKGROUND
Cervical spine fractures in the elderly are relatively common. The management of such injuries may be complicated by underlying medical debility and osteopenia as well as reduced tolerance to halo immobilization.

METHODS
Over a 1-year period, 43 cervical spine fractures were treated at our institution. Ten (23%) were in persons 70 years of age or older. This retrospective analysis describes the clinical features, treatment, and outcome of these 10 elderly patients. All fractures in this patient population involved the atlantoaxial complex, including five combination C1–C2 fractures. Six patients were treated with early halo immobilization and three were initially managed with a rigid cervical collar. Three patients required posterior cervical fusion.

RESULTS
Of the six patients undergoing halo immobilization, five progressed to osseous union. Three patients were immobilized in a Philadelphia collar resulting in one osseous union, one nonunion, and one death. Three patients underwent posterior cervical fusion with subsequent osseous union in all three.

CONCLUSIONS
Although external immobilization with a halo device is our treatment of choice for most C1 and C2 fractures in elderly patients, a Philadelphia collar is useful in select cases when halo immobilization or early surgical fusion is contraindicated. Posterior cervical fusion can be safely and effectively performed in elderly patients and should be strongly considered for initial therapy in the elderly with fracture types unlikely to progress to osseous union with external immobilization alone. © 1997 by Elsevier Science Inc.

KEY WORDS
Cervical spine fracture, elderly, spinal fusion, spine immobilization.

Cervical spine fractures in elderly patients are encountered with relatively high frequency in clinical practice [25,31]. This fact has been attributed to the propensity of the elderly to become involved in falls and motor vehicle accidents, as well as the significant incidence of senile osteopenia in this group. Moreover, as the population of aged persons rises steadily in the industrialized world, the prevalence of this problem is expected to progressively increase. The management of cervical spine fractures in elderly patients may be complicated by a number of factors including preexisting medical conditions such as cardiopulmonary compromise among others [17] diminished ability to tolerate halo immobilization, and reduced potential for osseous union. Despite the frequency of cervical spine fractures in the elderly and the special considerations in their management, relatively little has been written specifically on this subject [15,23,24]. We have retrospectively reviewed all such patients treated in our institution during a 1-year period in order to elucidate the salient epidemiologic characteristics of this cohort and to describe special therapeutic considerations in their management.

CLINICAL MATERIALS AND METHODS

PATIENT PROFILE

Forty-three patients with cervical spine fractures were treated at our institution over a 1-year period. Retrospective analysis of these patients was performed by review of hospital charts and all pertinent radiologic studies, and was supplemented by telephone interviews. Ten patients (23%) were 70 years of age or older (Table 1). This group of elderly patients included two males and eight females, with a mean age of 78 years (range: 70–85 years). The

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1 Patient Profile

Patient	Age	Sex	Mechanism of Injury	Fracture Type	Treatment	Outcome
1	78	M	MVA	Odontoid type III	Philadelphia collar, C1–C2 fusion	Nonunion at 20 weeks, fusion following atlantoaxial arthrodesis
2	70	F	MVA	C1-odontoid type II	Halo, occiput-C2 fusion	Fusion
3	72	F	Fall	Odontoid type III	Halo	Fusion
4	70	F	Fall	Jefferson	Halo	Fusion
5	85	F	Fall	C1-odontoid type II	Halo, occiput-C2 fusion	Fusion
6	85	F	Fall	Odontoid type II	Philadelphia collar	Died 6 weeks following injury 2° to lung cancer
7	79	F	Fall	Odontoid type III	Philadelphia collar	Fusion
8	74	F	Fall	C1-odontoid type III	Halo	Fusion
9	82	M	MVA	C1-odontoid type III	Halo	Died 5 weeks following injury 2° to cardiopulmonary complications
10	85	F	MVA	C1-odontoid type II	Halo	Died 11 days following injury 2° to sepsis

mechanism of injury was falls in 60% of the cases, and motor vehicle accidents in 40% of the cases. The clinical presentation was that of neck pain alone in 90% of the cases. No patient demonstrated evidence of myeloradiculopathy. The single patient with a neurologic deficit had severe concomitant cranial trauma (GCS = 4). All 10 fractures involved the atlantoaxial complex. There was one isolated C1 fracture (Jefferson fracture), and four isolated C2 fractures (one type II odontoid fracture, three type III odontoid fractures). In addition, there were five combination C1–C2 fractures (three C1-odontoid type II, two C1-odontoid type III).

CERVICAL IMMOBILIZATION

Of the 10 elderly patients in our series, six were managed with early immobilization in a halo device. The length of the immobilization ranged from 10–12 weeks. Radiographic criteria for assessing the presence of osseous union were used to determine length of immobilization [1]. Three patients were managed initially in a Philadelphia collar. Two of these patients had nondisplaced odontoid type III fractures and one had a 5 mm displaced odontoid type II fracture. One of these patients was referred to our institution with an odontoid type III fracture and nonunion following 20 weeks of immobilization in a Philadelphia collar at an outside institution. This patient was treated with atlantoaxial arthrodesis. The other two patients were deemed unable to tolerate either immobilization in a halo device or early surgical fusion because of medical debility and were, therefore, treated in a Philadelphia collar.

POSTERIOR CERVICAL FUSION

Three patients in our series underwent posterior cervical fusion. One patient had surgery within the first week following injury. This patient was an 85-year-old female with a significantly displaced type II odontoid fracture who was felt to be at high risk for nonunion if treated with external orthotic immobilization alone. Two additional patients underwent late posterior cervical fusion for nonunion after immobilization in a halo device and a Philadelphia collar, respectively. Two occipitocervical arthrodeses and one atlantoaxial arthrodesis were performed. Atlantoaxial arthrodesis was performed using the interspinous method [5], and occipitocervical fusion was accomplished using a ⅜-inch threaded Steinman pin contoured to the craniovertebral junction and supplemented with autologous corticocancellous bone [28].

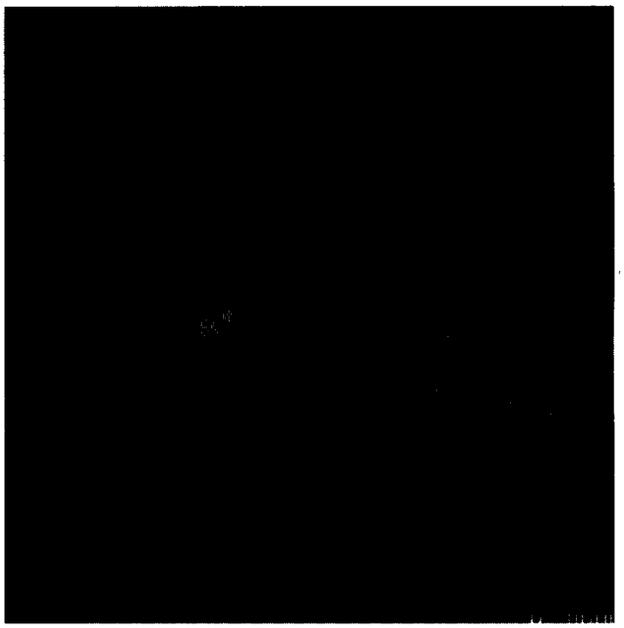
RESULTS

CERVICAL IMMOBILIZATION

Of the six patients undergoing immobilization in a halo device for 10–12 weeks, there was one nonunion. This occurred in a 70-year-old female with a 4 mm posteriorly displaced odontoid type II fracture and severe rheumatoid arthritis with significant periodontoid pannus. This patient refused early surgical fusion and was thus managed initially in a halo device. The mean length of hospitalization for patients treated with early halo immobilization



1 Lateral cervical radiograph demonstrates changes consistent with longstanding rheumatoid arthritis and possible odontoid fracture.



2 Computed tomographic (CT) scan includes portions of occiput, right C1 arch, and odontoid. A fracture of the right C1 arch is evident.

was 10 days. There were no complications of halo therapy in this group.

Of the three patients managed with immobilization in a Philadelphia collar, there was one osseous union following 14 weeks of immobilization (odontoid type III), one nonunion in a patient referred following 20 weeks of immobilization (odontoid type III), and one death 6 weeks following immobilization from complications related to a far advanced malignancy (odontoid type II).

POSTERIOR CERVICAL FUSION

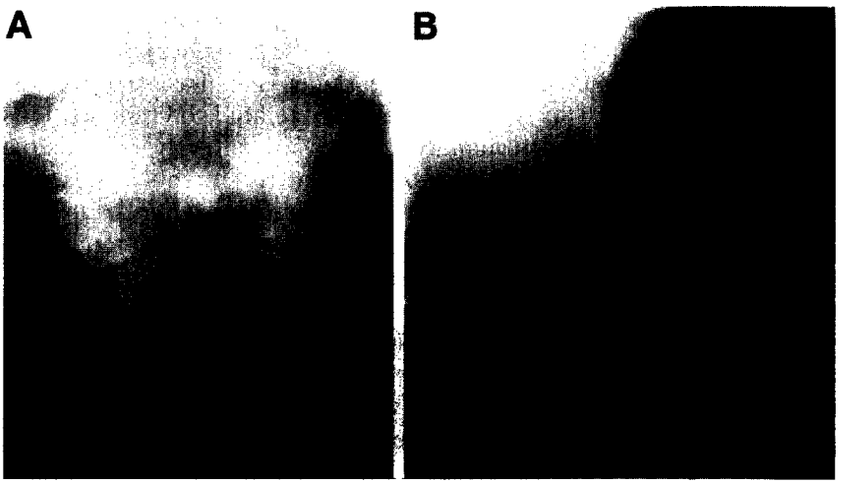
There was no perioperative morbidity or mortality as a consequence of the posterior cervical fusion performed in three patients. The average postoperative hospitalization was 5 days (range: 3–8 days), and all patients have progressed to osseous union. There is no evidence of late spinal instability in any patient (mean follow-up: 21 months).

PATIENT MORTALITY

Overall, three patients died within 6 weeks of their injury; all were managed nonoperatively. Two patients died during their initial hospitalization from complications of multitrauma. One of these patients had a C1-odontoid type III fracture and died of cardiopulmonary complications of systemic multitrauma 5 weeks following injury (patient 9), and the other had a C1-odontoid type II fracture and died of sepsis 11 days following injury (patient 10). Because of the severity of their associated injuries, both were treated nonoperatively and immobilized in a halo device. A third patient died following hospital discharge as a consequence of a bowel obstruction that was related to widely metastatic lung cancer (patient 6). This patient suffered a odontoid type II fracture and was treated with immobilization in a Philadelphia collar due to her profoundly debilitated state and inability to tolerate halo immobilization.

ILLUSTRATIVE CASE

This 70-year-old female with chronic rheumatoid arthritis presented to the emergency room following a motor vehicle accident with a complaint of posterior neck pain. On evaluation, the patient had moderate posterior cervical tenderness and paraspinous muscle spasm. Neurologic examination was within normal limits. A lateral cervical radiograph (Figure 1) demonstrated changes consistent with chronic rheumatoid arthritis including evidence of atlantoaxial subluxation. Computed tomography (CT) performed from the occiput through C3 demonstrated bilateral ring fractures of C1 (Figure 2), but was not useful in distinguishing between the presence of an odontoid fracture versus chronic atlantoaxial subluxation. Hypocycloidal polytomography was performed (Figure 3 **A,B**), revealing a type II odontoid fracture with 4 mm posterior displacement. Magnetic resonance imaging (MRI) of the patient's cervical spine (Figure 4), per-



3 Hypocycloidal polytomograms in the coronal (**A**) and sagittal (**B**) planes demonstrate a type II odontoid fracture that is posteriorly displaced.

formed to evaluate inflammatory changes that might affect the probability of osseous union, demonstrated exuberant periodontoid pannus.

Based on the patient's age, fracture type including the presence of posterior subluxation, and condition of the fracture area (periodontoid pannus and osteopenia), the patient was judged to be at high risk for nonunion if treated with external immobilization alone. This was explained to the patient, but she nonetheless refused early surgical fusion. The patient was thus initially managed with immobilization in a halo device. She returned at 10 weeks, at which time she was found to have no radiographic evidence of osseous union. At that time, the patient consented to surgery and underwent occipitocervical fusion. The fracture progressed to osseous union and there has been no evidence of late spinal instability.



4 Magnetic resonance imaging (MRI), midsagittal T_1-weighted, demonstrates erosion of the dens by exuberant rheumatoid pannus. Alignment appears to be satisfactory, and there is no compression of the neural elements at the craniocervical junction.

Discussion

Cervical spine fractures in elderly patients are commonly encountered in clinical practice. This may be attributed to the tendency of the elderly to be affected by falls and motor vehicle accidents, the two most common causes of cervical spine injuries [18, 20,31]. Several studies have reported that falls are very common among the elderly, particularly among women, and that the incidence of falls increases with age for both sexes [6,22,26]. Other studies have shown that elderly drivers have a higher motor vehicle accident rate than their younger cohorts [3,4,9] and that their accidents have more severe consequences [4,10,21]. Furthermore, the frequent presence of vertebral osteopenia in the elderly increases the likelihood that a traumatic event will result in a fracture.

In this series, 23% of cervical fractures treated at our institution during a 1-year period involved patients aged 70 or older. This incidence is approximately twice that previously reported in the literature [25,31], and may reflect changing demographic trends or different referral patterns. In contrast to a reported male to female ratio of 4:1 in the overall population of patients with cervical spine fractures [20,31], this ratio is reversed in our series of elderly

patients. This may be due to the relatively higher incidence of falls in elderly women compared to elderly men [6,22,26].

In our series of cervical fractures in the elderly population, all of the fractures involved the atlantoaxial complex. This is notable, as the incidence of atlantoaxial fractures in the overall population has been reported to range from 23%–29% of all cervical spine fractures [2,20,30]. Our data demonstrating the propensity of cervical fractures in the elderly to involve the atlantoaxial complex is consistent with data reported by Ryan et al. [25]. In their review of 717 cervical spine fractures, they found that the incidence of fractures of C1 and C2 progressively rose with age, predominantly due to increasing numbers of odontoid fractures in the elderly. Despite this trend, the incidence of fractures involving C1 and C2 in patients aged 60 and above was only 51.8% in that study.

In addition to the tendency of cervical fractures in the elderly to involve the atlantoaxial complex, there is also a tendency towards C1–C2 combination fractures. In the present series, there was a 50% incidence of C1–C2 combination fractures. This is remarkable because Sonntag and Hadley reported that C1–C2 combination fractures represented only 2% of the total population of acute cervical spine injured patients in their series [29]. The relatively high incidence of C1–C2 combination fractures in our series is most likely related to the fact that all fractures involved the atlantoaxial complex. Hadley has reported a 44% incidence of combination C1–C2 fractures in patients with upper cervical fractures [14]. In our series, all C1–C2 combination fractures included an odontoid fracture as the C2 component (three odontoid II, two odontoid III).

In this series, the mechanism of injury was falls in 60% of patients and motor vehicle accidents in 40% of patients. This reversal, in the elderly population, of the usual causes of cervical spine fractures is in accordance with previous reports that whereas motor vehicle accidents account for the majority of cases of cervical spine fractures in the overall population [18,20,31], falls predominate as the mechanism of injury in the elderly [8,15,31]. Tator et al. reported that the frequency of falls increased considerably after 50 years of age, reaching a peak of 100% in patients aged 81–85 [31].

The fact that no patient in our series presented with myeloradiculopathy is consistent with the previously reported low incidence of neurologic injury following upper cervical fractures [2]. Despite this low incidence of neurologic deficits, cervical spine fracture in the elderly is often associated with significant nonneurologic morbidity. It is known that trauma in the elderly results in an increased mortality for a given level of injury severity in comparison with younger persons [11]. Two of the three deaths in this series were related to complications of multitrauma. Although not directly responsible for the demise of any patient in this series, the presence of a cervical spine fracture may have been a contributory factor in the ultimate outcome. The mortality rate of 30% in this series is comparable to the mortality rate of 26.3% reported by Hanigan et al. in their review of odontoid fractures in the elderly [15].

Immobilization with a halo device is our treatment of choice for most C1 and C2 fractures in elderly patients. External immobilization obviates the necessity for surgical fusion in a significant number of elderly patients, and the halo is the most effective external immobilization device for the atlantoaxial region, reducing flexion, extension, and lateral bending to 4% and rotation to 1% of normal [16]. The halo device allows for expeditious immobilization and reduction in the setting of acute trauma. Following reduction of cervical fracture dislocations, the halo may be utilized to maintain alignment during in situ surgical fusion. Furthermore, the halo allows mobilization of most elderly patients in the early postinjury period. This is particularly important in this patient subset, as prolonged periods of immobilization are poorly tolerated by elderly patients [15,17]. In fact, in one report of elderly patients with odontoid fractures, one-third of those patients who underwent prolonged bed rest suffered respiratory complications, while none of the patients who ambulated early in treatment developed this problem, and two deaths were directly attributed to flat bed rest [15]. The majority of elderly patients appear to tolerate the halo device relatively well. Lind et al., reported an 8.5% reduction of vital capacity in neurologically intact patients treated with a halo vest, which was attributed to respiratory restriction by the vest [19]. Although this reduction in vital capacity would not be expected to cause significant respiratory compromise in most healthy individuals, this possibility must not be overlooked in the elderly population, particularly in the presence of underlying pulmonary disease or associated thoracic trauma.

In the present series, elderly patients managed with early immobilization in a halo were discharged expeditiously from the hospital following their acute presentation, with a mean length of hospitalization of 10 days. Considering the advanced age of the patient cohort, this compares favorably with reported average hospital stays of 7 days for all

patients treated in a halo for an isolated odontoid fracture [7], 8.5 days in another series of patients with odontoid fractures and no significant associated injuries [8], and 17.1 days in a group of patients aged 80 years or older treated with cervical immobilization for odontoid fractures [15]. There were no complications of halo immobilization in our patients. The single patient who developed a nonunion following halo immobilization was deemed initially to be at high risk for nonunion given her age, fracture type and characteristics, and underlying rheumatoid arthritis, and would have been optimally treated with early surgical fusion.

Immobilization in a rigid cervical collar appears to be an acceptable alternative treatment in cases where the patient is unable to tolerate rigid immobilization in a halo device and also has unacceptable surgical risks [15]. Although patient age has been reported to be one determinant of good outcome with Philadelphia collar immobilization (the others being degree of movement while in the collar and patient compliance), advanced age has not been cited to be a contraindication to Philadelphia collar immobilization [13]. In our series, two patients treated with immobilization in a Philadelphia collar had odontoid type III fractures. One progressed to union after 14 weeks of immobilization (patient 7) and the other developed nonunion despite 20 weeks of immobilization (patient 1). The third patient treated with a Philadelphia collar was an extremely debilitated 85-year-old female with an odontoid type II fracture and widely metastatic lung cancer, who was felt to be unable to tolerate either immobilization in a halo device or surgical fusion (patient 6). This patient died 6 weeks after presentation from complications related to her systemic malignancy. Although the Philadelphia collar is a useful treatment in selected elderly patients with cervical fractures, we feel that this alternative should be reserved specifically for patients unable to tolerate halo immobilization or early surgical fusion, preferably with fracture types with high rates of spontaneous osseous union with external immobilization (Jefferson, hangman's, odontoid type III fractures).

When elderly patients cannot tolerate the halo device or its use is contraindicated, and in the presence of fracture types unlikely to heal with external immobilization, consideration should be given to internal fixation. Whereas it has been suggested that surgical fusion may not be tolerated in the elderly [12,23,24], our experience suggests that posterior cervical fusion can be safely and effectively performed in elderly patients. In our series, there was no perioperative morbidity or mortality and the average postoperative hospitalization was 5 days. All patients treated with posterior cervical fusion have progressed to osseous union and there is no late spinal instability at a mean follow-up of 21 months. We believe that early cervical fusion should be strongly considered in elderly patients with fractures unlikely to fuse with immobilization alone. These include odontoid type II fractures with 6 mm or greater atlantoaxial subluxations or with posterior angulation of the dens, atlantoaxial fractures associated with transverse ligament disruption, hangman's or other axis fractures with 4 mm or greater C2–C3 subluxation, and cervical fractures associated with disk disruptions with vertebral body anterolisthesis [27]. In addition, odontoid fractures in the presence of rheumatoid arthritis or other chronic inflammatory disorders may be best treated with early internal fixation.

CONCLUSIONS

Cervical spine fractures in elderly patients are relatively common, comprising almost one-quarter of the total number in our series. Given that the proportion of greater than 65 years age group is growing steadily in industrialized countries, the prevalence can be expected to rise in the future. In contrast to younger patients with cervical spine fractures, females appear to be more affected than males, falls account for the majority of injuries, fractures of the atlantoaxial complex predominate, and combination C1–C2 fractures are common. The halo device is usually our first choice of treatment for most C1 and C2 fractures in elderly patients. However, the Philadelphia collar is a useful alternative in selected cases. Posterior cervical fusion can be safely and effectively performed in elderly patients, and early internal fixation should be strongly considered in elderly patients with fracture types that are unlikely to progress to osseous union with external immobilization.

This paper is dedicated to the memory of the senior author, Eugene Rossitch, Jr., M.D., who died tragically on November 18, 1994.

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COMMENTARY

I congratulate the authors, who emphasize that fractures in the elderly can be successfully treated, and that they are becoming more common. Although these fractures can be treated successfully, they are more difficult to treat because this patient population tends to have an increased frequency of associated medical problems. The authors also stress the fact that this population tends to have more fractures of the upper cervical spine, and it would be of interest to speculate why this is so. Is it the mode of injury, which is primarily falls? Does the lower cervical spine in the elderly, with progressive degenerative and ossified formation, become more stiff and therefore the upper cervical spine more prone to injury? The authors emphasize that we will see more of this patient population in the future and should be able to treat them successfully with halo orthoses or surgical intervention; this population seems to tolerate these modes of treatment relatively well.

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The authors have described a number of interesting cases, providing an excellent discussion of the decision making in choosing a specific approach to the patient's advantage. Each of the approaches has its advantages and disadvantages, but they are well appreciated by spine surgeons.