Type II Odontoid Fractures in the Elderly: Risk of Mortality Based on Intervention

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ABSTRACT

Background Context:

Despite the relatively high incidence of odontoid fractures, treatment of these fractures in elderly patients remains controversial. Some authors have proposed surgical treatment is superior for all patients, while others have suggested nonoperative treatment is more prudent. Furthermore, the effect of patient age and the presence of medical co-morbidities on mortality has not been clearly elucidated. Adding further controversy, the manner of nonoperative treatment has been debated, as halo use is considered a highly morbid nonoperative treatment in the elderly.

Purpose:

To define the influence of age and treatment, adjusting for co-morbidities, on mortality in elderly patients with acute type II odontoid fractures.

Study Design:

Retrospective series at a Level I University-affiliated trauma center.

Patient Sample:

156 consecutive patients (age 65 years or older) who sustained type II odontoid fractures

Outcome Measures:

Mortality at 3 month and 1, 2 and 3 years from injury.

Methods:

An institutional Research Patient Data Registry (RPDR) was utilized to identify all type II odontoid fractures sustained by patients age 65 and older from 1991-2006. Demographic information, date of injury, injury mechanism, fracture classification, associated injuries, treatment type, co-morbidities, post-treatment complications, and outcome/mortality were asbtracted from medical records. Data were analyzed by stratifying patients by age (65-74, 75-84, 85+) and treatment type (operative or non-operative treatment, and halo or collar immobilization).

Results:

156 patients met the inclusion criteria. The average age of the cohort was 81.5 years. One-hundred and twelve patients were treated non-operatively while 44 patients underwent surgery. Of those managed non-operatively, 28 (25%) were treated with halo vest immobilization. The mortality rate for the entire cohort was 21% at 3 months, 31% at 1 year, 37% at 2 years, and 39% at 3 years. At 3-year follow-up 29% of patients age 65-74 had died, while 35% of patients 75-84 and 49% of patients over age 85 died.

Conclusions:

This study showed that surgery was associated with lower three year mortality than nonoperative therapy and that the survival advantage associated with surgery was restricted to patients younger than 85.

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INTRODUCTION

The management of odontoid fractures has been recognized as a challenge since they were first described in the early 20th century.[1] Despite significant advances in diagnostic and treatment modalities, these injuries remain problematic, particularly in the geriatric population.[1,2,3,4,5,6,7,8] Odontoid fractures are the most common cervical spine fracture in the elderly. Due to their age associated co-morbidities and the ubiquitous presence of degenerative changes in the aging cervical spine[6], such individuals are at a higher risk for morbidity and complications than younger patients sustaining similar injuries.[1,2,3,4,6,7,9,10,11]

	Operative Treatment	Non-Operative Treatment		
	(N=44) N (%)	All (N=112) N (%)	Halo (N=28) N (%)	Collar (N=84) N (%)
Age				
65-74	13 (29.5%)	21 (19%)	10 (36%)	11 (13%)
75-84	21 (48%)	42 (37.5%)	8 (29%)	34 (40.5%)
85+	10 (23%)	49 (44%)	10 (36%)	39 (46%)
Gender				
Male	19 (43%)	52 (46%)	16 (57%)	36 (43%)
Female	25 (57%)	60 (53.5%)	12 (43%)	48 (57%)
Poly-Trauma*				
Yes	16 (36%)	40 (36%)	10 (36%)	30 (36%)
No	28 (64%)	72 (64%)	54 (64%)	54 (64%)
Charlson Comorbidity Score				
0	13 (29.5%)	32 (28.5%)	8 (29%)	24 (29%)
1	8 (18%)	21 (19%)	6 (21%)	15 (18%)
2	9 (20%)	19 (17%)	5 (18%)	14 (17%)
3+	8 (18%)	18 (16%)	4 (14%)	14 (17%)
Missing	6 (14%)	22 (20%)	5 (18%)	17 (20%)
Neurologic Involvement				
Yes	2 (4.5%)	1 (1%)	0 (0%)	1 (1%)
No	42 (95%)	111 (99%)	28 (100%)	83 (99%)

* The occurrence of injuries to more than one body system or region (i.e. Subdural hematoma, pneumothorax and odontoid fracture).

Table 1: Demographic Characteristics of Patients With Type II Odontoid Fractures

Furthermore, as the number of elderly patients continues to rise in the United States, the prevalence of such fractures can be expected to increase.

Several prior studies have documented increased morbidity and mortality among geriatric patients sustaining odontoid fractures.[1,2,3,4,5,6,7,9,10,12,13] Indeed, the non-union rate in this population has been reported to be as high as 85% (range 20-85%)[3,4,5,6,7,9,10,12,13,14] while the mortality rate approaches 50% in some investigations (range 10-57.1%).[2,3,4,5,6,7,9,10,12,13] Moreover, all choices of management (operative vs. nonoperative, halo-vest immobilization vs. cervical orthosis) has been consistently identified as having an adverse effect on outcome. The halo vest, in particular, has been associated with an increased risk of negative outcomes in elderly patients.[1,3,4,7,9,12,15] Unfortunately, most available evidence for outcomes in elderly patients with odontoid fractures derives from reviews of cohorts comprising less than 50 patients.[3,4,5,7,9,11,13]

Given the paucity of data available on treatment results for geriatric patients with odontoid process fractures, this investigation sought to define the influence of treatment, number of co-morbidities, neurological injury and type of trauma (poly-trauma vs. isolated injury) on mortality and final outcome in a cohort (n = 156) of elderly patients sustaining Anderson and D'Alonzo[15] type II fractures of the odontoid.

METHODS

Following Institutional Investigational Review Board Approval, an institutional Research Patient Data Registry (RPDR) was utilized to identify all cervical spine fractures that occurred in patients age 65 and over from 1991-2006. The RPDR is a data registry that has been maintained for all patients treated at two participating level-I trauma centers since 1979. For the purposes of this study, only those patients sustaining type II fractures of the odontoid process were included for review. Additional inclusion criteria included age 65 or older at the time of injury and radiographic evidence of an acute fracture documented in the electronic medical record.

Data obtained for each patient identified through the electronic medical record included age, race, gender, date of injury, fracture classification (Anderson and D'Alonzo[16]), associated injuries, presence of neurologic injury, treatment type, presence or absence of thirteen medical co-morbidities (Charlson index[17]), and mortality. Any discrepancies in the electronic medical record were resolved via a manual review of the patient's hard copy medical record.

Patients were initially divided into two groups based on whether they received operativeor nonoperative treatment. The nonoperative group was further stratified into patients receiving halo vest immobilization or cervical orthosis as treatment

for their odontoid fractures. Patients who received surgery as the definitive intervention in the acute period (first 3 weeks) following injury were included in the operative group. Patients treated with a halo vest for the majority of their clinical care (i.e. 8 of 12 weeks) were included in the halo vest group. Within each treatment group, patients were examined as a whole and based on age: patients 65-74, 75-84, and >85 each comprising a separate cohort.

Risks of mortality for 3-month and 1-, 2- and 3-year intervals, were calculated for the entire cohort. Since we hypothesized that the effect of treatment on the risk of mortality would vary by age, we also calculated mortality risks stratified by age and treatment.[18]

RESULTS

Study Sample

Between 1991-2006, 1,238 patients age 65 and older presented with cervical spine fractures to the authors' institutions. Of these individuals, 261 (21%) had fractures involving the second cervical vertebra, of which 242 (19.5%) involved the odontoid process. The majority (64.5%) of these odontoid process fractures (n=156) were found to be Anderson and D'Alonzo type II fractures as classified by the attending orthopaedic surgeon, and represented 13% of all patients age 65 and older presenting with cervical spine fractures.

Of the 156 individuals included in this investigation, 71 (45.5%) were male and 85 (54.5%) were female. One hundred thirty-five (86.5%) of the patients were Caucasian. Eighteen (11.5%) were African-American. The average age of the cohort was 81.5 years. Thirty-four patients (22%) were age 65-74, 63 (40%) were 75-84, and 59 (38%) were age 85 or greater.

Fifty-six patients (36%) sustained odontoid fractures in conjunction with polytrauma and 3 (2%) cases were associated with neurologic injury. Forty-four (28%) patients received surgery as the definitive treatment for their fracture, while 112 (72%) were managed non-operatively. Twenty-eight (18%) patients treated non-operatively were managed with halo-vest immobilization and 84 (54%) received a cervical orthosis. Additional demographic data on the investigational cohort can be found in Table 1.

3-Month Time-Point

The mortality for the entire cohort at the 3-month time-point was 21% (33 patients). Sixteen patients died during the initial hospital admission, for an in-hospital mortality of 10%. This included 1 of the 44 patients who received surgery and 15 of the 112 individuals managed non-operatively. There was a lower mortality for patients aged 65-74. When comparing non-operative versus operative groups, the risk of mortality was higher in the non-operatively treated patients (Figure 1). There was a 21% mortality rate for patients treated with halo immobilization.

Patients with a higher Charlson score had an increased risk of mortality. Gender and the type of trauma were not found to influence mortality. The risk of mortality stratified by neurologic involvement was not definable because of the small number of patients (3/156) who sustained neurologic injury in conjunction with their odontoid fractures.

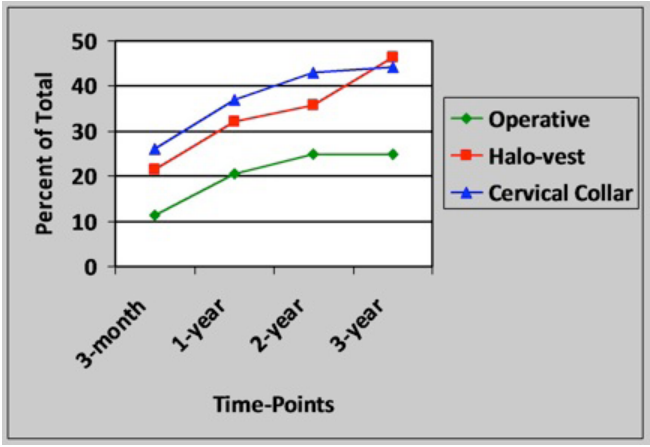

Figure 1
Mortality Rates for Patients by Treatment Type

1-Year Time-Point

The 1-year mortality was 31% (49 patients). Patients between 65 and 74 had the lowest mortality rate while those 85 and over had the highest. At the 1-year time-point, mortality for the operative group was 20.5%, while it was 36% for the nonoperative group. (Figure 1) Patients treated with halo immobilization had 32% mortality, while those managed in a collar had 37% mortality.

Time-points Beyond 1-Year

Mortalities for the cohort at 2- and 3-years were 36.5% (57 patients) and 39% (61 patients), respectively. At 2-year follow-up, mortality for the operative group was 25% and this remained constant at the 3-year time-point as no patients in the operative group died after 2 years. Patients in the nonoperative cohort had 41% mortality at 2 years, and this increased to 45% after 3 years. Those treated with halo immobilization had 36% and 46% mortalities at 2- and 3-years, respectively (Figure 1).

DISCUSSION

Odontoid fractures are the most common cervical spine fracture in elderly patients and are known to carry a high risk of complications and mortality.[2,3,4,6,7,9-13,15,19] Over the last twenty-five years, reports have documented high mortalities in this population as a whole, and in those patients treated with halo vests in particular. This trend may be attributed to the elderly population's increased risk for cardiac events and airway compromise, as well as a markedly decreased functional reserve.[12,19,20,21,22]

In light of these facts, controversy remains regarding the management of odontoid fractures in the elderly. Some authors have advocated for aggressive surgical stabilization in these patients, citing an increased fusion, or fracture healing, rate and decreased morbidity and mortality.[4,5,7,9,10,13] Other reports, however, have not shown a significant advantage for surgery versus non-operative management.[3,5] Additionally, while a few authors have documented safe and efficacious use of halo-vest immobilization in the elderly,[6,23] a variety of reports in the literature demonstrate poor outcomes in such patients.[4,5,7,9,12] The current investigation sought to determine

if such a finding held true for elderly patients with type II fractures of the odontoid.

The results of the present study indicate that surgical intervention for type II odontoid fractures may exert a protective effect on survival for patients 65-84. Although this benefit decreased as patients aged, only 25% of those treated surgically had died at 3-years post injury compared with 45.5% of the individuals managed nonoperatively.

Findings presented here would seem to support prior evidence of increased mortality rates among elderly patients with odontoid fractures, irrespective of the choice of treatment. For example, the in-hospital mortality rate in this study was 10%. While this value is fairly high, it is substantially lower than values presented in other investigations examining mortality in elderly patients with similar injuries. Three papers have previously cited a greater than 25% in-hospital mortality rate.[3,7,10] Koech et al., focused entirely on non-operative management of elderly patients with odontoid fractures, reported a 14% in-hospital mortality.[23] The work of Koech et al.[23], as well as that of Hart and colleagues[24], documented satisfactory outcomes in elderly patients with odontoid fractures treated non-operatively. However, both these investigations were conducted using comparatively small series of patients.

Additionally, the results of this study show a high mortality rate over the first 3 months post-injury that plateaus within 1-2 years. The mortality in this investigation may have been influenced by the presence of medical co-morbidities. The presence of medical co-morbidities may predispose patients to an increased risk of complications in the setting of fracture care, such as thromboembolic disease, urinary tract infections, cardiac events, and pneumonia.[7,12,25] The recent work of Stelfox et al. has documented a higher complication rate in elderly patients treated with prolonged cervical immobilization[25] and such a factor may account for the disparate outcomes between cohorts in this investigation as well.

The 3-month mortality in this investigation is comparable to figures presented by Frangen et al.[4] while the 2-year mortality is lower than that encountered in the work of Hanigan and colleagues.[10] While the data presented here cannot elucidate whether mortality was directly related to the fracture, or to complications surrounding fracture care, it does indicate that such injuries are a marker for an increased risk of mortality at 1-year.

Of note, patients in this study who were treated with halo-immobilization were not found to be at an increased risk for mortality when compared with patients receiving operative intervention or cervical orthosis (Figure 1). This is in contrast to prior reports documenting a higher mortality rate among elderly patients treated with a halo.[7,12] Majercik et al.[12] and Tashjian and colleagues[7] each documented greater than 40% acute mortality rates for elderly patients treated with halo-vest immobilization. Mortality rates for those managed with halo-vests in this study were markedly lower, 21% at 3-months and 32% at 1-year. Similarly, mortality rates for the operative and nonoperative cohorts in this investigation were lower than the estimates of 22-57.1% mortalities previously reported.[3,4,10]

It is important to note that most studies addressing this topic are retrospective in nature and conducted using small samples (mean = 34.4 patients, range 11-78) with short-term follow-up (mean = 15.5 months, range 3-28.8 months) and average patient age of 80.9 (range 74-85.5).[3,4,5,7,9,10,23] This series represents one of the larger studies investigating mortality in elderly patients with type II odontoid fractures and mid-range follow-up. Therefore, the mortality estimates presented here may be more valid than those encountered in studies utilizing smaller cohorts with less than 2-year follow-up. Moreover, as the average age of patients in these investigations was 80.9, it is possible that the higher mortality rates could be attributed to patient age alone. Unfortunately, most previous reports did not stratify their cohorts by age.

There are several limitations to the current investigation. First, this was a retrospective study, conducted using information compiled from an institutional database. Therefore by its very design, it suffers from the limitations inherent to all retrospective reviews, including the possibility of a strong bias in terms of surgical selection. The most accurate answer to the question of optimal intervention for these injuries could only be derived from a prospective, randomized trial that allocated elderly patients to specific arms of operative or non-operative management, stratifying them by age.

Another limitation was that data regarding the cause of death was not recorded. Such information would have been useful in order to quantify the number of patients who succumbed to complications directly related to their odontoid fracture or from the treatment rendered. As findings in this study demonstrated higher mortality rates among patients of advanced age, as well as in those with more co-morbidities, the roles of treatment, co-morbidity and age could have been more clearly elucidated had the cause of death been recorded.

CONCLUSIONS

The results of this investigation confirm the devastating nature of odontoid fractures, highlighting a high mortality rate that increases with patient age and the number of co-morbidities. While surgery may offer a protective benefit in patients less than 85 years old after adjusting for co-morbidity, the available data do not permit firm conclusions. More research of a prospective nature must be conducted in order to definitively describe the factors responsible for mortality in elderly patients with odontoid fractures. However, in light of the results presented here, future investigations regarding outcomes in elderly patients with odontoid fractures should stratify patients by age.

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