Rigid cervical collar treatment for geriatric type II odontoid fractures

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Abstract

Purpose To evaluate fracture healing, functional outcomes, complications, and mortality associated with rigid cervical collars.

Methods Thirty-four patients with <50% odontoid displacement were treated with a rigid cervical collar for 12 weeks (Average age = 84 years). Outcome scores were compared with a group of 40 age-matched control subjects (Average age 79.3).

Results At average 14.9-month follow-up, only 6% demonstrated radiographic evidence of fracture healing and 70% had mobile odontoid nonunion. NDI scores indicated only mild disability, pain scores were low, and neither differed significantly from age-matched controls. Mobile odontoid nonunion was not associated with higher levels of disability or neck pain. Mortality rate was 11.8%. Treatment complications occurred in 6% of patients.

Conclusions Odontoid nonunion and instability are high in geriatric patients treated with a rigid cervical collar. Fracture healing and stability did not correlate with improved outcomes. Outcomes did not differ significantly from age-matched cohorts.

Keywords Type II odontoid fracture · Cervical collar · Nonoperative management · Geriatric spine patients

Introduction

Odontoid fractures are the most common of all spinal fractures for patients older than 70 years of age. These fractures typically present significant challenges as geriatric patients often have multiple clinical comorbidities that may adversely affect fracture management.

High rates of morbidity and mortality have been published with the surgical treatment of geriatric odontoid fractures [1–3]. [29] External immobilization with a collar has had inconsistent reported results [4–8]. Halo-vest immobilization in the elderly is associated with significant complications, increased morbidity, and high rates of nonunion [5, 7, 9]. Numerous studies have demonstrated high rates of mortality with these injuries in elderly patients regardless of intervention [3, 9–12].

The management of geriatric odontoid fracture patients should be focused on rapid mobilization of the patient after whatever means is chosen for odontoid stabilization. Functional outcomes after surgical or collar management in this population have not been well defined in the literature. Furthermore, outcomes for those patients who do not achieve fusion or fracture healing after treatment remain unclear. The purpose of this study is to evaluate fracture healing rates, functional outcomes, complications, and mortality associated with rigid cervical collars for the management of geriatric type II odontoid fractures.

Methods

Institutional Research Review Board approval was obtained for this study. During the period from 2003 to 2011, 34 consecutive patients over age 70 years with acute type II odontoid fractures were treated by the same

University of Rochester Medical Center Institutional Review Board approval was obtained prior to initiation of this study.

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fellowship-trained spinal trauma specialist (RWM) at a Level-1 trauma center. All patients had <50% odontoid displacement on initial imaging studies and were treated with a rigid cervical collar for 12 weeks. Patients presenting with more than 50% odontoid displacement were not treated with cervical collars and were not included in this study. Additionally, preinjury patient activity level was not assessed in series of consecutive geriatric fracture patients.

Of the 34 patients who were identified as having <50% odontoid displacement on initial imaging studies and were treated with a Miami-J type rigid cervical orthosis (Collar Group), 17 were males and 17 females. The average age of the patients was 84 years with a range from 71 to 99 years. Thirty-two of the 34 patients were identified as having medical comorbidities. The average number of comorbidities was 4.3 with a range from 0 to 10 comorbidities (Table 1). Patients were instructed to wear their rigid Miami-J cervical collar 24-hours a day for a period of 12 weeks. They were also provided with a second cervical liner for showering. All patients reported wearing the collar full-time for the entire duration of the 3-month treatment period. Routine follow-up visits were performed at the 2-week, 6-week, and 3-month post-injury periods. Twenty-nine patients (85.3%) were available for additional clinical follow-up beyond the 3-month post-injury period and 27 patients (79.4%) had at least 6 months of clinical follow-up. Additional clinical follow-up beyond the 3-month visit in a small percentage of patients was achieved by nursing home visitation or telephonic interview.

Hospital and outpatient chart reviews were prepared evaluating patient treatment complications and mortality rates. At the time of ultimate office follow-up, patients had open-mouth and flexion–extension radiographs to assess fracture healing and stability. Additionally, functional outcomes were assessed using neck disability index (NDI), analog pain, and treatment satisfaction questionnaire scores at the time of ultimate follow-up. NDI scores and analog pain scores were compared with that of 40 age-matched control subjects who had no history of ever being treated for a cervical disorder (Control Group). The average age of the control group subjects was 79.3 years with a range from 70 to 91 years. The age-matched control group consisted mainly of elderly subjects who were randomly selected from a busy orthopedic clinic and waiting room setting with non-cervical spine related issues or no orthopedic issue at all.

Study parameters included fracture healing, fracture stability, treatment complications, mortality, and functional outcomes. Additionally, functional outcomes (NDI, pain, and treatment satisfaction scores) were compared between those patients who developed mobile nonunion and those who had a stable odontoid after treatment. Additional comparison of functional outcomes was performed between those

patients with mobile odontoid nonunion and the age-matched control group.

Results: (Table 1)

A total of four patients died and three were declared lost to follow-up after completing 3 months of treatment. All other surviving geriatric patients were available for at least 6 months of follow-up. Patients averaged 4.3 comorbidities with a range from 0 to 10 comorbidities. Comorbidities for each patient varied in severity and are listed in Table 1.

Mortality

The overall mortality rate was 11.8% (4/34 patients) (Table 2). Identifiable 1-year mortality was 5.9% (2/34 patients). Two of the 33 Collar Group patients died during surgery or during the initial 3-month treatment period and another two patients died approximately 23 months after injury. The cause of death was investigated and death certificates were viewed for all four of the Collar Group patients. One of the four Collar Group deaths was attributed to blunt head trauma and three were listed as death occurring from natural causes.

Complications

Collar Group complications were limited to two patients who developed significant skin breakdown in the neck region from prolonged full-time cervical collar wear (5.9%). (Table 2)

Odontoid fracture healing

Fracture healing was determined by evaluating the neutral lateral and open-mouth radiographs for evidence of bridging bone across the odontoid fracture site. Radiographic fusion rates were low. Evidence of radiographic fracture healing rates was observed in only two of the 34 patients (5.9%). Two patients had CT scans in the post-treatment period. Both patients' CT scans confirmed the presence of odontoid nonunion.

Nonunion of the fracture site was observed in 30 of the 32 study patients who completed at least 3 months of fracture treatment (94%).

Nonunion was further classified as stable or mobile depending on the presence of any detectable odontoid fracture site motion on the ultimate patient follow-up flexion–extension lateral radiographs. Twenty-one of the 30 Collar Group patients (70%) who had odontoid fracture nonunion demonstrated mobile odontoid nonunion on flexion and extension lateral radiographs at the time of

Table 1 Patient characteristics

Gender	Age (years)	Complications	Comorbidities	Follow-up (months)
F	86		1. HTN	44
			2. Osteoporosis	
F	84		1. Gout	6
			2. B12 deficiency	
M	86		None	4
F	77		1. HTN	24
			2. Osteoporosis	
			3. Hyperlipidemia	
M	71		1. Insulin dependent diabetes	34
			2. Status post a CVA with some residual left-sided weakness	
			3. Hypercholesterolemia	
			4. Coronary artery disease status post CABG	
F	91		1. HTN	3
M	81		1. HTN	6
			2. Angina	
			3. Chronic bronchiectasis	
F	87		1. Demential	3 ^a
			2. AAA (5 cm)	
			3. HTN	
			4. Depression	
			5. GERD	
			6. Left bundle branch block	
			7. CHF	
			8. COPD	
			9. Peripheral vascular disease	
F	81		1. Hypothyroidism	48
			2. HTN	
			3. Breast cancer-bilateral	
			4. DMT2	
			5. Glaucoma	
			6. Depression	
			7. GERD	
			8. HLD	
			9. Anemia	
			10. CKD	
M	76		1. Atrial fibrillation	48
			2. Hypertension	
M	80		1. Cirrhosis (alcoholic)	4
			2. CVA	
			3. Esophageal varices	
			4. Liver varices	
			5. Abdominal aortic aneurysm	
			6. Splenomegaly	
			7. Basal cell skin cancer	

Table 1 continued

Gender	Age (years)	Complications	Comorbidities	Follow-up (months)
M	88		1. HLD	2 ^a
			2. DM II	
			3. CAD-s/p pacer	
			4. Dementia	
			5. PUD s/p perforation and repair	
			6. Ovarian CA-s/p oophorectomy	
			7. Osteoporosis	
			8. Cardiomyopathy	
M	87		1. Hypertension	17
			2. Hypercholesterolemia	
			3. Prostate cancer, status post brachytherapy	
			4. CAD- s/p 4 vessel CABG	
			5. Possible factor V Leiden	
M	80		1. Barrett's esophagus	14
			2. Carpal tunnel syndrome	
			3. Chronic renal failure	
			4. Diabetes mellitus poorly controlled	
			5. Diabetic autonomic neuropathy	
			6. Diabetic retinopathy	
			7. Gout	
			8. Malignant essential hypertension	
			9. Obesity	
F	78		1. Coronary artery disease	22
			2. Irritable bowel syndrome	
			3. Arthritis	
			4. Chronic UTI	
			5. Hypothyroidism	
			6. Urge incontinence-s/p sling	
M	89		1. HTN	16
			2. Prostate cancer	
			3. CAD- s/p stent	
F	78		1. Megaloblastic anemia	3
			2. HTN	
			3. Hyperlipidemia	
			4. Depression	
F	84		1. Parkinson's disease	26
			2. CAD w/MI 1998- s/p 2 vessel CABG	
			3. Osteoarthritis	
			4. Right carpal tunnel syndrome	
			5. Colonic polyps- s/p R	
			6. Hemicolectomy	

Table 1 continued

Gender	Age (years)	Complications	Comorbidities	Follow-up (months)
F	71		1. HTN 2. Depression	6
M	86		1. Atrial fibrillation 2. Hypertension	21
F	79		1. MRN match	23
F	83		1. Coronary artery disease 2. Congestive heart failure 3. Osteoarthritis 4. Anemia 5. DVT88 6. Hypercholesterolemia 7. Parkinson's disease	41 ^a
M	77		1. Diabetes type 2 2. Anemia 3. Hypothyroidism 4. Coronary artery disease s/p CABG 1980 & 1992; s/p DES in 2003, 2008 5. Hypertension-diagnosed at age 17 6. Hyperlipidemia 7. Osteoarthritis 8. Mitral valve disease	6
F	99		1. HTN	6
M	79		None	7
F	77		None	12 ^a
F	72		1. Prostate cancer 2. Hyperlipidemia 3. HTN 4. Myasthenia gravis 5. Osteoarthritis 6. DM II 7. Venous insufficiency	12
M	98		1. Hx falls 2. Hearing loss	3
M	83		1. HTN 2. HLD	15
M	88		1. Hypertension 2. COPD 3. Asthma	6
M	97	Skin breakdown	1. Atrial fibrillation 2. HTN 3. Dyslipidemia 4. BPH 5. COPD 6. CAD	6
F	81		1. CAD 2. CHF 3. Dyslipidemia 4. HTN	6

Table 1 continued

Gender	Age (years)	Complications	Comorbidities	Follow-up (months)
F	91	Skin breakdown	1. Atrial fibrillation 2. CHF 3. COPD 4. DM 5. Asthma	6
M	82		1. HTN 2. HLD 3. Asthma 4. Osteoarthritis	7
Average	84			14.9

^a Deceased**Table 2** Patient outcomes

	Collar group
Mortality	11.8% (4/34)
Complications	5.9% (2/34)
Fracture healing	5.9% (2/34)
Mobile nonunion	70% (21/30)

ultimate follow-up. The average mobility of the nonunion was 2.5 mm with a range of 1–12 mm. (Fig. 1; Table 1). No patient with mobile union was observed to developed clinical myelopathy or spinal cord injury during the follow-up period.

Functional outcomes

Neck disability index

Neck disability index scores were used to assess functional outcomes for patients in each group. The NDI is scored using a point scale that ranges from 0 to 50. Each patient's raw score is doubled to achieve a percent score. Using this scoring system, a score of 10–28% (that is, 5–14 points) is considered to constitute mild disability; 30–48% is moderate; 50–68% is severe; and $\geq 72\%$ is complete disability. The average NDI score for patients in the Collar Group was 15.7 with a range of 0–58 points. NDI scores in the 40 age-matched geriatric patients in the Control Group averaged 12.9 points with a range of 0–58 points. The 2.8-point difference between average NDI scores between the Collar Group and the Control Group was not statistically significant ($p = 0.35$, t test) (Fig. 2).

Pain score

Pain was scored using an analog pain scale with a range from 0 (no pain) to 10 (maximal pain). Analog pain scores

Fig. 1 Flexion and extension lateral radiographs of four separate Collar Group patients with mobile odontoid nonunion

Fig. 2 NDI Scores for control, collar, stable odontoid, and mobile odontoid groups

at the time of ultimate follow-up indicated low levels of pain in Collar Group patients. The average pain score for the Collar Group was 1.3 points with a range of 0–5 points. Pain scores for the 40 age-matched control patients averaged 1.1 points with a range of 0–5 points. There was no statistically significant difference in pain scores between the Collar Group and the Control Group ($p = 0.52$, t test) (Fig. 3).

Patient satisfaction

The degree of patient satisfaction with treatment and outcomes was evaluated using an analog satisfaction scale with scores from 0 (no satisfaction) to 10 (maximal

satisfaction). Satisfaction scores for the 34 geriatric patients were high. Satisfaction scores for the Collar Group patients averaged 9.1 with a range from 3 to 10 (Fig. 4).

Mobile odontoid nonunion

Twenty-one of the 30 Collar Group patients had mobile odontoid nonunion. Mobile nonunion was not associated with lower functional outcome scores at the time of ultimate follow-up.

NDI scores for the 21 patients with mobile odontoid nonunion averaged 16.1 points with a range of 0–58 points. NDI scores for those patients who had a stable odontoid after treatment averaged 15 points with a range of 4–28 points. There was no significant difference in NDI scores between those patients who had mobile and stable odontoids ($p = 0.94$, t test). (Figure 2) There was also no statistically significant difference in NDI scores between the 20 patients with mobile odontoid nonunion and the 40 age-matched control patients. ($p = 0.62$, t test) (Fig. 2).

Pain scores for the 20 patients with mobile odontoid nonunion averaged 1.4 points with a range from 0 to 5 points. Pain scores for the 10 patients who had stable odontoids was 1.1, range 0–3 points. No significant difference was present in pain between mobile and stable odontoid patients. There was no statistical significance between the pain scores when compared with age-matched controls ($p = 0.52$, t test) (Fig. 3).

Fig. 3 Pain Scores for control, collar, stable odontoid, and mobile odontoid groups

Scores for patient satisfaction were equally high for those patients who had mobile and stabile odontoids with both groups averaging a pain score of 1.1 ($p = 0.94$, t test) (Fig. 4).

Discussion

The nonunion rate in our series is among the highest reported in the existing literature for geriatric odontoid fracture treatment. Reported nonunion rates with nonsurgical management of type II odontoid fractures have ranged from 35 to 85%. [6, 10, 13–17, 28]. However, few of these studies have described and included strict criteria for the documentation of odontoid fracture healing. Using the combination of flexion–extension lateral radiographs with neutral lateral and open-mouth radiographs, we were able to identify radiographic evidence of odontoid fracture healing in only 6% of the elderly patients in our study. Either radiographic evidence of a complete visible fracture line or fracture site motion was identified in 30 of our 32 geriatric study patients who completed at least 3 months of collar wear at the time of ultimate follow-up. Furthermore, 70% of these elderly patients who had identifiable odontoid nonunion demonstrated a mobile nonunion (Fig. 1).

The high rate of odontoid nonunion in our study may be related to a number of factors including the advanced age of our study group (average 84 years), the majority of the fractures presenting with displacement, and the inability of the cervical collar to provide rigid odontoid immobilization. Apfelbaum et al. [13] have shown 8 mm of motion across the dens fracture site with respiratory cycles and concluded that even more rigid halo-vest wear also does not adequately immobilize the dens fracture site. Excessive fracture site motion combined with advanced patient age and osteopenia may all be predisposing factors contributing

Fig. 4 Satisfaction Scores for collar, stable odontoid, and mobile odontoid groups

to high rates of geriatric odontoid nonunion with cervical collar treatment.

Varying rates of odontoid fracture healing in the elderly population after treatment have been reported in the literature. Omeis et al. reported a 30.7% odontoid healing rate with posterior C1-2 surgery and a 37.5% healing rate with anterior odontoid screw fixation in the elderly population [18]. Chaudhary et al. reported 87% fracture union after surgical treatment and 66% union with cervical collar treatment [2]. Osti et al. report 29.0 and 8.6% morbidity and mortality in geriatric patients following anterior screw fixation of type II odontoid fractures [30]. Geriatric odontoid fracture healing in our study appears to be the lowest reported in the literature.

We observed high rates of preexisting comorbidities in our patients averaging 4.3 comorbidities (Table 1). Only two of the 34 patients treated with a cervical collar died within 3 months of treatment (5.9% acute mortality). The overall 11.8% rate for mortality in this series is similar to previously reported rates in the literature for geriatric patients with type II odontoid fractures and multiple comorbidities [6, 19–24]. However, rates for acute mortality in the Collar Group are also among the lowest reported with conservative management of geriatric type II odontoid fractures. The low mortality rate for patients in our study may possibly be attributed to the emphasis on earlier mobilization of these patients soon after collar fitting.

Our study is among the few to evaluate neck disability after elderly odontoid fracture management. We found functional outcomes to be similar in both the Collar Group and the group of age-matched controls subjects who had no history of receiving medical care for a cervical spine disorder. Both the Collar and Control groups had average NDI scores that were consistent with low levels of disability, and there was not a statistically significant difference

between the NDI scores for both groups. ($p = 0.35$, t test). Analog pain scores were also low at the time of ultimate follow-up indicating baseline levels of low neck pain in the Collar Group. Levels of pain in the Collar Group also did not differ from the age-matched control subjects ($p = 0.52$, paired t test). A high level of treatment satisfaction was also demonstrated in the Collar Group patients at the time of ultimate follow-up.

The frequency, risk, and morbidity of odontoid fracture nonunion in the elderly population are not well defined. Because of the risk of progressive myelopathy or sudden neurologic injury, many surgeons recommend operative stabilization for patients with mobile dens nonunions who are able to withstand an operation. There is, however, a lack of information about the radiographic and neurologic progression of dens nonunions. Long-term follow-up evaluation of patients with resulting nonunions has not been adequately reported [23, 25]. One of the few studies was published by Hart et al. [26] who performed a retrospective review of five elderly patients treated without surgery for chronic mobile nonunions of the odontoid process. Patients were observed on an annual basis for 4.5 years with clinical examinations and flexion/extension plain film radiographs. None of the patients developed myelopathic symptoms during the follow-up period, and no patient experienced more than a 1-mm radiographic increase in atlantoaxial excursion. The authors suggest that this close follow-up treatment protocol may be considered for patients who are poor candidates for surgical fusion. Other limited studies have also reported satisfactory outcomes in isolated patients with dens nonunions [16, 25, 27].

Rates of odontoid nonunion for the elderly patients in our study were higher than that previously reported in the literature for cervical collar treatment. We were unable, however, to demonstrate a worse functional outcome in these patients. Additionally, we identified a high rate of mobile odontoid nonunion after collar treatment. Consistent with the findings of Hart et al., no patient with mobile nonunion in our study was observed to develop clinical myelopathy or spinal cord injury during the follow-up period. The elderly patients with extremely mobile nonunions did not have poor functional outcomes—even when compared with age-matched control subjects. The occurrence of catastrophic neurologic demise with spinal cord injury is a concern in those patients who do not achieve odontoid fracture healing. While our study cannot eliminate this concern, we have defined a reasonably low mortality rate for elderly patients who were treated with a cervical collar. A further investigation into the cause of death of the four collar group patients revealed that only one of the four expired from complications involving a fall and resultant head trauma. This is the only study patient who we could identify as possibly experiencing an

untoward neurologic event related to the odontoid nonunion—without conclusive evidence. While not clearly defined in this investigation, it is our opinion that the rate of occurrence of catastrophic neurologic demise in patients with hypermobile nonunion may be acceptably low after cervical collar management of geriatric odontoid fractures that present with less than 50% initial displacement.

Conclusion

In this series of 34 consecutive geriatric patients with type II odontoid fractures treated with a rigid cervical collar, levels of post-treatment neck pain and disability were low and did not differ significantly from age-matched cohorts. Rates of odontoid healing and stability were extremely low. Fracture healing and stability did not correlate with improved outcomes with respect to levels of pain, function, and satisfaction. Mortality and complication rates are low when the rigid cervical collar is combined with early patient mobilization.

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Conflict of interest None.

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