Original Article

Clinical outcomes of elderly patients treated with halo vest immobilization

ABSTRACT

Introduction: There is a lack of consensus on the efficacy and safety of halo vest immobilization (HVI) in elderly patients. The objective of this study was to evaluate HVI's impact on outcomes in patients 60 years or older with cervical spine fractures.

Methods: This was a retrospective study of patients 60 years or older who underwent HVI for treatment of cervical spine fractures between January 2003 and March 2024 at a single institution. Key features of clinical presentation, outcomes at final follow-up, complications, and 1-year mortality rates were recorded.

Results: A total of 54 patients were included for analysis. The average time spent in a halo vest was 2.69 (0.58) months, and the average time to final follow-up was 5.49 (5.84) months. The most common fracture morphologies were the Hangman variant (29.6%) and type III odontoid (29.6%). Forty-nine patients (94.2%) out of 52 patients considered were successfully treated as defined by the lack of need for surgical intervention. Three patients (5.6%) experienced medical complications; two of the three patients died within 30 days of HVI. Lastly, 18 patients (33.3%) experienced HVI instrumentation-related complications, the most common of which was loose halo pins (13.0%).

Conclusion: HVI is associated with lower morbidity and mortality in elderly patients than previously reported and thus may be safely used in this population. However, providers should be mindful of initial clinical presentation and underlying comorbidities when weighing between surgical and nonsurgical intervention.

Keywords: Cervical spine fracture, elderly, halo vest immobilization, outcomes

INTRODUCTION

Estimates indicate that the number of individuals aged 60 years or over will double by 2050, reaching 2.1 billion people or 22% of the global population.[1] In the United States alone, the proportion of elderly patients is projected to increase from 18% in 2024 to 23% of the national population in 2054.[2] Cervical spine fractures following traumatic events are associated with high morbidity and mortality;[3-5] as the elderly population grows, the number of falls and subsequent traumatic injuries is expected to rise concurrently.[6] Halo vest immobilization (HVI) provides a nonoperative method of cervical spine immobilization[7] and is a potentially viable option for management. This technique is particularly effective at stabilizing the upper cervical spine, as it limits flexion at the atlantoaxial joint to a greater degree than standard orthoses.[8] Previously, studies have identified that HVI can successfully heal cervical fractures, with comparable outcomes to those of patients undergoing operative fixation.[9,10] However, there are also conflicting reports that HVI is associated with high rates of morbidity

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and mortality in the elderly, and that surgical management is preferable.[11,12] In addition to potentially contributing to early death, HVI-related complications frequently noted in the literature include dysphagia, pneumonia, and respiratory failure, among others.[13-16]

Given the mixed evidence on HVI's effectiveness and safety, the use of HVI in the elderly remains controversial.[17,18] Additional studies into clinical outcomes, morbidity, and mortality following HVI are warranted to provide greater clarity and consensus. Furthermore, much of the pre-existing literature in this domain has focused on the use of HVI for nonoperative management of upper cervical spine injuries;[19-22] there is a relative lack of insight into the use of HVI for fractures of the lower cervical spine. Thus, the aim of this retrospective cohort study at a Level I trauma center was to evaluate the impact of HVI on outcomes, including the need for surgical intervention, complications, and mortality, in elderly patients with upper and lower cervical spine fractures.

METHODS

Study population

This was a retrospective study of patients 60 years of age or older who underwent HVI between January 2003 and March 2024 for management of fractures of the cervical spine at a single institution's Level I trauma center. The initial query used Current Procedural Terminology codes 20661 and 20664 to identify potentially relevant patients within the specified timeframe. On review of electronic medical records following this query, patients were thereafter excluded if they did not suffer a cervical fracture, underwent HVI for traction or fixation prior to, concurrently with, or following surgery, or were otherwise lost to follow-up (defined as no additional pertinent records present beyond the initial documentation of HVI application).

Descriptive analysis

Electronic medical records provided insight into demographic features, including age, sex, and race, as well as characteristics of initial clinical presentation, such as mechanism of injury. Fracture morphologies were classified via review of CT images; however, for patients for whom no images were available, morphologies were classified via chart review of patient notes. Duration in a halo vest, time to final follow-up from HVI application, and time between HVI application and death (if applicable) in months were additionally calculated. Patient mortality was defined as death within 1 year of HVI. Finally, records were reviewed to note the presence of complications as well as to report outcomes at the final follow-up. Complications were categorized into the following: (1) medical complications (encompassing congestive heart failure, respiratory failure, pneumonia, and dysphagia), (2) halo-related complications (encompassing halo pin loosening, pin-site infections, and pin-site skin irritation), and (3) vest-specific complications (encompassing thoracic ulcers and local skin irritation due to the vest). Successful resolution of cervical fracture was defined as a lack of need for subsequent surgical intervention among patients who were alive during the entire duration of HVI. Alternatively, the unsuccessful resolution was defined as a need for surgical intervention following HVI.

RESULTS

Descriptive characteristics

In total, 54 patients met the inclusion criteria. The average age of the cohort was 73.1 (7.42) years; 72.2% of patients were female, and 3.7% of patients identified as Black or African American. Regarding characteristics of initial clinical presentation and injury, 37.0% of patients suffered a motor vehicle collision and 63.0% of patients suffered a fall. The mean time spent in a halo vest was 2.69 (0.58) months, while the mean time to final follow-up was 5.49 (5.84) months.

Fracture morphology characteristics

Most patients (83.3%) suffered fractures at C2; the most common morphologies were atypical Hangman variant fracture (29.6%) and type III odontoid fracture (29.6%), followed by type II Hangman fracture (13.0%). Eight patients (14.8%) suffered C1 fractures, and the breakdown of fracture morphology at this vertebra was as follows: type I (3.7%), type II (1.9%), type IIIa (1.9%), type IIIb (3.7%), type IV (1.9%), and unspecified (1.9%). In addition, 21 patients (38.9%) suffered fractures of two or more cervical vertebrae. The distribution of fractured vertebral levels is listed in Table 1.

Clinical outcomes

Two patients were deceased during the duration of HVI and were therefore excluded from calculations of success and failure rates. Of the 52 remaining patients, 49 did not need to undergo subsequent surgery to resolve their cervical fractures. Thus, the overall success rate was

Table 1: Distribution of cervical fracture vertebral levels

Vertebral level	Patient count (percentage of total population)
C1	8 (14.8)
C2	45 (83.3)
C3	3 (5.6)
C4	1 (1.9)
C5	1 (1.9)
C6	5 (9.3)
C7	2 (3.7)
Two or more levels	21 (38.9)

94.2%. A representative case is shown in Figure 1. Of the three patients who failed HVI, two were treated surgically for symptomatic pseudarthrosis, while the third patient experienced loss of acceptable reduction 1 day after the halo vest was placed. All three of these patients underwent posterior fusion surgery afterward.

Notably, three patients presented with clinical concerns for pseudoarthrosis after completion of treatment but were managed with observation. In addition, three patients had early termination of HVI due to thoracic ulcers, substantial anterior halo pin loosening, and intolerance of HVI due to pain. Nonetheless, all three patients were subsequently placed into a cervical collar and managed with observation and physical therapy. Finally, one patient underwent halo replacement due to a fall that dislodged the halo ring from the skull; however, this patient was ultimately successfully treated through a continued course of nonoperative management.

Medical complications and mortality

Three patients (5.6%) presented with medical complications during the duration of halo vest wear. One patient (1.9%) experienced respiratory failure and congestive heart failure and expired 3 days after initiation of HVI. In addition, a second patient (1.9%) contracted lower lobe pneumonia in the left lung and expired 22 days after HVI from complications due to pneumonia. A third patient (1.9%) experienced mild dysphagia, which resolved. The distribution of medical complications is listed in Table 2. Including the two aforementioned patients, nine patients total (16.7%) died within 1 year of HVI. The mean time to death was 4.22 months, with a range of 3 days to 11.2 months.

Halo vest instrumentation complications

In total, 18 patients (33.3%) experienced complications related to halo vest instrumentation. Twelve patients (22.2%) experienced halo-specific complications; seven patients had loosening of halo pins (13.0%), four patients had irritation of the skin at pin sites (7.4%), and one patient had a pin-site infection (1.9%) that necessitated an incision and drainage procedure. Six patients (11.1%) experienced vest-specific complications; two patients had thoracic ulcers due to the vest (3.7%), and four patients had irritation of the skin beneath the vest (7.4%). Finally, as previously described, one patient (1.9%) suffered a fall that dislodged the halo ring from the skull and required a return to the operating room for halo replacement. The distribution of halo vest instrumentation-related complications is listed in Table 3.

DISCUSSION

Given that elderly patients comprise an increasing proportion of the spine trauma population, it is critical to identify effective, safe treatment options for traumatic cervical injuries.[23] In the literature, the use of HVI in older patients remains controversial; while it provides strong stability to the cervical spine to promote healing, it is also associated with high rates of complications and mortality.[24] We found that HVI was a viable means for nonsurgical management of cervical fractures in an elderly patient population, as indicated by a success rate of 94.2%. Furthermore, only 5.6% of patients experienced medical complications during the duration of halo vest wear. Thus, in contrast to the findings of previous studies, HVI may be used to heal cervical fractures in the elderly without contributing to excessive morbidity and mortality.

The reported effectiveness of HVI varies, with fracture healing rates ranging from 67% to 93.9%.[25] Our success rate of 94.2% aligns with these findings. Providers may consider HVI to be a preferable form of cervical fracture treatment, as it is a straightforward means of management and circumvents the

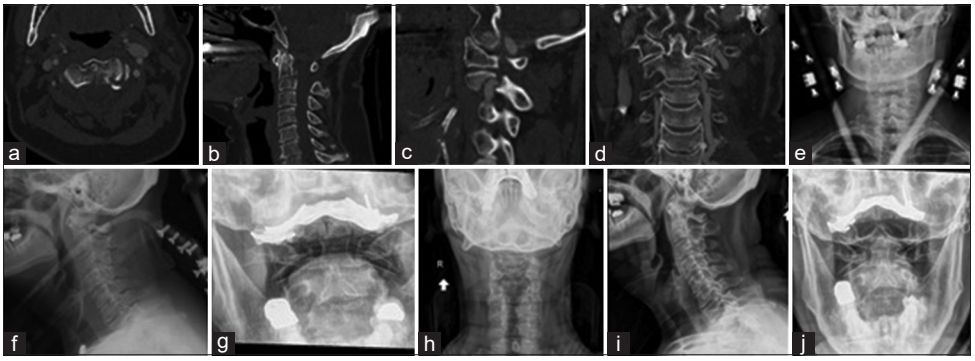

Figure 1: Representative imaging demonstrating successful fracture healing following halo vest immobilization. A 67-year-old female sustained a C2 vertebral fracture with posterior extension into the left pars interarticularis after motor vehicle collision. Representative slices of axial (a), midsagittal (b), left parasagittal (c), and coronal (d) computed topography scan performed at presentation to emergency department. Immediate postprocedure anterior-posterior (AP) (e), lateral (f), and odontoid (g) radiographs demonstrate appropriate alignment. Three-month postprocedure AP (h), lateral (i), and odontoid (j) view radiographs demonstrate maintained alignment after halo removal

Table 2: Distribution of medical complications

Complication	Patient count (percentage of total population)
Respiratory failure	1 (1.9)
Congestive heart failure	1 (1.9)
Pneumonia	1 (1.9)
Dysphagia	1 (1.9)

Table 3: Distribution of halo vest instrumentation-related complications

Complication	Patient count (percentage of total population)
Halo-specific complications	12 (22.2)
Loose halo pins	7 (13.0)
Irritation of skin at pin sites	4 (7.4)
Pin-site infection	1 (1.9)
Vest-specific complications	6 (11.1)
Thoracic ulcers	2 (3.7)
Irritation of skin beneath vest	4 (7.4)
Halo replacement	1 (1.9)

need for surgery.[9] On the other hand, there exists a body of literature indicating that fracture union is achieved at higher rates through surgery compared to HVI.[26] Huybregts *et al*. assessed the surgical and nonsurgical treatment of patients with types II and III odontoid fractures; the authors reported that osseous union was achieved in 66%–85% versus 28%–44%, and fracture stability in 82%–97% versus 53%–79% of surgical and nonsurgical patients, respectively.[27] Though surgery may be considered preferable in terms of increasing the likelihood of clinical success in certain instances, one cannot discount the risks associated with surgical procedures, often requiring an extended period of anesthesia.

Estimates of complication rates following cervical fusion in the elderly range from 10.6% to 13.4%.[28,29] In comparison, our determined rate of medical complications was 5.6%, far lower than those previously reported in the literature. Thus, HVI may be a viable alternative to surgical intervention in this population.

However, it is feasible that HVI can worsen pre-existing conditions. Corroborating this, prior literature has demonstrated that comorbidities are associated with reduced physical health status following halothoracic bracing for cervical facet injuries.[30] High rates of complications have been associated with HVI use in the elderly, prompting recommendations for its avoidance in this patient population.[11] For example, Tashjian *et al*. found that pneumonia and cardiac arrest occurred in 34% versus 8%, and 26% versus 5% of patients greater than 65 years of age treated with HVI and surgery, respectively.[12] Likewise, Horn *et al*. reported that approximately 27% of elderly patients undergoing halo fixation presented with dysphagia.[31] However, in our study, only 3.7% of patients experienced pneumonia or dysphagia. Thus, we found that HVI presents with far less morbidity than reported in prior literature, indicating that it is a safe treatment modality in an elderly population. Furthermore, while two patients died within 30 days of HVI due to pathologies possibly exacerbated by the halo vest, these were the only two out of the entire cohort who died while wearing the orthosis. Estimates indicate that mortality rates in elderly patients undergoing HVI range from 16% to 42%;[32] this study's 16.7% 1-year mortality rate falls on the low end of this range, further demonstrating that HVI is not associated with excessive mortality.

Nonetheless, it must be noted that this treatment modality is potentially only useful for specific fracture types without neurologic deficits that are appropriately reducible by closed means. In addition, there are important contraindications to HVI to be wary of. These include fractures to the cranium, other intracranial pathology, and soft-tissue injury that may preclude safe pin placement. Likewise, obesity, pneumothorax, pulmonary contusion, and barrel-shaped chest (which would preclude proper fitting of the vest) are factors that may discourage the use of HVI.[17] Furthermore, any neurologic compromise in the setting of severe spinal cord injury would likely require open surgery.[33] Given these considerations, a review of both injury characteristics upon initial presentation and relevant comorbidities is critical to ensure that an appropriate decision is made regarding operative versus nonoperative treatment. While HVI may be effectively and safely used, providers should consider individual circumstances on a case-by-case basis before proceeding with this treatment modality. If HVI is indeed ultimately used, subsequent serial imaging and neurologic exams are likely needed to ensure no further fracture displacement or symptomatic neural compression.

This study has several limitations. Given that the patient cohort analyzed was relatively small and drawn from a single institution, our findings may be disproportionately skewed by outliers and not generalizable to larger populations. Follow-up studies at other institutions with larger sample sizes are warranted to corroborate our conclusions and establish greater validity. Additionally, given the expansive timeframe covered by this study, several records presented with incomplete data; this data loss could affect results. In the future, prospective studies with defined protocols that capture standardized sets of variables would mitigate the impact of missing data on conclusions. A third limitation of our study is that we did not compare the outcomes measured to those from another group of patients who underwent surgery for cervical fracture management. Using two matched cohorts would have provided a more definitive perspective on the advantages and disadvantages of HVI; however, the process of matching patients between control

and experimental populations would introduce selection bias, which could affect our results.

CONCLUSION

Overall, HVI was successfully used in 94.2% of patients 60 years of age or older to heal fractures of the cervical spine. HVI was associated with medical complications in 5.6% of patients, with two of these three patients dying from pathologies exacerbated by the halo vest within 30 days of immobilization. Given these findings, HVI is associated with lower morbidity and mortality in elderly patients than previously reported in the literature and may be used safely in this population. Nonetheless, its application is dependent on both injury characteristics at initial presentation as well as pre-existing comorbidities. It is critical for providers to thoughtfully consider the benefits and risks that this treatment modality presents when deciding whether surgical or nonsurgical management optimizes care.

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Conflicts of interest

There are no conflicts of interest.

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