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Comparison of Hard and Soft Cervical Collars for the Management of Odontoid Peg Fractures in the Elderly

Nichola Coleman, MBChB, MRCS(Eng)[1], Hoi-Ying H. Chan, MBChB[1], Veronique Gibbons, PhD[2], and Joseph F Baker, MBChB, FRCSI, CHST Trauma & Ortho[1,3,4]

Abstract

Introduction: Odontoid peg fractures (OF) are the most common cervical spine fracture in the elderly. This retrospective analysis aimed to compare the outcomes of older patients with OF who had been managed non-operatively with either a hard or soft cervical collar. **Materials and Methods:** We analysed the retrospective data of the clinical and radiographic records of patients 60 years or older who presented over a 10-year period with OF and were treated non-operatively with a cervical collar. Mortality was the primary outcome measure with mechanism of injury, complications, and fracture healing secondary measures. **Results:** 45 patients (hard collar n = 22; soft collar n = 23) were included with comparable demographics for frailty and co-morbidities in each group; age was significantly higher in the soft collar group (80.6 vs 86.4 years; $P = .0065$). Associated injuries and complications were not significantly different overall, or when Type II fractures were separately analysed ($P = .435$ associated injuries, $P = .121$ complications). All-cause mortality was greater in the soft collar group (30-day mortality hard: 0%, soft: 9%; 1-year mortality hard: 18%, soft: 48% $P = .035$). However, once corrected for age, this proved not to reach significance ($P = .333$) in any fracture type. Non-union was common (77%) but was not significantly different (hard = 70%; soft = 87%; $P = .419$). **Discussion:** Consistent with other reports, non-union rates remained substantial regardless of which collar was used. After controlling for age, there was no difference in all-cause mortality between elderly patients treated with a hard or soft cervical collar for odontoid peg fractures. **Conclusions:** Soft collars appear suitable for the treatment of odontoid peg fractures in the elderly without compromising outcome. Larger cohort analyses will help confirm this finding.

Keywords

odontoid fracture, peg fracture, non-operative management, soft collar, hard collar, elderly

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[1]Department of Orthopaedic Surgery, Waikato Hospital, Hamilton, New Zealand
[2]Clinical Effectiveness, Quality and Patient Safety, Waikato Hospital, Hamilton, New Zealand
[3]Department of Surgery, University of Auckland, Auckland, New Zealand
[4]Waikato Institute of Surgical Education and Research, Hamilton, New Zealand

Corresponding Authors:
Nichola Coleman, Department of Orthopaedic Surgery, Waikato Hospital, Hague Road, Private Bag 3200, Hamilton 3240, New Zealand.
Email: nichola.coleman@doctors.org.uk

Joseph F Baker, Department of Orthopaedic Surgery, Waikato DHB, Hague Road, Private Bag 3200, Hamilton 3240, New Zealand.
Email: joe.baker@auckland.ac.nz

Introduction

Odontoid peg fractures (OF) are the most common cervical spine fractures encountered in the over 65 years age group and are an ever-increasing problem as the global population ages. As of 2016, 12% of the overall population of New Zealand was aged 65 years and over, and this is expected to double over the next 30 years.[1] This is in keeping with a worldwide census in 2015 reporting 8.5% of the global population is 65 years or older, and this is expected to increase to 12% by 2030.[2] Determining optimal treatment is therefore essential to allow timely decision making and reduce unnecessary morbidity and mortality.[3,4]

Fracture management in the elderly is a challenge due to reduced bone density, potentially poor general health and frailty. These characteristics make this group high risk when considering operative management and make decisions regarding the most appropriate treatment difficult.[4] Unfortunately, best non-operative management of odontoid fractures remains inconclusive within the literature.[3,4]

A variety of cervical orthoses may be appropriate in older patients as they can aid in maintaining quality of life and provide adequate fracture stabilisation resulting in (usually) a fibrous union.[3–6] Soft cervical collars for the management of OF have increasingly been used in the geriatric age group due to concerns about the discomfort with hard collars, the potential for non-compliance and the risk of developing pressure sores that can be painful and may require prolonged treatment for healing.[7] Outcomes however are yet to be determined with this approach, and the literature does not provide evidence upon which to base practice. Some opinions have been published for their use only after time in a hard collar.[8]

We undertook a retrospective analysis of patients aged 60 years and over treated non-operatively with a cervical collar for odontoid peg fractures over a 10-year period. Our aim was to compare outcomes between the 2 treatment modalities with a focus on mortality rates. Type II fractures were also sub-analysed as this is a cohort where treatment controversy is the greatest.

Methods

Ethical Approval

This study was registered and approved as an outcome analysis by our hospital Clinical Audit Support Unit (Audit number: 3929).

Case Selection

A retrospective analysis of patients' electronic clinical records with OF between January 2008 and December 2018 was performed – selected dates allowed confirmation of diagnosis via access to the digital radiographic record. All cervical spine fractures were identified from clinical coding on discharge. Each clinical and radiographic record was reviewed to confirm the diagnosis of OF, which allowed correction of potential coding errors relating to the spinal level in which the fracture had occurred. Patients were excluded if less than 60 years old, treated in another hospital, missing data (including CT imaging to accurately confirm diagnosis and define fracture pattern), pathological fracture and treatment other than a collar. A total of 45 patients were included in the final analysis (Figure 1).

At our institution, where acute spine injuries are managed by 3 fellowship-trained orthopaedic spine surgeons, possible reasons for surgical interventions rather than non-operative, as discussed here, include overt instability with significant change between supine-erect imaging, neurologic impairment and polytrauma. However, a case by case decision is made taking into account patient co-morbidities and a risk vs benefit discussion had with the patient. This included the decision for soft vs hard collar.

Data Collected

Collected parameters were age, gender, treatment modality (hard or soft collar), mechanism of injury, associated injuries, 30-day and 1 year mortality, comorbid conditions to allow calculation of Charlson Co-morbidity Index (CCI)[9] and the modified Frailty Index-11 (mFI-11),[10] complication, and fracture healing (union or non-union). Fractures were classified using Anderson and D'Alonzo classification,[11] and the degree of angulation and amount of translation were calculated. Fracture union was determined by presence of trabeculae across the fracture, absence of visible fracture line, absence of movement on dynamic radiographs (where available) on anteroposterior and lateral cervical spine radiographs (assessed by single fellowship-trained spine surgeon).

Statistical Methods

Data were collected onto a Microsoft Excel spreadsheet and analysed using Stata 11.2 (StataCorp LP, USA). Student's T test (parametric), Wilcoxon rank-sum (non-parametric, ordinal), Chi-squared test and Fisher's Exact tests were used to assess statistical significance. Logistic regression was used to adjust for patient age when analysing mortality. The significance level was set at $P = .05$.

Results

Baseline Demographics

Of the 45 patients identified for analysis, 22 were treated in a hard collar and 23 in a soft. Almost two-thirds were female (62%). Table 1 shows the patient characteristics in each

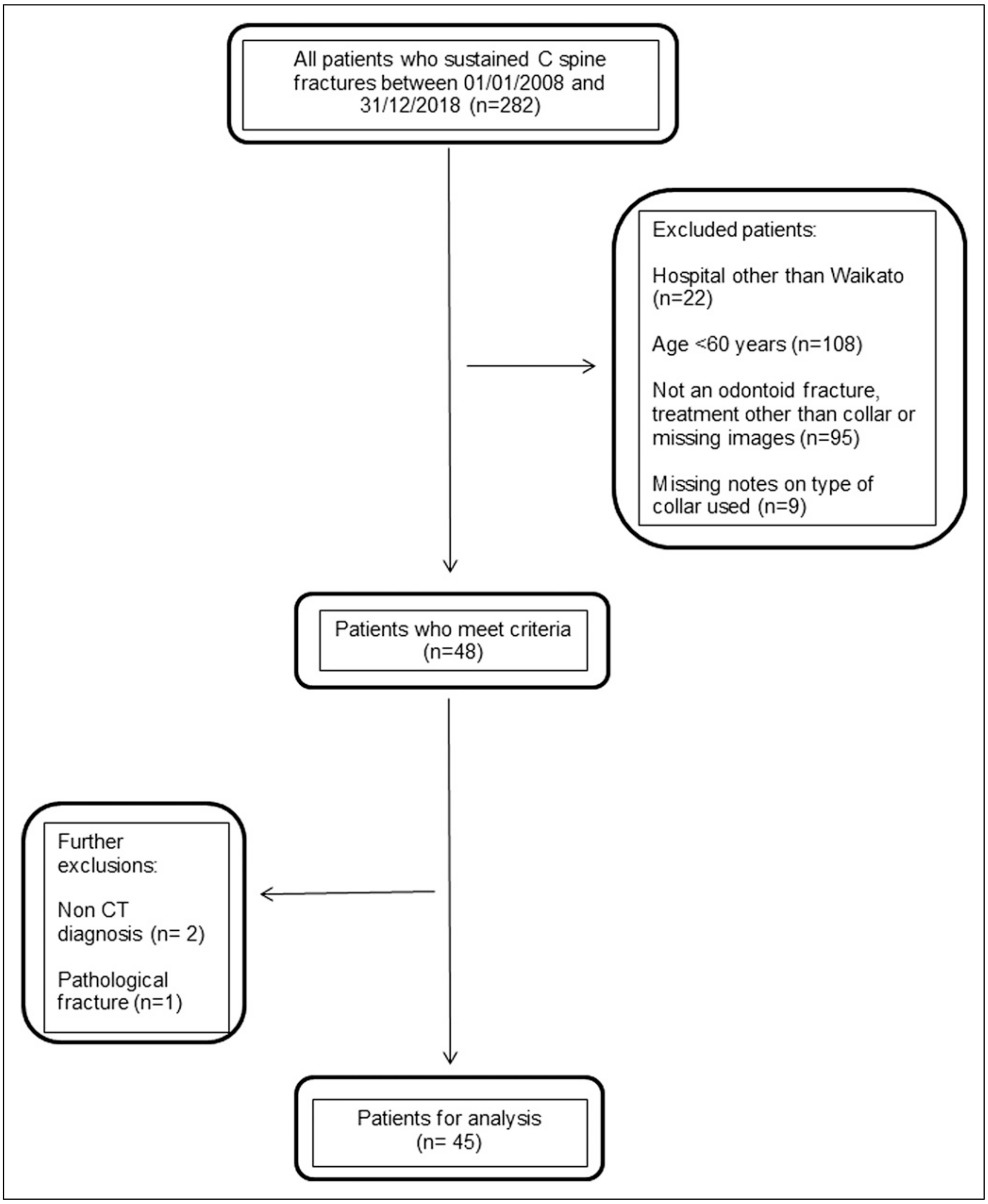

Figure 1. Exclusion criteria.

group. Age was statistically different in the 2 groups, (mean age hard collar: 80.6, soft collar: 86.4 years P = .0065).

Fracture Type and Configuration

Table 1 depicts the type of fractures present, with type II having the highest frequency in both hard and soft collar groups. Angulation and translation did not significantly differ between groups.

Primary Outcome

Mortality. Overall mortality was 33% at 1 year, 18% in the hard collar and 48% in the soft collar groups. Two patients in the soft collar group died within 30 days of presentation. One died of pneumonia following multiple injuries in a high-speed motor vehicle collision, and the other cause of death is not known.

At 1 year, 4 patients had died in the hard collar group and a further 7 in the soft. The cause of death was found for 1 patient (stroke); however, the cause was not found for the other patients. In the soft collar group, suspected malignancy, hypernatraemia, myocardial infarction and pneumonia were listed as causes. The remaining patients did not have recorded causes.

The mean age at death was 88.6 years. The hard collar group (n = 4) died younger at 84.5 years (male: 86 female:

Table 1. Patient Characteristics.

Characteristic	Hard collar group (n = 22)	Soft collar group (n = 23)	P-value
Gender	Male–9 female-13	Male–8 female-15	*P* = .672
Mean age[a]/−SD (range)	80.6[a]/−8.06 (61–91)	86.4[a]/−5.32 (74–95)	*P* = .0065
Median CCI[b] (IQR) (range)	5 (4–7) (3–14)	6 (4–7) (3–14)	*P* = .3230
Median mFI[a] (IQR) (range)	.23 (.18–.36) (.0–.55)	.27 (.09–.36) (.09–.45)	*P* = .9630
Fracture type (Types I–III)	I: 0 II: 13 III: 9	I: 1 II: 15 III: 7	*P* = .646
Mean fracture angulation degrees[a]/−SD (range)	9.86[a]/−11.45 (0–41.1)	13.5[a]/−11.52 (0–30.4)	*P* = .150
Mean translation mm[a]/− SD (range)	1.95[a]/−2.50 (0–9.0)	1.91[a]/−2.28 (0–7.4)	*P* = .821

[a]mFI – Modified Frailty Index. Death was treated as maximum frailty and given an mFI of 11. mFI calculated by number of answers divided by possible maximum total of 11.
[b]CCI – Charlson Co-morbidity Index.

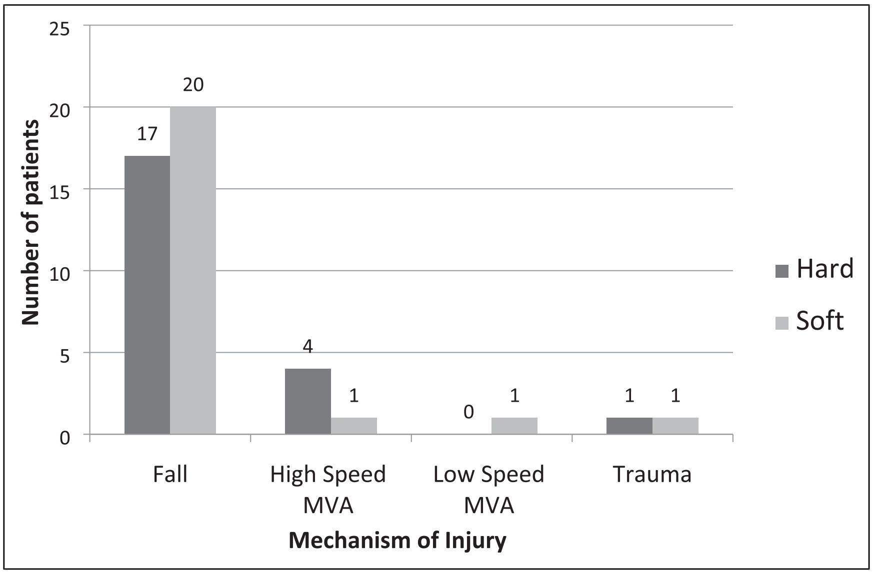

Figure 2. Mechanism of injury.

89) than the soft collar group (n = 11): 88.7 years (male: 90.7, female: 88).

Initially, mortality appeared to differ between the groups ($P = .035$); however, the soft group were significantly older ($P = .0065$), and once this was accounted for using logistic regression, no difference in mortality was found ($P = .333$).

Secondary Outcomes

Mechanism of Injury. The main mechanism of injury was a fall from standing height. Figure 2 depicts the mechanisms of injury. No difference was found between the groups ($P = .451$). Motor vehicle accident (MVA) at high or low speed and trauma for other reasons made up the remaining mechanisms.

Table 2. Associate Injuries/Conditions.

Associated Injury/ Condition	Hard collar group (n = 16)	Soft collar group (n = 11)
Soft Tissue	5	2
Spine fracture	6	4
Other fracture	7	4
Other	3	2
Total	**21**	**12 *P* = .152**

Associated Injuries and Complications

Table 2 depicts the associated injuries found. There were no differences found between the groups. Both groups showed high frequencies of soft tissue injuries as well as other fractures. Of the spine fractures, other cervical spine fractures accounted for the majority (hard = 4/6, soft = 4/4). Other conditions included alcohol withdrawal, anaemia, dental abscess, seizure and atrial fibrillation with fast response. Other fractures were found in multiple locations.

Table 3 shows the complications documented during the inpatient and follow-up. There was no significant difference between the groups (*P* = .223). Complications that can be directly related to collar use were pressure sores in 2 patients (9%), both in the hard collar group. No documented altered neurology or myelopathy was found in either group.

Fracture Union

Patients were classed as showing union or non-union. This was reviewed on last available radiograph of at least 6 weeks from injury. Not all patients had appropriate follow-up imaging, and so patient numbers were smaller in both groups (hard n = 20; soft n = 15). Both groups showed non-union as the main finding (hard n = 14 (70%); soft n = 13 (87%)). No significant difference was found for fracture union when all fracture types were included (*P* = .419).

Table 3. Complications.

Complications	Hard collar group (n = 8)	Soft collar group (n = 4)
Cardiac	3	1
Pulmonary	2	3
Infection (not chest)	3	0
Pressure sore	2	0
Other	1	3
Total	**11**	**7 *P*=.062**

[a]1 patient had 2 separate episodes of pneumonia and is counted as 2 complications.

Type II Fracture Group

Table 4 depicts the findings for type II fractures in relation to mortality, associated injuries, complications and union rates. Overall mortality for the hard collar group was 13.3% (3/13) and 60% (9/15) the soft collar group; however, there was no significant difference between the groups (*P* = .254). There were no significant differences between the groups for any of these measures or any of the other measures. 100% of the type II fractures (n = 8) showed non-union in the soft collar group compared to 75% (n = 9) in the hard collar (*P* = .125).

Discussion

This study compared the outcomes of odontoid peg fractures in elderly patients treated non-operatively with either hard or soft cervical collars. Accepting this retrospective analysis comprised small numbers, we could not detect any difference in mortality between those treated with a hard or soft collar.

Our study population was mainly female, in keeping with the higher prevalence of osteoporosis in women and OF being a fragility fracture in patients over 65 years.[4] The 2 groups were comparable in comorbid status and frailty with the CCI and mFI-11 being similar in each group. Also, our results show that type II fractures were the most common and type I the least, again consistent with other studies.[12–14]

The overall 1-year mortality rate in our cohort was 33%. This is in line with other reports on hard collar use in the elderly, with mortality rates from 5.9% in a review of 34 patients,[5] to 37% of hard collar patients in a larger review of type II fracture treatment,[15] up to 41% of non-operative management (excluding Halo-vest) in a review of treatments of type II fractures in octogenarians.[16] As there are no reports on the use of soft collars for OF in the elderly,

Table 4. Type II Fractures – Subset Analysis.

Outcome	Hard collar group (n = 13)	Soft collar group (n = 15)	P-value
Mortality	3	9	*P* = .254
30 day	0	2	*P* = .172
1 year	3	7	*P* = .194
Mechanism of injury	13	15	
Fall	12	14	*P* = .916
All other causes	1	1	*P* = .916
Associated injuries	14	11	*P* = .342
Complications	9	3	*P* = .865
Fracture union[a]	12	8	*P* = .693
Union	3	0	*P* = .125
Non-union	9	8	*P* = .125

[a]Sample size reduced due to missing data (hard collar n = 13, soft collar n = 8).

Table 5. Literature Review of Mortality Rates in the Elderly with Odontoid Fractures.

Author(s) and date	Study design	Treatment	Sample size	Patient age (years)	Fracture types included	Follow-up duration	Mortality rate
Venkatesan, M et al. (2014)[25]	Retrospective review	Hard collar, halo-vest and surgical intervention	32	≥65	Type I, II and III	Mean follow-up = 29 months	25% (30 days) 34.4% (180 days) 37.5% (1 year) (Combined treatment options)
Bajada et al. (2017)[26]	Retrospective review	Hard collar and Halo-vest	83	≥65	Type I, II and III	Data reviewed between 2005–2014	Halo: 0% (30 days), 66.7% (1 year) Hard collar: 16.3% (30 days), 22.5% (1 years)
Aquila, Tacconi and Baldo (2018)[22]	Retrospective review	Hard collar	25	≥75	Type II or com bined with C1	Follow-up between 18–24 months	12% (3 months) 36% (24 months)
Chapman et al. (2013)[27]	Retrospective review	Operative vs non-operative (no clear definition given)	322	≥65	Type II	Mean follow-up = 647.5 days (non-operative), 851.2 days (operative)	7% (operative) (30 days) 22% (non-operative) (30 days)
Charles et al. (2019)[9]	Prospective multicentre study	Hard collar, surgery (various)	144 (out of 204 cohort)	≥70 (sub-group)	Type I, II and III	Max 1 year	16.7% (1 year)
Clark et al. (2018)[28]	Retrospective review	Posterior C1-2 fusion	43	≥80	Type II	To study completion (not otherwise stated)	2.3% (30 days) 18.6% (1 year)
Faure et al. (2017)[29]	Retrospective review	Harms technique, anterior screw fixation	70	≥75	Type II and III	Average follow-up=23.4 months	ASF: 35.3% (3 months), 35% (1 year) Harms: 18.7% (3 months), 22% (1 year)
Hong et al. (2018)[30]	Retrospective review and literature review	Hard collar, Halo-vest	50	≥65	Type II	Median follow-up = 27 months	2% (6 months) 4% (12 months) 30% (24 months) (Combined treatment options)
Graffeo et al. (2017)[15]	Retrospective review	Hard collar, surgery (various)	94	≥80	Type II	Mean follow-up = 24 months (hard collar), 32 months (surgery)	Hard collar: 27% (30 days). 41% (1 year) Surgery: 24% (30 days). 41% (1 year)
Raudenbush and Molinari (2015)[13]	Retrospective review	Hard collar	34	≥70	Type II	Up to 6.67 years	68% (average 3.8 years from injury)
Joestl et al. (2016)[31]	Retrospective review	Anterior screw fixation, halo-vest	80	≥65	Type II	≥5 years	9% (over study period)

(continued)

Table 5. (continued)

Author(s) and date	Study design	Treatment	Sample size	Patient age (years)	Fracture types included	Follow-up duration	Mortality rate
Longo et al. (2019)[32]	Retrospective review	Anterior screw fixation	198	≥65	Not specifically stated	30 days	7.6% (30 days)
Molinari et al. (2012)[5]	Retrospective review	Hard collar	34	≥70	Type II	Average follow-up = 14.9 months	5.9% (1 year)
Schoenfeld et al. (2011)[16]	Retrospective review	Operative, halo-vest, hard collar	156	≥65	Not specifically stated	Up to 3 years	Operative: 11% (3 months), 21% (1 year) Halo: 21% (3 months), 32% (1 year) Hard collar: 26% (3 months), 37% (1 year)
Shafafy et al. (2019)[17]	Retrospective review	Hard collar	82	≥65	Type I, II and III	Data reviewed between 2008–2016	14.6% (30 days) 34.1% (1 year)

the seemingly high mortality in the soft collar group cannot be further contrasted but aids as a benchmark for future research.

Table 5 depicts the mortality rates of papers currently published. The treatment modalities vary; however, our outcomes are very similar to others who reviewed the use of a hard collar.[15–17] Although not assessed in this paper, Table 5 also shows good mortality rates with other forms of treatment options, especially surgical options. However, there are currently no papers available assessing the use of a soft collar, and there is a paucity of information on direct comparisons between treatment modalities in terms of mortality.

By having hard collar mortality figures in keeping with other studies, it appears that our cohort behave similarly to others, and thus, the findings obtained from the soft collar group could potentially be recreated on further research. The hard collar mortality rate (13.3%) in the sub-group of the type II fractures, is in the middle of the range found on review, between 5.9% at the lowest[5] and 41% at the highest[16] (see Table 5).

The fracture type and configuration (angulation and translation) did not differ between the groups, thus suggesting that this may not be a deciding factor between collar types in this population. Unlike other studies and reviews on non-operative management,[15,16,18–23] we included all fracture types to assess if these groups could also be affectively treated with a soft collar and not just the hard collar option. As such, we note that older patients with type I and III fractures can potentially also be treated non-operatively in soft as well as hard collars. None of the studies before have compared hard with soft collars. Therefore, this study provides a unique insight into the use of the soft collar in the elderly population.

To enable better comparison between studies, we have separated out the type II fractures as a sub-group analysis. We did not find any significant difference between the collar types for any of our outcome measures. Although, the difference in mortality between the groups in this subset (13.1% vs 60%) may appear large, it was not found to be statistically significant on analysis once patient age was considered (as shown in the overall mortality similarly).

We feel this gives evidence towards the use of either a soft or hard collar in the elderly population, with the soft collar potentially being favoured due to the increased likelihood of compliance and reduced complications possible with this collar.[3,7]

A factor in deciding for a hard or soft collar could have been associated injuries or conditions. The hard collar group had 16 patients with associated injuries compared to 11, which was not statistically significant. Thoracic fracture (T4) as well as lumbar fractures (L1, 2, 4, 5) were present. Patel et al. found that 40% of their cohort, 57 patients with a median age of 78 years, had associated injuries, most of which were orthopaedic.[18] In this current study, all the associated spinal fractures in the soft collar group occurred in the C1 vertebrae which is in keeping with other reports.[19]

There were more associated complications in the hard collar group than the soft. Of note, 2 patients who developed pressure sores were in the hard collar group. However, only the pressure sores can be reliably linked directly to the use of a collar and it would be inappropriate to suggest associations with the other complications found. Pressure sores are a recognised complication of hard collar use.[3,7] Consideration of skin fragility in the elderly, which may result in unnecessary risk of infection, pain, poorer compliance with the hard collar and overall affect the quality of life of these individuals, needs to be performed when choosing a collar. This may have been a factor in some of the patients who are older and have been treated in a soft collar. Neither group were found to have had neurological complications during the admission or follow-up. It could be suggested that a soft collar can provide adequate stability to prevent neurological compromise, which is what Leddy and Ahern argue with regards to type II fractures in the elderly.[4] However, more studies and of larger sample size are needed to confirm this supposition.

Fracture union did not occur in most cases. This is variable in the literature as some report non-union as high as 94% with the use of a hard collar.[5] Although the concern regarding non-union is that of subsequent myelopathy, this was not found in our study. This could be explained by the Miller and colleagues, who found that there were similar amounts of restriction in range of movement with both soft and hard collars when performing certain activities of daily living,[24] although the subject characteristics for this paper greatly differed from our own. Also, our finding on myelopathy is in keeping with a longer follow-up study on type II non-union fractures by Raudenbush and Molinari[6]; however, Raudenbush and Molinari do point to other studies which are contrary to these findings.

Study Limitations

This study cohort was small, and the analysis is retrospective in nature; therefore, we are reliant on the accuracy and completeness of previous clinical documentation. Our follow-up varied greatly from little to no follow-up, mostly in the soft collar group, to over 15 months (453 days) for a hard collar patient. Patients who were lost to follow-up or discharged back to their GP may have had complications missed in the overall analysis. The short follow-up duration and loss to follow-up may also influence our data with regards to longer-term complications such as myelopathy. This study was not a randomised control trial, and as such, variation exists between clinicians when choosing a treatment option. This may have influenced the results due to clinician bias and preference as the treatment decision was taken on a case by case basis.

Conclusion

This is the first study that compares outcomes of odontoid peg fractures in the elderly treated with either hard or soft cervical collars. Our findings suggest that satisfactory outcomes are achievable with either orthosis with no difference in mortality evident although non-union rates remain high no matter what orthosis is chosen. A soft collar avoids the potential for pressure sores encountered with hard collar use and may be a safer option in this population.

Recommendations

We recommend clinicians consider the use of soft collars for non-operative treatment of odontoid peg fractures in the elderly. Prospective or randomised controlled trial study design would help reduce the limitations found in our study. Longer-term follow-up would also aim to evaluate complication rates better and get a truer picture of outcome.

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Author Contribution

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NC was the primary researcher for this project and production of this manuscript.
HC acted in study design and data collection.
VG acted in providing the statistical analysis of the data.
JB acted in concept, study design, radiographic analysis, supervisory and editing role.

Declaration of Conflicting Interests

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ORCID iDs

Nichola Coleman https://orcid.org/0000-0001-9137-6828
Hoi-Ying H. Chan https://orcid.org/0000-0001-5308-7195

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