Name – Brooke Nash

Student Number – 1902199

Title - The Incidence, Presentation and Management of Odontoid Peg Fractures in the Geriatric Population.

Tutor – Mr Stuart James, Mr Michael McCarthy

Institution – University Hospital of Wales, Heath Park Way, Cardiff, CF14 4XW

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The Incidence, Presentation and Management of Odontoid Peg Fractures in The Geriatric Population

Abstract

Objective: To assess trends in presentation and management of odontoid peg fractures over a 2-year period. This analysis aims to identify a superior cervical orthosis for the management of odontoid peg fractures.

Methods: Retrospective analysis of data collected from referrals to UHW Spinal Surgery Unit from January 2020- December 2022. Patients' medical records and radiological imaging were reviewed.

Results: Conservative management is used in elderly patients presenting with odontoid peg fractures. Of the different types of conservative management, semi rigid collars are used most frequently. There is not a significant difference between union rates and the use of hard and cervical collars.

Conclusions: Geriatric odontoid peg fractures should be managed by finding a balance between safe fracture union whilst considering patient quality of life which is why soft cervical collars should be the treatment modality of choice.

Introduction

Fractures of the second cervical vertebra (C2) are the most common cervical spine fracture in the geriatric population (1) and of all C2 fractures, fractures of the odontoid peg seem to predominate (2). There tends to be a bimodal age distribution with odontoid peg fractures, where different mechanisms of injury are seen; in the younger age group (20s-30s) high speed road traffic accidents tend to be the most prevalent cause. This is in stark contrast to the over 65 age group who tend to suffer from peg fractures due to low energy trauma, such as falls from standing height (1).

Odontoid peg fractures are classified by a system created by Anderson and D'Alonzo (3) which is dependent on the fracture pattern. Type I fractures are avulsion fractures of the rostral tip of the odontoid process. Type II is the most common type and presents as a fracture through the base of the odontoid process, usually due to a hyperextension injury of the cervical spine. There are additional classification systems proposed by Grauer (4) which aims to provide a more anatomical description to type II fractures which enables more intricate surgical planning for surgical fixation candidates. Type III fractures occur through the body of the C2 vertebrae and may involve a portion of the C1/ C2 facets.

As the UK moves towards an ageing population (1) this has been associated with an increasing incidence of peg fractures reported over recent years (5). Numerous studies have demonstrated high mortality and morbidity rates of elderly patients with peg fractures. In the elderly, the consensus is that a conservative approach to management should be followed due to the increased risk of surgical intervention (6). However, there is not a consensus surrounding the most appropriate cervical orthosis for treating these fractures.

The aim of cervical orthoses is to minimise motion of the cervical spine and to promote fracture union, however between the different types of collars, there are varying levels of immobilisation and patient comfort (7). The two most used orthoses in odontoid peg fracture management are soft and semi rigid collars and it has been established that soft collars tend to restrict movement the least. Halo vests have been used previously but have been associated with increased incidence of early mortality and morbidity in the elderly, so their use is now limited (8).

Aims/ Objectives

This retrospective analysis aims to ascertain whether there is a correlation between the type of cervical orthoses used and whether it results in bony union of the fracture site. This analysis aims to identify whether there is a superior conservative method for managing over 65s with odontoid peg fractures, dependent on quality of life and mortality.

Methods

This is a retrospective analysis of patients who were referred to the Welsh Centre for Spinal Surgery, UHW within a 24-month period between January 2020- December 2022. For the purpose of this analysis, only patients who sustained new fractures to the odontoid peg were included. Additional inclusion criteria included age of 65 years or older and radiographic evidence of an acute fracture, as well as conservative non-surgical approach to treatment.

Information was obtained for all patients who had suffered an acute odontoid peg fracture of the C2 vertebra. Their medical records were reviewed to analyse age, sex, date of injury, mechanism of injury, fracture classification and management. Fracture displacement and angulation were measured on the initial sagittal Computed Tomography (CT) scans. Fracture displacement was measured by drawing a line along the anterior aspect of the dens and the body of C2 (Figure 1a). Fracture angulation was measured as the angle between two tangent lines drawn along the posterior aspect of the odontoid fragment and posterior aspect of C2 (Figure 1b). Fractures were grouped into either type I, II or III according to the Anderson and D'Alonzo classification system of Odontoid Peg fractures (3).

Figure 1a: Method to measure fracture displacement

Figure 1b: method to measure fracture angulation

Follow up Lateral X Rays once the patient was in their cervical collar were also reviewed to include the fracture alignment. The patients 3-month post-injury follow up X Rays and clinic referral letters were then analysed to see if stable fibrous union or bony union was achieved. Union was deemed to have been achieved if there was no fracture movement on follow up flexion/ extension radiographs.

Ethical Approval was not required for this analysis. This is a retrospective report where patient management had already occurred. Data was sourced from existing Welsh Clinical Portal Records and imaging based on the hospitals Picture Archiving and Communication System (PACS).

Microsoft Excel and SPSS statistics were used for analysis of the quantitative data. Mean scores and standard deviations were calculated. Mann Whitney U test with a p value of <0.05 was used to determine the significance of fracture characteristics on union rates. Chi Squared p value of <0.05 was used to determine whether there was a significant difference between fracture union rates when using hard or soft cervical collars.

Results

Patient Characteristics

In total, 57 patients were referred to UHW Spinal Surgery Team with Odontoid Peg Fractures within the 24-month period. Of these 57 patients, 30 were found to have new odontoid fractures, were over the age of 65 and were treated conservatively.

The average age of the patients was 82.7± 6.73 (range = 25years). Of the 30 patients, 24 were female (80%) and 6 were male (17.2%).

The most common mechanism of injury were low energy falls (e.g. falls from standing height or from bed/ chair) (n= 24). 5 patients sustained injuries from falling down a flight of stairs (a flight of stairs being quantified as more than 14 steps). 1 patient was involved in a high-speed road traffic accident.

Fracture Characteristics

Of the different Dens fracture subtypes, Type II fractures were the most common (n=18), followed by Type III (n= 7) and finally type I (n=5). Although a significant variation in standard deviation, type II fractures tended to be associated with greater displacement and angulation.

Fracture Type	Frequency	Posterior Displacement (mm)	Angulation (degrees)
I	5	2.26 ± 1.65	11.5 ± 8.5
II	18	3.46 ± 3.81	19.7 ± 19.5
III	5	2.58 ± 4.11	11.4 ± 16.5

Figure 2: Fracture Characteristics

The effect of posterior displacement and angulation on non-union rate was assessed to determine if there was a significant relationship

Variable	P Value
Posterior Displacement	0.482
Angulation	0.384

Figure 3: The Effect of Fracture Characteristics on Non Union

Management

In type II and III fractures, the use of a rigid cervical collar (n=15) was the most common, followed the soft collar (n=11). The Cervical Thoracic Orthoses (CTOs) were only used twice, and both of whom sustained a type III fracture.

The average age of patients treated using a semi rigid collar was 78.2 compared to 87 years for those treated with the soft collar.

The mean length of time that patients were followed up was 99.5 days and at this time, only 7 (23%) patients had been documented to have achieved bony union on their follow up X Ray. The most common subgroup of patients to achieve bony union was those who had type III fractures and were treated with a semi rigid orthoses.

8 patients did not have any follow up scans or clinical letters to evaluate whether bony union had been achieved or not. Of these 8 patients who didn't have follow up scans, 5 unfortunately died. The mean length of time after referral to the patient's death was 25.8 days. Of the 5 patients who died, all were managed using a semi-rigid collar, no patient who was treated using a soft collar died during the time period.

For the patients treated with the soft collar, mean posterior displacement averaged at 2.28mm and for those with the semi rigid collar averaged at 3.05mm.

Orthoses		Frequency	Union
Soft	I	2	0
	II	7	2
	III	1	1
Semi Rigid	I	1	0
	II	10	1
	III	4	3
CTO	I	0	0
	II	0	0
	III	2	0

Figure 4: Management Options and whether Union was Achieved

Discussion

As previously mentioned, there is a bimodal age distribution and studies have found that there is a male predominance of odontoid fractures in the young, and this shifts to a female predominance with increasing age (9), which is also seen in this cohort as 80% of patients

were female. This could be due to women having a higher incidence of osteoporosis than men meaning that they are more susceptible to fragility fractures following low level trauma (10). Low velocity falls are the leading cause of trauma in the UK (11) which is in keeping with this set of data, as 80% of patients suffered a fracture due to low level trauma.

Previous publications have shown that under 5% (3, 12) of all odontoid fractures are type I, however, 5 patients in this cohort had been documented to have type I fractures. These fractures have been found to be the most stable, and our data shows that these fractures were the least displaced. 2 of the patients were unfortunately lost to follow up, so it is not known whether union was achieved; however, in the remaining patients, fracture union was not achieved. 2 of the patients were treated with a soft collar, and one of the patients was originally started on a semi rigid collar, however this was not tolerated by the patient, and they were switched to a soft collar for the remaining duration of treatment.

Type II fractures were the most common, accounting for 60% of the fractures treated in this cohort. Non-union rates of type II fractures have always been reported to be high, with one study reporting a non-union rate of 94% (13). This data set showed a non-union rate of 83%, similar to other published studies (6). Type II fractures have also been found to be the most unstable (3), and surgical stabilisation is often advised for patients who can tolerate surgery (14). Type II fractures in this cohort had the greatest measurements of displacement and angulation, but there was also a large amount of variation between patients. 55% of the type II fractures were treated with a semi rigid collar, perhaps due to their increased instability which required a more intense intervention to prevent movement at the fracture site which has the potential to cause complications.

A recent study has analysed consultant neuro/ orthopaedic surgeons management plan for a geriatric type II fracture based on a hypothetical case study. Most surgeons opted for a conservative approach, with 84% choosing a semi rigid collar over a soft collar (15). Semi rigid collars are the most frequently used option for type II fractures (9, 16-17), despite there being no difference between fracture union rates. This current data set found that there is not a significant difference across all fracture types on union rates dependent on the choice of cervical orthotics (X^2 (1, N=25) = 0.0331, p=0.855702).

A CTO was used in two cases of type III fractures, but not in any of the other types of fracture. CTOs provide a greater form of immobilisation in comparison to a semi rigid collar without the thoracic brace (18), but in this data set, the greater immobilisation did not achieve union in either patient. Previously, type III fractures used to frequently be treated with a halo-vest, however their use is now associated with increased mortality and serious cardiopulmonary complications (8).

Neither posterior displacement nor angulation of the fracture site had a significant effect on fracture union, despite previous studies having found that greater initial fracture displacement decreased the likelihood of fracture union (19). The reason this analysis may have not found a significant difference is due to a small sample size which is not representative. Insignificance of results may also be due to human error in the radiographic measurements obtained (20).

The overall 3-month mortality rate of this study was 16.6%. Studies have found 3-month mortality rates of 33% in patients who have been treated conservatively (21). Type II fractures were associated with the greatest mortality, as 4/5 patients who died had that fracture subtype. The cause of death for the patients this set of data is unknown, so it is not possible to correlate fracture type with mortality.

The mean length of time from referral to final follow up before discharge from the fracture clinic was 99.5 days, however this varied from 43 days – 176 days. There was also variation between the frequency of follow up in these patients, however this could be due to individual patient factors and pre-existing comorbidities (15). Predominantly plain films were used to determine bony union on follow up in lateral extension and flexion views, however CT scans were used as an adjunct in 3 of the patients. It is important to note that the data collected for this analysis was during the peak of the COVID-19 pandemic which may have an influence on both mortality rates and time between follow up.

Conclusions

Treatment of odontoid peg fractures are complex. In younger individuals, there is evidence to suggest that surgical management is superior in providing fracture union. However, in elderly patients with multiple comorbidities and increased risk of surgical complication, a conservative approach is favoured.

Whether a soft or rigid collar should be used is still a matter of debate. Rigid collars tend to offer increased immobility of the cervical spine which has been associated with increased bony union of the fracture site. Soft collars, although having a lower union rate, tend to be favoured by patients as they are more comfortable for the patient and are associated with greater treatment compliance.

Management of odontoid peg fractures in the elderly needs to find a balance between achieving safe fracture union, so that complications are minimal, and offering the most comfort for the patient. I believe that using a soft collar is the superior treatment for odontoid peg fractures in the geriatric population, however there is a need for more high-quality studies providing evidence for this.

References

1. Tarawneh A, Taqvi S, Salem K, Sahota O. Cervical spine fragility fractures in older people: 5-year experience at a regional spine centre. Age and Ageing. 2020;49(6):1102-4. doi: 10.1093/ageing/afaa088
2. Robinson A-L, Möller A, Robinson Y, Olerud C. C2 Fracture Subtypes, Incidence, and Treatment Allocation Change with Age: A Retrospective Cohort Study of 233 Consecutive Cases. Biomed Res Int. 2017;2017:8321680-. doi: 10.1155/2017/8321680
3. Anderson LD, D'Alonzo RT. Fractures of the Odontoid Process of the Axis. JBJS. 1974;56(8)
4. Grauer JN, Shafi B, Hilibrand AS, Harrop JS, Kwon BK, Beiner JM, et al. Proposal of a modified, treatment-oriented classification of odontoid fractures. The Spine Journal. 2005;5(2):123-9. doi: https://doi.org/10.1016/j.spinee.2004.09.014

5. 5. Health and Social Care Information Centre. Hospital Episode Statistics [cited Sept 4th 2020]. Available from: http://www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937
6. Müller EJ, Schwinnen I, Fischer K, Wick M, Muhr G. Non-rigid immobilisation of odontoid fractures. Eur Spine J. 2003;12(5):522-5. doi: 10.1007/s00586-003-0531-1
7. Ivancic PC. Effects of orthoses on three-dimensional load-displacement properties of the cervical spine. Eur Spine J. 2013;22(1):169-77. doi: 10.1007/s00586-012-2552-0
8. Tashjian RZ, Majercik S, Biffl WL, Palumbo MA, Cioffi WG. Halo-vest immobilization increases early morbidity and mortality in elderly odontoid fractures. J Trauma. 2006;60(1):199-203. doi: 10.1097/01.ta.0000197426.72261.17
9. Rizvi SAM, Helseth E, Rønning P, Mirzamohammadi J, Harr ME, Brommeland T, et al. Odontoid fractures: impact of age and comorbidities on surgical decision making. BMC Surgery. 2020;20(1):236. doi: 10.1186/s12893-020-00893-7
10. Alswat KA. Gender Disparities in Osteoporosis. J Clin Med Res. 2017;9(5):382-7. doi: 10.14740/jocmr2970w
11. Kehoe A, Smith JE, Edwards A, Yates D, Lecky F. The changing face of major trauma in the UK. Emergency Medicine Journal. 2015;32(12):911. doi: 10.1136/emermed-2015-205265
12. Greene KA, Dickman CA, Marciano FF, Drabier JB, Hadley MN, Sonntag VKH. Acute Axis Fractures: Analysis of Management and Outcome in 340 Consecutive Cases. Spine. 1997;22(16)
13. Molinari RW, Khera OA, Gruhn WL, McAssey RW. Rigid cervical collar treatment for geriatric type II odontoid fractures. European Spine Journal. 2012;21(5):855-62. doi: 10.1007/s00586-011-2069-y
14. Fan L, Ou D, Huang X, Pang M, Chen X-X, Yang B, et al. Surgery vs conservative treatment for type II and III odontoid fractures in a geriatric population: A meta-analysis. Medicine. 2019;98(44):e10281-e. doi: 10.1097/MD.0000000000010281
15. Watts A, Athanassacopoulos M, Breakwell L, Chiverton N, Cole A, Ivanov M, et al. Management of C2 odontoid peg fragility fractures – A UK survey of spinal surgeons. Injury. 2022;53(3):1057-61. doi: https://doi.org/10.1016/j.injury.2021.09.057
16. Hong J, Zaman R, Coy S, Pastel D, Simmons N, Ball P, et al. A Cohort Study of the Natural History of Odontoid Pseudoarthrosis Managed Nonoperatively in Elderly Patients. World Neurosurgery. 2018;114:e1007-e15. doi: https://doi.org/10.1016/j.wneu.2018.03.133
17. Chan H-YH, Segreto FA, Horn SR, Bortz C, Choy GG, Passias PG, et al. C2 Fractures in the Elderly: Single-Center Evaluation of Risk Factors for Mortality. Asian Spine J. 2019;13(5):746-52. doi: 10.31616/asj.2018.0300
18. Sandler AJ, Dvorak J, Humke T, Grob D, Daniels W. The Effectiveness of Various Cervical Orthoses: An: In Vivo: Comparison of the Mechanical Stability Provided by Several Widely Used Models. Spine. 1996;21(14
19. Koivikko MP, Kiuru MJ, Koskinen SK, Myllynen P, Santavirta S, Kivisaari L. Factors associated with nonunion in conservatively-treated type-II fractures of the odontoid process. The Journal of Bone and Joint Surgery British volume. 2004;86-B(8):1146-51. doi: 10.1302/0301-620X.86B8.14839
20. Karamian BA, Liu N, Ajiboye RM, Cheng I, Hu SS, Wood KB. Reliability of radiological measurements of type 2 odontoid fracture. The Spine Journal. 2019;19(8):1324-30. doi: https://doi.org/10.1016/j.spinee.2019.04.020

21. Coleman N, Chan H-YH, Gibbons V, Baker JF. Comparison of Hard and Soft Cervical Collars for the Management of Odontoid Peg Fractures in the Elderly. Geriatric Orthopaedic Surgery & Rehabilitation. 2022;13:21514593211070263. doi: 10.1177/21514593211070263