Open Access Library Journal
2020, Volume 7, e6132
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Non-Operative Treatment of Odontoid Peg Fractures

Falethu M. Sukati*, Mthunzi V. Ngcelwane, Maleho Maku

Department of Orthopaedics, Steve Biko Academic Hospital, University of Pretoria, Pretoria, South Africa
Email: *falethu@icloud.com

How to cite this paper: Sukati, F.M., Ngcelwane, M.V. and Maku, M. (2020) Non-Operative Treatment of Odontoid Peg Fractures. *Open Access Library Journal*, **7**: e6132.
https://doi.org/10.4236/oalib.1106132

Received: February 3, 2020
Accepted: March 21, 2020
Published: March 24, 2020

Abstract

Objective: The aim of this study was to review the results of non-operative treatment of odontoid fractures in Steve Biko Academic Hospital, Pretoria. **Methods:** Records for all patients treated for odontoid fractures from 2008 to 2018 were reviewed. 28 patients met the study criteria. Demographic data, mechanism of injury, associated injuries, neurology, imaging studies and treatment were reviewed. **Results:** There were 23 males and 5 females. The average age at presentation was 39.5 years. 25 patients were injured in road traffic accidents. Associated injuries were present in 21 patients, mostly involving the spine and head. 18 fractures were classified as Type II and 15 as Type III. Fracture comminution (5), angulation (6) and translation (10) were noted. Primarily treatment modalities were cones callipers, Philadelphia collar or halo vest. Fracture union was assessed radiologically at 3, 6 and 9 months. Type II and III fractures had high union rates at 6 and 9 months. Significantly displaced fractures had a statistically lower union rate ($p = 0.0285$) at 6 months. **Conclusion:** Minimally displaced odontoid Type II and III fractures can be effectively treated non-operatively in young adults. Extent of fracture displacement is the single important factor in non-union rate.

Subject Areas

Orthopedics

Keywords

Odontoid Peg Fracture, Axis, Non-Operative, Anderson D'Alonzo

1. Introduction

The second cervical vertebra is an important component of the cervical spine, being responsible for most lateral rotation of the head. Even though the space

available for the cord at this level is large, it is not always sufficient to avoid injury to the cord. Odontoid fractures account for as much as 20% of all cervical spine fractures. Their incidence increases significantly in elderly patients [1]. Anderson and D'Alonzo Type II fractures of the odontoid are the most common, being found in 65% to 74% of all cases [2]. Type III is the one most associated with vertebral artery injury [3].

Recent studies have identified a decrease in osseous healing of odontoid fractures with increasing age. Consequently, elderly patients have higher non-union and mortality rates [4] [5]. Non-union has also been correlated with a fracture gap more than 1 mm, posterior displacement more than 5 mm, delayed treatment greater than 4 days and posterior re-displacement of more than 2 mm [6].

The extent of associated injuries is determined by the energy transfer and age of the patient. Young patients usually sustain odontoid fractures from high energy trauma, like motor vehicle accidents. Older patients experience low energy deadly falls. Their advanced skeletal age with associated degeneration predisposes them to serious associated injuries [7]. Both groups may have spinal cord injuries leading to neurological fallout. Literature reports the rate of neurological fallout between 0% and 27% [8] [9].

Data from the National Crash Severity Study showed a 40% mortality rate at the crash scene in cervical spinal cord injury victims [8]. Elderly patients who sustain cervical spine fractures after falls from a standing height have a mortality of 24% - 26% [10].

Treatment for Type II odontoid fractures has historically been surgical for young and non-operative for elderly patients. In non-operative treatment, Koech *et al*. showed that both hard neck collar and halo vest treatment resulted in radiographic healing. However, in both the rates of union were low [11]. It has been shown that immobilisation with a halo vest provides more stability than a hard neck collar [11] [12]. Close radiological follow-up is important in conservative management for early detection of worsening displacement [13].

Surgical treatment of type II fractures in the elderly does not negatively impact survival [14]. It is also more cost-effective than conservative treatment in this patient group. However, the advantage of surgery over nonsurgical management is lost as the patients age further, with studies placing the turn between 75 years and 84 years [15] [16]. Treatment with halo vest immobilisation is associated with higher mortality in elderly than younger patients [17]. Knowledge of factors associated with poor outcomes for conservative treatment raises the possibility to better stratify and manage patients. Careful patient selection for each procedure is very important since the modifiers have a significant impact on outcomes [18].

We undertook this study to review the results of non-operative treatment of odontoid fractures in our institution. Our secondary aim was to identify the demographic patterns of this injury in the population within the service area of the hospital.

2. Materials and Methods

This study was a retrospective review over eleven years, from January 2008 to December 2018. It was conducted in the tertiary care orthopaedic unit at Steve Biko Academic Hospital. All patients admitted to the orthopaedic unit for fractures involving the axis and treated non-operatively were included in the study. Patients treated surgically and those with axis fractures not involving the odontoid peg, incomplete clinical records or pathological fractures were excluded. Demographic, clinical, treatment data was collected from patient files in hospital records. Radiological data was collected from the hospital's Picture Archiving and Communication System (PACS).

The patient's age at the time of injury, gender and pre-injury co-morbidities were recorded. Neurological deficits and associated injuries on admission were documented. Fracture pattern and displacement were evaluated on the initial radiographs and computed tomography (CT) scans where applicable. On the basis of this information, each fracture was classified according to the Anderson and D'Alonzo classification of odontoid fractures. Fracture displacement was assessed on three parameters as described by the Spine Trauma Study Group *i.e.* translation, angulation and fracture gap. A tangent line is drawn along the anterior aspect of the odontoid fragment and the anterior aspect of the C2 body. At the level of the fracture, a transverse line is drawn connecting these 2 lines. This distance is measured in millimetres and represents sagittal fracture translation. A tangent line is drawn along the posterior aspect of the odontoid fragment and the posterior aspect of the C2 body. The angle subtended by these lines would be the degree of fracture angulation [19]. Significant displacement was defined as a translation > 5 mm, fracture gap > 1 mm or angulation > 10˚ [6].

Treatment given and its duration was recorded. Fracture union was assessed using radiographs or CT scans. Union was defined as stability on cervical spine flexion extension radiographs, cross trabecular at the fracture site. A CT scan was used in cases where the radiographs were inconclusive to evaluate callus formation. Fracture union was evaluated at three, six and nine months. Length of hospital stay was recorded.

3. Results and Statistical Analysis

3.1. Results

A total of 186 patients were treated during the period under review. The following exclusion criteria were applied: cervical fractures not involving the odontoid, patients with incomplete radiological or clinical records, pathological fractures and patients treated surgically as shown in **Figure 1**. Of the 28 patients eligible for the study, 23 were male and 5 were female. The mean age at presentation was 39.5 years (range 16 - 78 years). There was a bimodal distribution and most of the patients were aged from 21 years to 40 years. This is illustrated in **Figure 2**. Road traffic accidents accounted for 25 (89.3%) of the injuries and the remainder were due to falls (n = 2), and unspecified mechanisms (n = 1).

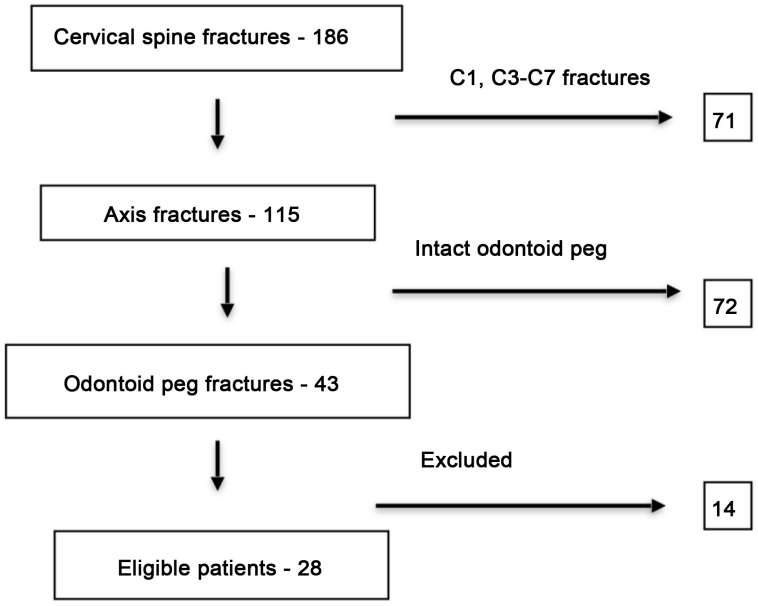

Figure 1. Study flow diagram.

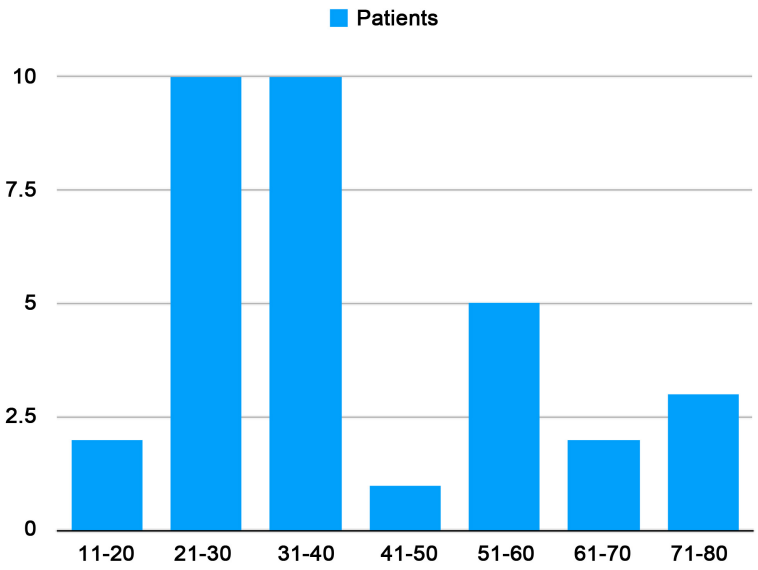

Figure 2. Age distribution.

Patients had the following pre-injury co-morbidities, hypertension, diabetes mellitus, spondylosis, gout, HIV infection, alcoholism, bipolar mood disorder and epilepsy. Associated injuries are shown in Table 1. Neurological deficits on admission were present in 6 patients and could not be assessed in another 3. These were due to associated head and other cervical spine injuries. Three of these patients did not regain full neurology.

There were 15 patients classified as Type II and 13 as Type III. Surgical treatment was administered in 5 patients (Type II - 3, Type III - 2), these were excluded. A decision to treat surgically was made in patients with significant fracture displacement, a need for decompression or failed non-operative treatment.

Table 1. Associated injuries by body region.

Body Region	Patients
None	12 (36.4%)
Head	10 (30.3)
Chest	4 (12.1%)
Limbs	4 (12.1%)
Spine	18 (54.5%)
Cervical	11 (30%)
Thoracic	6 (5.5%)
Lumbar	1 (3.0%)

In the non-operative group 6 patients had fracture angulation between 9˚ and 12˚ and 10˚ patients had translation from 2 mm to 10 mm. Five of these patients had a significant displacement and a further 5 had comminuted fractures. Non-operative treatment consisted of a Philadelphia collar (3 patients), cones callipers (18 patients) or a halo vest (7 patients) as the primary mode of treatment for 6 weeks. This was followed by another 6 weeks of immobilisation in a Philadelphia collar. The average length of stay in hospital was 38.36 days (range 2 - 168) for this group. Fracture union was assessed at 3, 6 and 9 months. Patients had to be pain-free before flexion extension radiographs could be done.

3.2. Statistical Analysis

Statistical analysis using the Fisher exact test showed a significant difference in the union rate of significantly displaced fractures and those with an insignificant displacement at 6 months as illustrated in **Table 2**. **Table 3** and **Table 4** show that age and fracture classification did not have a significant effect on the union rate.

4. Discussion

The results of this study show that both Type II and III odontoid fractures can be effectively treated non-operatively. Good fracture union rates were achieved at 6 and 9 months from the injury. Displacement of the odontoid fracture plays a key role in determining union. Significantly displaced fractures have lower union rates than fractures with insignificant displacement. This was demonstrated by a statistically significant p-value (0.0285) at 6 months. It is therefore important to use established fracture displacement criteria to carefully select patients who can be successfully treated non-operatively.

In our population group, there is a bimodal distribution of odontoid peg fractures with the first peak among young adults and the second as expected in the elderly. High energy trauma accounts for the first peak, especially road traffic accidents. This mechanism of injury gives rise to odontoid fractures that are often associated with other injuries. Identifying the associated injuries, particularly of the head and cervical spine is an important part of management since these

Table 2. Displacement and Union.

Months	Displacement		P value
	Significant	Insignificant	
3	2/5	16/23	0.3150
6	3/5	22/22	0.0285
9	4/5	22/22	0.1852

Table 3. Age and Union.

Months	>65y	<65y	P value
3	0/1	18/27	0.3571
6	1/1	25/26	1
9	1/1	25/26	1

Table 4. Classification and Union.

Months	Type II	Type III	P value
3	10/15	8/13	1
6	13/14	13/13	1
9	13/14	13/13	1

are often responsible for the neurological deficits observed.

Treatment for Type I and III odontoid fractures is traditionally conservative. Controversy remains in the treatment of Type II fractures. The trend is to surgically fix Type II fractures with associated instability or specific risk factors for non-union [13]. Dynamic radiographs to assess instability in the acute setting are not done in our institution as they carry a risk of further displacement. In this study, the union rate for Type III fractures was high and consistent with literature [9] [20] [21]. For Type II fractures our union rate was higher than the rates reported in literature [9] [21] [22]. A high incidence of cervical spine fractures among young adults is reported in literature, however the subaxial spine is the area usually affected. The age distribution in this study is in line with the study by Zusman *et al*. who also reported an adult bimodal distribution [1]. Association of odontoid fractures in young adults with high energy mechanisms is widely reported in literature [1] [23].

Limitations of the study were the retrospective design, a small cohort and the number of patients lost to follow up or due to incomplete records. A prospective study with a longer follow up period and patient reported outcome measures could add valuable information in future.

5. Conclusion

Type II odontoid fractures can be effectively treated non-operatively. Applying displacement criteria is important in selecting patients for successful non-operative treatment.

Conflicts of Interest

The authors do not have any conflict of interest to report.

References

[1] Zusman, N.L., Ching, A.C., Hart, R.A. and Yoo, J.U. (2013) Incidence of Second Cervical Vertebral Fractures far Surpassed the Rate Predicted by the Changing Age Distribution and Growth among Elderly Persons in the United States (2005-2008). *Spine*, **38**, 752-756. https://doi.org/10.1097/BRS.0b013e31827ab62a

[2] Reinhold, M., Bellabarba, C., Bransford, R., Chapman, J., Krengel, W., Lee, M., *et al*. (2011) Radiographic Analysis of Type II Odontoid Fractures in a Geriatric Patient Population: Description and Pathomechanism of the "Geir" Deformity. *European Spine Journal*, **20**, 1928-1939. https://doi.org/10.1007/s00586-011-1903-6

[3] Durand, D., Kalra, V.K., Abbed, K.M. and Malhotra, A. (2015) Predictors of Vertebral Artery Injury in Isolated C2 Fractures Based on Fracture Morphology Using CT Angiography. *Spine*, **40**, E713-E718. https://doi.org/10.1097/BRS.0000000000000893

[4] Smith, H.E., Kerr, S.M., Fehlings, M.G., Chapman, J., Maltenfort, M., Zavlasky, J., *et al*. (2010) Trends in Epidemiology and Management of Type II Odontoid Fractures: 20-Year Experience at a Model System Spine Injury Tertiary Referral Center. *Journal of Spinal Disorders & Techniques*, **23**, 501-505. https://doi.org/10.1097/BSD.0b013e3181cc43c7

[5] Daniels, A.H., Arthur, M., Esmende, S.M., Vigneswaran, H. and Palumbo, M.A. (2014) Incidence and Cost of treating Axis Fractures in the United States from 2000 to 2010. *Spine*, **39**, 1498-1505. https://doi.org/10.1097/BRS.0000000000000417

[6] Koivikko, M.P., Kiuru, M.J., Koskinen, S.K., Myllynen, P., Santavirta, S. and Kivisaari, L. (2004) Factors Associated with Nonunion in Conservatively-Treated Type-II Fractures of the Odontoid Process. *Journal of Bone and Joint Surgery*, **86**, 1146-1151. https://doi.org/10.1302/0301-620X.86B8.14839

[7] Graffeo, C.S., Perry, A., Puffer, R.C., Carlstrom, L.P., Chang, W. and Mallory, G.W. (2017) Deadly Falls: Operative versus Nonoperative Management of Type II Odontoid Process Fracture in Octogenarians. *Journal of Neurosurgery Spine*, **26**, 4-9. https://doi.org/10.3171/2016.3.SPINE151202

[8] Harrop, J.S., Sharan, A.D. and Przybylski, G.J. (2000) Epidemiolgy of Spinal Cord Injury after Acute Odontoid Fractures. *Neurosurgical Focus*, **8**, Article 4. https://doi.org/10.3171/foc.2000.8.6.5

[9] Greene, K.A., Dickman, C.A., Marciano, F.F., Drabier, J.B., Hadley, M.N. and Sonntag, V.K.H. (1997) Acute Axis Fractures. Analysis of Management and Outcome in 340 Consecutive Cases. *Spine*, **22**, 1843-1852. https://doi.org/10.1097/00007632-199708150-00009

[10] Radovanovic, I., Urquhart, J.C., Rasoulinejad, P., Gurr, K.R., Siddiqi, F. and Bailey, C.S. (2017) Patterns of C-2 Fracture in the Elderly: Comparison of Etiology, Treatment, and Mortality among Specific Fracture Types. *Journal of Neurosurgery Spine*, **27**, 494-500. https://doi.org/10.3171/2017.3.SPINE161176

[11] Koech, F., Ackland, H.M., Varma, D.K., Williamson, O.D. and Malham, G.M. (2008) Nonoperative Management of Type II Odontoid Fractures in the Elderly. *Spine*, **33**, 2881-2886. https://doi.org/10.1097/BRS.0b013e31818d5407

[12] Polin, R.S., Szabo, T., Bogaev, C.A., *et al*. (1996) Nonoperative Management of Types II and III Odontoid Fractures: The Philadelphia Collar versus the Halo Vest.

Neurosurgery, **38**, 450-456. https://doi.org/10.1227/00006123-199603000-00006

[13] Gonschorek, O., Vordemvenne, T., Blattert, T., Katscher, S. and Schnake, K.J. (2018) Treatment of Odontoid Fractures: Recommendations of the Spine Section of the German Society for Orthopaedics and Trauma (DGOU). *Global Spine Journal*, **8**, 12S-17S. https://doi.org/10.1177/2192568218768227

[14] Chapman, J., Smith, J.S., Kopjar, B., Vaccaro, A.R., Arnold, A., Shaffrey, C.I., *et al*. (2013) The AOSpine North America Geriatric Odontoid Fracture Mortality Study. *Spine*, **38**, 1098-1104. https://doi.org/10.1097/BRS.0b013e318286f0cf

[15] Barlow, D.R., Higgins, B.T., Ozanne, E.M., Tosteson, A.N.A. and Pearson, A.M. (2016) Cost Effectiveness of Operative versus Non-Operative Treatment of Geriatric Type-II Odontoid Fracture. *Spine*, **41**, 610-617. https://doi.org/10.1097/BRS.0000000000001275

[16] Fan, L., Ou, D., Huang, X., Pang, M., Chen, X.X., Yang, B. and Wang, Q.Y. (2019) Surgery vs Conservative Treatment for Type II and III Odontoid Fractures in a Geriatric Population: A Meta-Analysis. *Medicine* (*Baltimore*), **98**, e10281. https://doi.org/10.1097/MD.0000000000010281

[17] Tashjian, R.Z., Majercik, S., Biffl, W.L., Palumbo, M.A. and Cioffi, W.G. (2006) Halo-Vest Immobilization Increases Early Morbidity and Mortality in Elderly Odontoid Fractures. *The Journal of Trauma*, **60**, 199-203. https://doi.org/10.1097/01.ta.0000197426.72261.17

[18] Marton, E., Billeci, D. and Carteri, A. (2000) Therapeutic Indications in Upper Cervical Spine Instability. Considerations on 58 Cases. *Journal of Neurosurgical Sciences*, **44**, 192-202.

[19] Bono, C.M., Vaccaro, A.R., Fehlings, M., Fisher, C., Dvorak, M. and Ludwig, S. (2007) Measurement Techniques for Upper Cervical Spine Injuries—Consensus Statement of the Spine Trauma Study Group. *Spine*, **32**, 593-600. https://doi.org/10.1097/01.brs.0000257345.21075.a7

[20] Osmana, A., Alagelip, N.A., Shortc, D.J. and El Masri, W.S. (2017) Conservative Management of Odontoid Peg Fractures, Long Term Follow Up. *Journal of Clinical Orthopaedics and Trauma*, **8**, 103-106. https://doi.org/10.1016/j.jcot.2017.06.003

[21] Anderson, L.D. and D'Alonzo, R.T. (1974) Fractures of the Odontoid Process of the Axis. *Journal of Bone and Joint Surgery*, **56**, 1663-1674. https://doi.org/10.2106/00004623-197456080-00017

[22] Govender, S., Maharaj, J.F. and Haffajee, M.R. (2000) Fractures of the Odontoid Process: An Angiographic and Clinical Study. *Journal of Bone and Joint Surgery*, **82**, 1143-1147. https://doi.org/10.1302/0301-620X.82B8.0821143

[23] Patel, A., Lindsey, R., Bessey, J., Chapman, J., Rampersaud, R. and the Spine Trauma Study Group (2010) Surgical Treatment of Unstable Type II Odontoid Fractures in Skeletally Mature Individuals. *Spine*, **35**, S209-S218. https://doi.org/10.1097/BRS.0b013e3181f32ca5