The Journal of International Medical Sciences Academy
2018; (October - December); Vol 31; No. 4

ORIGINAL ARTICLE

To study factors influencing Neurological Outcome, Fusion Rates and Complications in Traumatic Odontoid Fractures – Non Randomized Ambispective Study.

Anil Kumar[1], T. J. Rappai[2], Parikshit Gopal[3], Salil Jena[4]

[1] Classified Specialist & Assistant Professor, Surgery and Neurosurgeon,
[2]Head of Department & Senior Advisor Surgery and Neurosurgeon, [4]Resident, General Surgery
Department of Neurosurgery, Base Hospital Delhi Cantt, New Delhi, India
[3]Assoc Prof, ACMS & Base Hospital Delhi Cantt, New Delhi, India

Abstract

Background: The cervical spine is the most mobile portion of the spine and the most common site of spinal injuries. Cervical spine is involved in 60% of adult spine injuries. Teens and young adults are the most frequently injured population. Odontoid fractures comprise 9-20% of all cervical spine injuries. Due to the strategic location of the fracture, many patients succumb at the scene of the accident due to spinal cord injury.

Methods: Around 150 patients admitted for elective/emergency surgery at the Neurosurgical Centre of a tertiary care hospital having traumatic odontoid fracture-dislocation were included in the study after applying inclusion and exclusion criteria. A preoperative x-ray of the cervical spine with anteroposterior and lateral view, NCCT with 3D Recon CVJ, MRI CVJ &Cervical spine, to asses bony injuries, ligamentous injuries, cord contusions/myelomalacia were done. Post-surgery after 3 months X-ray CVJ and NCCT 3D Recon CVJ done to assess screw placement accuracy, mal-alignment and fusion. Improvement in neurological status and complications postoperatively, after 3 months was recorded and analyzed using relevant statistical data.

Results: Around 135 (89.4%) out of 151 sustained injury due to RTA. Amongst them preoperatively 74.9% were neurologically intact. In cervical spine injuries, odontoid fracture was most common and 87.5% patient improved neurologically after surgery, while in 12.5% patients no neurological improvement was seen. Fusion was seen in 59.6% patients with odontoid fracture. In 67 patients with odontoid fractures, in 77.2% patients lag effect was observed. In 22 [55%] patients in whom fusion was seen, lag effect was seen in 77.2% patients, whereas in 18 [45%] patients where fusion was not seen lag effect was found in 22.2% patients. In 19 patients in whom fusion was not seen, 6 patients had lag effect present. This was statistically significant ($p<0.001$).

Conclusion: In odontoid fractures, 69.54% had Neurological improvement, in anterior approach 25.82% fusion of odontoid screw occurred in 60.6% while in posterior it was 55%. The patients in whom after odontoid screw fixation lag effect were seen better fusion was observed.

Keywords: Odontoid, Myelopathy, Lag effect, Fusion, Cervical spine

Introduction

The cervical spine is the most mobile portion of the spine and the most common site of spinal injuries. Cervical spine involves 60% of adult spine injuries. Teens and young adults are the most frequently injured population. Odontoid fractures comprise 9-20% of all cervical spine injuries [1-4]. Due to the strategic location of the fracture,patients succumb at the scene of the accident due to spinal cord injury [5]. Insurviving patients,the most common symptom is pain;major neurological deficits are infrequent [6]. The problem with the conservative management of these fractures is the risk of non-union and delayed development ofmyelopathy [7,8].

Anderson and D.Alonzo (1974)[9] have classified odontoid fractures into three types. Based on this universally accepted classification, the type II and III

Address for correspondence
Dr T J Rappai, Head of Department & Senior Advisor Surgery and Neurosurgeon, Department of Neurosurgery, Base Hospital Delhi Cantt, New Delhi- 110010 e-mail: tjrappai@hotmail.com

Received: 13.09.18
Accepted: 25.01.19

odontoid fractures often require some form of stabilization[10]. However, optimum treatment strategy, whether to perform surgery or to continue the patient on conservative management is still mired in controversy [11,12]. The surgical approaches prevalent for dealing with acute odontoid fractures include either anterior odontoid screw placement or posterior fixation [13-15]. Anterior fixation has advantage of preserving C1-C2 motion and head/neck rotation. We conducted thisstudy to assess factors influencing neurological outcomes, fusion rates, complications in traumatic odontoid fractures –nonrandomized ambispective study.

Material and Methods

Present study conducted in Department of Neurosurgery at Tertiary Centre where admitted cases with odontoid fractures injuries were included in the present study. Patients were studied prospectively from Jan 2015 to Dec 2017 and retrospectively from Jan 2004 to 31 Dec 2014. Patients havingsub axial spine injuries and congenital CVJ anomaly were excluded from study. Purpose of study was explained and written and informed consent obtained from all patients who participated in the study. Sample size of 151 participants were evaluated with preoperative imaging X-ray, CT, MRI and postoperative imaging at 03 months with X-ray and CT scan to see for fusion and complications. Neurological outcome was assessed using ASIA and SF36 scoring.

Data was analyzed using statistical software Stata 12.1. Quantitative variables were expressed as Mean +/- SD. Qualitative variables expressed as frequency and percentage.Quantitative variables followed normal distribution were compared by independent test. McNemor test used to assess change in ASIA score. Chi square/Fischer exact test used to check the statistical significance for categorical variable; $p<0.05$ was considered as statistically significant.

Results

One hundred and fifty-one patients were studied, odontoid fractures commonly occurred in young age groups <40yrs (69.5%) and predominantly in males (89.4%). Majority of these injuries were caused by high energy trauma (54.9%) and largely patients were neurologically intact preoperatively (74.1%). Only 25.8% patients had neurological deficit preoperatively. Statistically significant association was observed between odontoidfractures and demographic variables like age and sex.

In odontoid fracture (56.9%) underwent anterior odontoid screw fixation while (43.1%) patient underwent posterior fixation and this was statistically significant. (87.5%) patient improved neurologically after surgery while in (12.5%) patients were neurologically same and this association was statistically significant.Bony fusion was seen in (59.6%) odontoid fracture patients. Main complications that occurred postoperatively in odontoid fracture was CSF leak in (9.2%) patients while wound infection occurred in (2.3%), meningitis occurred in (1.5%) patients, death occurred in (1.3 %) patients. Redo surgery was done in 5 patients after odontoid screw fixation who subsequently underwent posterior fixation.

Patients with odontoid fractures, lag effect were seen in (77.2%) patients. In (55%) patients in whom fusion was seen, lag effect was found in (77.2%), whereas in (45%) patients where fusion was not seen, lag effect was found in 22.2%.

Table 1: Demographics of Odontoid Fractures

TYPE OF FRACTURE	AGE	SEX	MOI	PREOP. NEUROLOGICAL STATUS
ODONTOID FRACTURE [n=151]	<40yr-105[69.5%] 40-60yr-36[23.8%] >60yr-10[6.6%] *P* value-0.002[S]	Male-135[89.4%] Female-16[10.5%] *P* value-0.017[S]	High velocity trauma-83[54.9%] Low velocity trauma-61[40.3%] Others-7[4.6%]	Normal[ASIA- E]-112[74.1%] Deficit[ASIA-A,B,C,D]-39[25.8%]

Table 2: Neurological and Radiological Outcome

TYPE OF FRACTURE	NEUROLOGICAL OUTCOME	RADIOLOGICAL OUTCOME
Odontoid Fracture [n-40]	(n-40)Improved-35[87.5%] Same-5[12.5%] Worse-Nil *P*value-0.00001[S]	n-62 Fusion- 37(59.6%) No Fusion-25(40.3%)

Table 3: Lag effect and fusion in anterior odontoid screw fixation (n= 67)

TYPE OF FRACTURE (n =67)	LAG EFFECT ATTAINED (n =44)	LAG EFFECT NOT ATTAINED (n =23)
Fracture Configuration Transverse-(n=15)-22.3% Oblique-(n=38)-56.7% Reverse Oblique-(n=14)-20.8%	 12[80%] 25[65.7%] 7[50%]	 3[20%] 13[34.2%] 7[50%]
TAL RUPTURE- Yes-[n=6] No-[n=39]	 Not attempted 30[76.9%]	 Not attempted 9[23.0%]
DISPLACEMENT Yes[n=12] No[n=55]	 2[16.6%] 49[89.0%]	 10[83.3%] 6[10.9%]
BICORTICAL PURCHASE Yes[n=23] No[n=44]	 22[95.6%] 24[54.5%]	 1[4.3%] 20[45.4%]
SCREW TRAJECTORY		
Ideal-[n=48]	40[83.3%]	8[16.6%]
Non Ideal-[n=19]	4[21%]	15[78.9%]
FUSION-[>3month](n=43)* Yes[24]55% No[19]45%	 22[91.6%] 6[31.5%]	 2[8.3%] 13[68.4%]

P value <0.001(S)

Figure 1: No bony fusion

Figure 3: Bicortical purchase of screw

Figure 2: Bony fusion seen

Figure 4: Unicortical purchase of screw

Discussion

Odontoid fracture Type II is the most common type of odontoid fractureand is considered to be highly unstable. Type II fractures are managed by cervical collar, anterior odontoid screw fixation and posterior C1-C2 instrumentation with fusion. In light of high incidence of nonunion with external immobilization, primary surgical management has been recommended (anterior odontoid screw fixation or posterior C1-C2 instrumentation and fusion).Posterior C1-C2 fusion rather than anterior odontoid screw fixation is used in type II displaced odontoid fractures that are associated with C1-C2 instability secondary to transverse ligament injury and symptomatic nonunion that develops after external immobilization or failure to achieve anterior odontoid screw fixation (technical/patients factors).

Conservative management using a halo brace is associated with variable fusion rate between 53-93% [19]. Shetty et al. [15] demonstrated an 84.2% fusion rate with conservative management in stable type IIfractures. Literature shows that there is a growing trend towards surgical fixation of these fractures as fusion rates are better and the patients may be mobilized early. In the present series primary surgical intervention was preferred in all patients except the 13, who were either declared unfit for surgery or were not willing for surgical intervention.

Since its initial description by Nakanishi and by Bohler [16,17], anterior odontoid screw fixation has withstood the test of time. This procedure allows for a more physiological fusion by direct osteosynthesis of the fracture lines and has the advantage of preserving normal rotation at atlantoaxial joint. Eighty sixpatients,who had acute, well defined odontoid fractures with an intact transverse ligament, underwent odontoid screw fixation at our Centre. The fusion rate of 60.6%% after odontoid screw fixation noted in present series while in literature it is 80-100%[13,14], while as per Dattaraj etal fusion rate was[95%][18]. Many authors have recommended posterior fixation as the procedure of choice for the surgical approach in type III fracture due to slightly higher nonunion rate associated with odontoid screw fixation. Our results of 45.83% fusion rates in type II fractures is different from published literature. [22] Moon et al., Fountas et al. [19] and Lee et al. [20] in their series showed fusion rates of 100%, 87%and 96% respectively. Bhanot etal. [21] reported a 94% fusion rate with one case of non-union and one screw pull out in their series of 17 type II odontoid fractures after an anterior odontoid screw fixation. N Shrinivasan et al. [22]could successfully place odontoid screw in 84.6% type II fractures with an 82% fusion rate.

Aldrian etal. [2011] [23] showed a good fusion rate of 87% after odontoid screw fixation in type II fracture and have also recommended it as the first line of management in comminuted odontoid fractures. Other authors, in a contrasting opinion, have recommended against utilizing an odontoid screw fixation in comminuted fractures due to the high nonunion rates and have preferred the posterior fixation technique. In our present series out of four patients patients with comminuted fracture, with type II A fracture who underwent odontoid screw fixation, three patients showed a good union while one patient, who developed non-union was successfully managed by posterior fixation which are comparable to results of Duttaraj et al.[18]. A recommendation by Aldrian et al.[23] is that in type II A fracture, the initial surgical procedure should be an anterior odontoid screw fixation; and posterior fixation should be reserved for cases where the initial procedure fails.

In elderly patients, the available class III evidence recommends surgical over conservative management. Which operative approach to adopt is still a matter of debate. According to a recent meta-analysis by Ryken et al. [14] a wide ranging opinion exists with some authors reporting no difference in the results of anterior versus posterior approaches while others have preferred one approach over other. Overall, ten patients with age greater than 60 yrs underwent surgical intervention (odontoid screw fixation-6; posterior fixation-4 patients) and all of them showed a good bony union, while as per literature Duttaraj et al. (18) seven patients with age greater than 60 yrs underwent surgical stabilization [OS fixation-6,PF -1] and all of them showed good bony union.Therefore, an elderly age should not be a contraindication for the odontoid screw fixation. We used a single cannulated, partially threaded lag screw in all these patients with good results. The current literature also supports our approach in that there is no difference in the fusion rates with either a single or double screw placement.

Overall there was morbidity of 11% and mortality of 1.1% in our series. This was comparable to the published literature [18]. The one procedure related death was due to diffuse SAH as a result of cranial migration of the K wire. Occurrence of SAH was probably due to vascular injury. This complication has rarely been reported with an odontoid screw placement and only three cases have been published in the literature. In our patient, this may have been the result of a mal-positioned K wire or a misplaced screw [18]. Hence, one should be very careful while drilling a hole in the odontoid process especially during the process of achieving the bicorticalpurchase. Maneuvers such as the use of a stopper to prevent migration, screwplacement under image guidance and

utilizing only a unicortical purchase are possible solutions to avoid this un- fortunate complication.

We performed primary posterior fixation in 65 patients [43.04%] with fusion rate of 45.83%. Inclusion of occipital bone in the construct was associated with significant compromise of neck movements. Mageryl technique may be used as a stand-alone procedure or may be supplemented with a C1-C2 sub laminar wiring. Addition of sub-laminar wiring, however, did not change results of this technique in our series. This procedure is technically difficult and requires a steep upward trajectory. The three-point rigid fixation and cost effectiveness of the procedure is responsible for its popularity. The Goel/Harms technique of C1-C2 fixation is more versatile when compared to the former procedure. There is, however, a risk of 1.3-5.8% [more with Mageryl technique] of vertebral artery injury in posterior fixation technique. In our study, one patient had vertebral artery injury [0.71%] following posterior fixation. The C1-C2 wiring and graft placement technique was used in 11 patients who, however, had a poor outcome The biomechanical strength of this fixation is also less than ideal as compared to Mageryl or Goel/ Harms procedure [that provides a strong rotational stability]. Therefore C1-C2 sub laminar wiring technique should be used as the last resort. Shetty et al. [15] in their retrospective series showed a 100% fusion rate after posterior C1-C2 arthrodesis with the Mageryl technique [eight patients] and the Goel/Harms technique [three patients] compared with C1-C2 sublaminar wiring and graft fixation [nine patients] that had failure rate of 33%.

Occipito cervical fixation is the final option available when segmental posterior C1-C2 fixation procedures cannot be performed; or when the patient has undergone a simultaneous trans oral decompression of the malunitedfractures. We performed an occipito cervical fusion in 27 patients. 9 of them underwent occipito cervical fusion following transoralodontoidectomy for anterior compression. All these patients had a good fusion [and results were comparable to literature] but at the cost of significant neck movements compromise.

Conclusions

1.) In odontoid fractures, patients improved neurologically after surgery and majority were managed by anterior odontoid screw fixation. Posterior approach was used onlyfor displaced fracture fragments with ruptured transverse atlantoaxial ligament.

2.) Bony fusion was good if lag effect was achieved. Patients with fracture type – transverse, oblique with ideal screw angle, lageffect, reduction of intersegmentary distance and bicortical purchase had good fusion rate and clinical outcome.

Conflict of interest:	All authors declare no COI
Ethics:	There is no ethical violation as it is based on voluntary anonymous interviews
Funding:	No external funding
Guarantor:	Dr T J Rappai will act as guarantor of this article on behalf of all co-authors.

References

1. BucholzRW,BurkheadWZ, Graham et al.Occult cervical spine injuries in fatal traffic accidents. J Trauma 1979;19:768-71.
2. RizviSA,FredoHL,Lied B,NakstadPH,RonningP,Helseth E etal. Surgical management of acute odontoid fractures:surgery related complications and long term outcomes in a consecutive series of 97 patients. J Trauma Acute Care 2012;72:682-90.
3. MoskovichR,Crockard HAetal. Myelopathy due to hypertrophic non union of dens: Casereport.J Trauma 1990;30:222-5.
4. Crockard HA, HeilmanAE,StevensJM etal.Progressive myelopathy secondary to odontoid fractures: Clinical, Radiological and Surgical features.JNeurosurg1993;78:579-86.
5. Anderson LD,D Alonzo RT etal. Fractures of the odontoid process of the axis. J Bone Joint Surg Am 1974;56:1663-74.
6. Hadley MN, Browner CM, Liu SS, Sonntag VK etal. New subtype of acute odontoid fractures. Neurosurgery 1988;22:67-71.
7. Roy-Camille R, Saillant G,JudetT, deBotton G, Michael G etal. Factors of severity in the fractures of the odontoid process. Revchirorthop Reparatrice Appar Mot 1980;66:183-6.
8. Shears E, Armitstead CP etal. Surgical versus conservative management for odontoid fractures. Cochrane Database Syst Rev 2008:cd 005078.
9. RykenT,Hadley M, Aarabi B, DhallS, Gelb D, Hurlbert J etal. Management of isolated fractures of the axis in adults.Neurosurgery 2013;72:132-50.
10. AebiM,Etter C, Coscia M. etal.Fractures of the odontoid process. Treatment with anterior odontoid screwfixation. Spine[Phila Pa 1976] 1989;14:1065-70.
11. ApfelbaumRI,Lonser RR, VeresR,Casey A. etal.Direct anterior screw fixation for recent and remote odontoid fractures. J Neurosurg2000;93:227-36.
12. MagerIF,Seeman PS. etal.Stable posterior fusion of the atlas and axis by transarticular screw fixation. In KehrP,Weidner A, editors. Cervical spine.Berlin Heidelberg New York: Springer;1986.pp 322-327
13. Harms J,MelcherRPetal.Posterior C1-C2 fusion with polyaxial screw and rod fixation. Spine [Phila Pa 1976]2001;26:2467-71.
14. JulienTD,FrankelB,TraynelisVC, Ryken T C etal.Evidence based analysis of odontoid fractures management.Neurosurg Focus 2000;8:e1.
15. ShettyA ,KiniAR,Prabhu J etal.Odontoid fractures: A retrospective analysis of 53 cases. Indian J Orthop2009;43:352-60.
16. Nakanishi T. Internal fixation of the odontoid fractures. Cent Jpn J

Othop Trauma Surg 1980;23:399-406.

17. Bohler J. Screw-osteosynthesis of fractures of the dens axis. Un fallheilkunde1981;84:221-3.
18. DattarajPS, PankajKS, SaquibAzadSiddique, DeepakA, GuruduttaS, DeepakKG,SumitS,KaleSS,BhawaniSS.Surgical management of odontoid fractures at level one trauma centre:singlecentre series of 142 cases 2015;65:40-48.
19. FountasKN, KapsalakiEZ, KarampelasI, FeltesCH, DimopoulosVG, MachnisTG,etal. Results of long term follow up in patients undergoing anterior screw fixation for type II and rostral type III odontoidfractures.
20. Lee SC, Chen JF,Lee ST. Management of acute odontoid fractures with single anterior screw fixation. J ClinNeurosci2004;11:890-5.
21. Bhanot A, Sawhney G, Kaushal R, Aggarwal AK, Bahadur R. Management of odontoid fractures with anterior odontoid screw fixation. J SurgOrthopAdv2006;15:38-42.
22. Srinivasan US, Dhillion CS,MahesaK,KumarV.Anterior single lag screwfixation in type II dens fracture – Indian experience. Int J Neurotrauma 2008;5:87-91.
23. AldrianS,ErhartJ,SchusterR,WernhartS,Ostermann R. Surgical v/s nonoperative treatment of Hadley type IIA odontoid fractures. Neurosurgery 2012;70:676-83.