Review Article

Indian Journal of Neurotrauma (IJNT)
2005, Vol. 2, No. 1, pp. 3-6

Current Management of Odontoid Fractures

Awadhesh Kumar Jaiswal M Ch, **Manish S Sharma** M Ch, **Sanjay Behari** M Ch
Bernard T. Lyngdoh M Ch, **Subodh Jain** M Ch, **Vijendra K. Jain** M Ch
Department of Neurosurgery
Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow 226014

Abstract: Odontoid fracture frequently occurs following cervical trauma. As C1-2 vertebral level allows the maximum motion in the cervical spine, these fractures may often be unstable, causing catastrophic spinal cord trauma and respiratory compromise. In this article, the current management of odontoid fractures is reviewed.

Keywords: cervical spine injury, odontoid fracture, odontoid process

INTRODUCTION AND CLASSIFICATION

Off all the cases of cervical trauma, about one out of five involves the axis[1]. The commonest type of the axis injury is an odontoid fracture at the junction of the dens and the body (type II odontoid fracture)[2].

The C1-2 complex allows far more motion than any other single level in the cervical spine. This motion is predominantly rotational, since translational motion at C1-C2 is limited by the strong transverse ligament. This restriction is lost after fracture of the odontoid and may be associated with antero- or retrolisthesis of the C1-C2 complex in relation to the C2 body. This may result in spinal cord compression producing severe neurological deficits[3].

Anderson and D' Alonzo[2] classified dens fracture into three types:

Type I- involves the tip of the odontoid process. This is the least common type of odontoid fracture.

Type II- is the commonest type of dens fracture. The fracture line involves the junction of the body of dens with the body of axis. Sometimes type II fracture is associated with a comminuted fragment at the base of dens called the type II A variety of fracture. This fracture is markedly unstable[4].

Type III- The fracture line involves the body of C2 in addition to passing through dens.

The commonest cause of dens fracture is hyperflexion at the neck. This may lead to an anterior displacement of C1 on C2 (atlanto-axial subluxation). Extension only occasionally produces odontoid fracture and this is usually associated with posterior displacement of the C1 arch-fragment relative to the body of axis[5].

Address for correspondence: Dr. Sanjay Behari, MCh, DNB Associate Professor, Department of Neurosurgery, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow 226014, E mail: sbehari27@yahoo.com; sbehari@sgpgi.ac.in, Fax: 91-522-2668017, 2668078

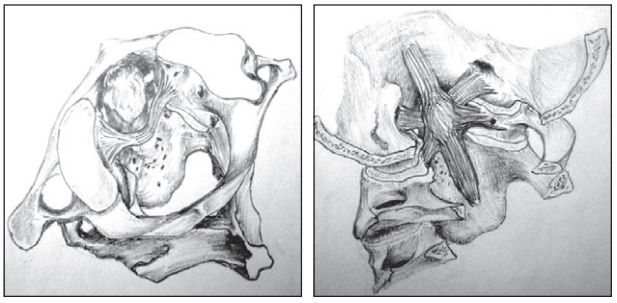

FIGURE 1: Diagrams showing **a)** the transverse ligament supporting the dens to the C1 arch; and, **b)** the cruciate ligament supporting the occipito-atlanto-axial complex

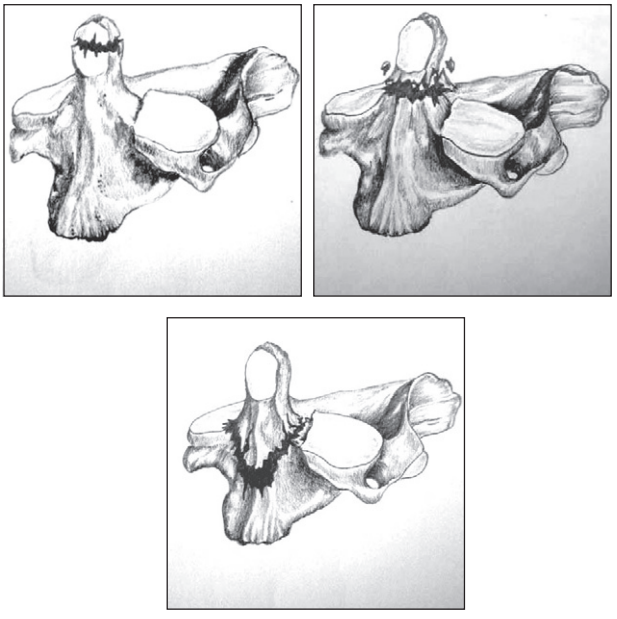

FIGURE 2: Diagrams showing **a)** the type I; **b)** type II; and, **c)** type III odontoid fractures

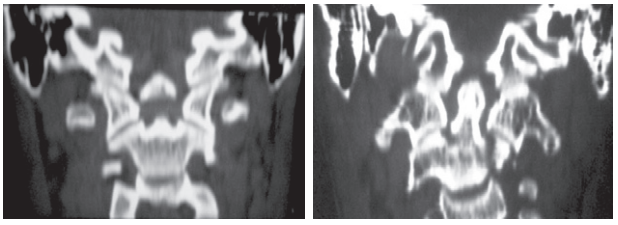

FIGURE 3. Coronal CT scan showing **a)** type II; and, **b)** type III odontoid fractures

CLINICAL FEATURES

Patients with acute dens fractures usually present with upper cervical pain and restriction of neck movements. They may have a tendency to support their head with their hands while moving from an upright to a supine position. In case of cord compression by the displaced fracture segments, cervical myelopathy may occur. In a study, 82% patients of type II fractures presented with intact neurological status; 8% had minimal sensory disturbances over the scalp or limb; and 10% had significant neurological deficits. Type I and type III odontoid fractures are rarely associated with neurological deficits[6]. About 25-40% of dens fractures are fatal at the time of accident.

MANAGEMENT

Type I odontoid fractures

Most neurosurgeons agree that these fractures are generally stable and can be managed with external immobilization using a hard cervical collar. There is very low incidence of non-union, and surgery is seldom indicated for these fractures[2,7].

Type II odontoid fractures

Conservative treatment

In the management of type II odontoid fractures, long-enduring controversies exist: Should conservative management with halo immobilization be adopted; or, should surgical reduction and fusion be undertaken? In case of the latter, should the approach be anterior or posterior? Studies utilizing external immobilization have reported a wide-ranging result[8-15] varying from ineffectualness[14] to 93 percent[15] success. Various factors affecting the rate of union of fractured odontoid include elderly age, degree of dens displacement, presence of concomitant C1-2 fracture, pre-existing pathological condition and age of the fracture[16]. Apuzzo et al[8] reported that dens displacement exceeding 4mm and an age above 40 years are associated with 88% chance of non-union of fracture odontoid treated with external immobilization alone. Dunn et al[12] reported that age greater than 65 years along with retrolisthesis correlated with about 70-78% chance of non-union of fracture odontoid treated with external immobilization alone. Hadley[4] described that type II A dens fractures have a very high tendency of non-union. The current role of external immobilization in case of type II dens fractures is where patients are unfit for general anesthesia or they have sustained severe concurrent injury that precludes primary surgical intervention for the fractured odontoid. Apfelbaum et al[17] have found a lower rate of bony fusion in patients with anterior oblique fractures when compared to patients in whom posterior oblique or horizontal fractures were demonstrated.

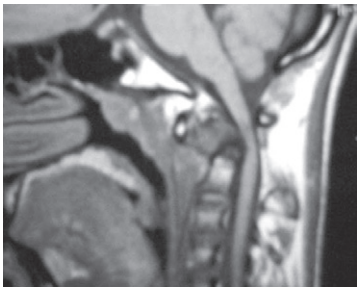

FIGURE 4. Sagittal MR scan showing an atlantoaxial dislocation due to type II odontoid fracture

Surgical treatment

Anterior approach

Anterior odontoid screw fixation was first reported by Nakanishi[18] and Bohler[19]. This procedure provides immediate spinal stability, preserves the normal rotation between C1-2, allows the best anatomical and functional outcome for type II odontoid fracture, and is associated with rapid patient mobilization, minimal postoperative pain and a short hospital stay. Acute odontoid fractures treated by anterior screw fixation have a fusion rate of approximately 90 percent[20].

Table 1: Surgical approaches for odontoid fracture

Anterior approach
Anterior odontoid screw fixation
Single screw
Multiple screw
Posterior approach
C1-2 sublaminer wire fixation and bone grafting
Gallie's method
Brook's method
Sonntag's method
Posterior C1-2 transarticular screw fixation
Magerl's procedure
Magerl's procedure supplemented with C1-2 sublaminar wire fixation
Jain's method of creating artificial arch on the occipital bone with sublaminar wiring
Ransford's contoured rod fixation

In the anterior screw fixation procedure, one or more screws may be used. Earlier studies emphasized on the concept of multiple screw usage for type II odontoid fractures mentioning that multiple screws augment the structural strength of the fusion and prevent the rotation of odontoid on the body of C2[21,22]. Recent studies found no significant difference in the fusion rate in the patients treated with single or two odontoid screws[23].

Various types of screws are available, including cortical or cancellous bone screws, self-tapping or non self-tapping screws, lag screws or cannulated screws, and, fully or partially threaded screws. Partially threaded lag screws are commonly used for fixating the odontoid. Lag compression helps to unite the fracture line by producing a compressive force. This helps in coupling the fractured fragments in addition to providing rigid fixation. Non self- tapping screws provide stronger screw purchase in the bone than self tapping screws[16].

The anterior odontoid screw fixation has certain limitations. Surgery requires adequate high cervical exposure and soft tissue retraction, which create anatomical limitations, as does the inability to add graft material to enhance fusion stability. Patients with short neck and barrel-shaped chest may not be suitable surgical candidates for the anterior approach because their anatomy interferes with an appropriate screw trajectory. A prerequisite for anterior screw fixation is an intact transverse ligament and a horizontal fracture line, which may not always be the case. In cases of chronic odontoid fracture, anterior screw fixation is associated with a high chance of non-union. The anterior screw fixation for odontoid fracture should be only performed when the fractured odontoid and the remaining C2 body are adequately aligned prior to screw insertion[16].

Posterior approach

Posterior approach for stabilization of odontoid fracture is indicated in the cases of odontoid fracture that are not amenable to anterior screw fixation. Commonly used procedures involve wedging a bone graft between posterior arch of C1 and the C2 lamina with sublaminar wiring. The well-described different methods for this C1- 2 posterior fusion procedure are the Gallie[24], Brooks[25], Sonntag[26] techniques. These procedures have a satisfactory fusion rate of about 74 percent[20]. The demerit of this procedure is that it causes elimination of the normal C1-2 rotatory motion (which accounts for more than 50% of all cervical spine rotatory movements) and reduced cervical spine flexion–extension by 10 percent[21].

Another excellent alternative technique for odontoid fracture is the posterior C1-2 transarticular screw fixation (Magerl's procedure) using unilateral or bilateral screws[27,28]. This provides an excellent spinal rotational spinal stability. This is an indirect method of stabilizing the fracture (in which the normal anatomical configuration is disrupted). Preoperative CT evaluation is mandatory to avoid vertebral artery injury in this procedure. This technique can be supplemented with metal plate for occipito-cervical stabilization. Alternatively, Jain's technique of occipitocervical fusion[29], Goel's plate and screw lateral mass fixation[30], or a Ransford's contoured rod technique[31] may be utilized.

Type III odontoid fracture

Conservative treatment

For type III odontoid fractures, external immobilization is a successful treatment option. Various studies have reported about 85% fusion rate for type III dens fractures treated by external immobilization[2,7]. Age was not clearly a predictor of successful fusion. The degree of fracture displacement had a negative correlation in few studies. About 97% fusion rate has been demonstrated in cases of type III dens fracture treated with posterior cervical fixation methods and almost 100% fusion rate has been shown by anterior screw fixation[20].

CONCLUSIONS

For type I and type III dens fractures, external immobilization provides a satisfactory fusion rate of almost 100% and 84% respectively. However, anterior screw fixation for type III dens fractures improves the fusion rate to nearly 100%. For type II odontoid fractures, the role of external immobilization is limited to only select cases who are not fit for a surgical procedure as it provides a fusion rate of approximately 65%. Anterior screw or posterior cervical stabilization procedures provide a 74 to 90% fusion rate. The former is preferred in acute Type II fractures due to its ability to preserve C1-C2 axial rotation but cannot be applied in cases of transverse ligament disruption, significantly displaced fractured segment or with communited fractures.

REFERENCES

1. Huelke DF, O'Day J, Mendelson RA. Cervical injuries suffered in automobile crashes. *J Neurosurg* 1989; 54: 316-22
2. Anderson LD, D'Alonzo RT. Fractures of the odontoid process of the axis. *J Bone Joint Surg* (*Am*). 1974; 56: 1663-74.
3. White AA III, Panjabi MM. Clinical Biomechanics of the Spine, ed 2. Philadelphia: JB Lippincott, 1990, pp 92-7.
4. Hadley MN, Browner CM, Liu SS et al New subtype of acute odontoid fracture (type II A). *Neurosurgery* 1988; 22: 67-71.

5. Stillerman CB, Roy RS, Weis MH. Cervical spine injuries: Diagnosis and treatment. In Wilkins RH, Rengachary SS (eds) Neurosurgery Vol II, ed 2. 2875-2904.

6. Przybylski GJ. Management of odontoid fractures. *Contemp Neurosurg* 1998; 20: 1-6.

7. Hadley MN, Bishop RC. Injuries of the craniocervical junction and upper cervical spine, in Tindall GT, Cooper PR, Barrow DL (eds): The Practice of Neurosurgery. Baltimore: Williams and Wilkins, 1996; 2: 1687-701.

8. Apuzzo MLJ, Heiden JS, Weiss MH et al, et al. Acute fracture of the odontoid process. An analysis of 45 cases. *J Neurosurg* 1978;48: 85-91.

9. Fujii E, Kobayashi K, Hirabayashi K. Treatment in the fractures of the odontoid process. *Spine* 1988; 13: 604-609.

10. Schatzker J, Rorabeck CH, Waddell JP. Fracture of the dens (odontoid process). Analysis of thirty-seven cases. *J Bone Joint Surg (Br)* 1971; 53: 392-405.

11. Hadley MN, Browner C, Sonntag VKH. Axis fractures: a comprehensive review of management and treatment in 107 cases. *Neurosurgery* 1985; 17: 281-90.

12. Dunn ME, Seljeskog EL. Experience in the management of odontoid process injuries: an analysis of 128 cases. *Neurosurgery* 1986; 18: 306-10

13. Wang GJ, Mabie KN, Whitehill R et al. The nonsurgical management of odontoid fracture in adults. *Spine* 1984; 9: 229-30.

14. Maiman DJ, Larson SJ. Management of odontoid fractures. *Neurosurgery* 1982; 11: 471-6.

15. Lind B, Nordwall A, Sihlbom H. Odontoid fracture treated with halo-vest. *Spine* 1987; 12: 173-7.

16. SK Shilpakar S, McLaughlin MR, Haid RW, Rodts GE et al. Management of acute odontoid fractures: operative techniques and complication avoidance. *Neurosurg Focus* 2000; 8: 17-23.

17. Apfelbaum RI, Lonser RR, Veres R, Casey A. Direct anterior screw fixation for recent and remote odontoid fractures. *Neurosurg Focus* 2000; 8: 7-16.

18. Nakanishi T. Internal fixation of odontoid fractures. *Cent J Orthop Trauma Surg* 1980; 23: 399-406.

19. Bohler J. Anterior stabilization for acute fractures and non-unions of the dens. *J Bone Joint Surg (Am)* 1982; 64: 18-27.

20. Julien TD, Frankel B, Traynelis VC, Ryken TC. Evidence-based analysis of odontoid fracture management. *Neurosurg Focus* 2000; 8: 1-6.

21. Apfelbaum RI: Anterior screw fixation of odontoid fractures, in Camins MB, O'Leary PF (eds): Diseases of the cervical spine. Baltimore: Williams and Wilkins, 1992, pp 603-8.

22. Geisler FH, Cheng C, Poka A et al. Anterior screw fixation of posteriorly displaced Type II odontoid odontoid fractures. *Neurosurgery* 1989; 25: 34-8.

23. Jenkins JD, Coric D, Branch CL Jr. a clinical comparison of one and two screw odontoid fixation. *J Neurosurg* 1998; 89: 366-70.

24. Gallie WE. Fractures and dislocations of the cervical spine. *Am J Surg* 1939; 46: 495-9.

25. Brooks Al, Jenkins EB. Atlanto-axial arthrodesis by the wedge compression method. *J Bone Joint Surg (Am)* 1978; 60:279-284

26. Dickman CA, Sonntag VKH, Papadopoulos SM et al. The interspinous method of posterior atlantoaxial arthrodesis. *J Neurosurg* 1991; 74: 190-8.

27. Jeanneret B, Magerl F. Primary posterior fusion of C1/2 in odontoid fractures: indication, technique, and result of trans-articular screw fixation. *J Spinal Disord* 1992; 5: 464-75.

28. Magrel F, Seemann PS. Stable posterior fusion of the atlas and axis by transarticular screw fixation, in Weidner PA (ed): Cervical Spine. New York: Springer-Verlag, 1987, Vol 1, 322-7.

29. Jain VK, Behari S. Posterior occipitoaxial fusion for atlantoaxial dislocation associated with occipitalized atlas. In: Wilkins R, Rengachary S (eds):Neurosurgical Operative atlas, Volume 7. American Association of Neurological Surgeons, Illinois,1997, pp 249-56

30. Goel A, Laheri V: Plate and screw fixation for atlantoaxial subluxation. *Acta Neurochir (Wien)* 1994; 129:47-53.

31. Ransford AO, Crockard HA, Pozo JL, et al. Craniocervical instability treated by contoured loop fixation. *J Bone Joint Surg (Br)* 1986; 68:173-7.

Acknowledgment

All sketches in this paper have been prepared by Dr. Bernard T. Lyngdoh