Journal of Spine
ISSN: 2165-7939

Campos and dos Santos Sousa, J Spine 2014, 3:2
DOI: 10.4172/2165-7939.1000162

Case Report Open Access

# Anterior Screw Fixation for Odontoid Fracture Using the Direct Approach at the C2-C3 Level: Case Report and Literature Review

**Wuilker Knoner Campos* and Daniel dos Santos Sousa**

*Neuron – Institute of Neurosurgery, Baia Sul Medical Center, Florianopolis, Brazil*

## Abstract

Fractures of the odontoid process comprise 10–15% of all cervical fractures. Almost two thirds of all dens fractures are classified as type II according to Anderson and D'Alonso classification system. Currently, the direct anterior odontoid screw fixation provides the best anatomical and functional results for this type of fracture and it is considered as the treatment of choice. Regarding the approach to the C2 vertebra, about 80% of authors usually make a skin incision at the lower cervical level (C4-C5 or C5-C6) for creating a working corridor. However, the required exposure and the relatively blind passage of the screw can damage the surrounding soft tissue. The direct approach at the C2-C3 level could be a shorter and safer working corridor to the odontoid screw fixation with less soft tissue retraction. Here we present a case report of a 62-year-old man who presented with Type II odontoid fracture and subsequently underwent a direct anterior odontoid screw fixation through a mini-open approach at the C2-C3 level. The literature available in the English language on related-approach complications of anterior odontoid screw fixation is reviewed.

**Keywords:** Odontoid fracture; Cervical spine fracture; Odontoid screw fixation; Minimally invasive spinal surgery

## Introduction

Fractures of the odontoid process comprise 10–15% of all cervical fractures [1]. Almost two thirds of all dens fractures [2] are classified as type II using Anderson and D'Alonso classification system, indicating that they involve the base of the odontoid process [3]. When these fractures are treated non-operatively, rates of non-union and pseudoarthrosis are high [4-6], besides infection and clinical complications associated to halo devices [7,8].

Presently, direct anterior odontoid screw fixation provides the best anatomical and functional results for type II odontoid process fractures with intact transverse ligament, and it is considered as treatment of the choice for type II-B fractures [4,9-11]. The mainly advantage of this method is that preserves rotatory motion of the cervical spine with immediate stabilization of the spine through the well-known Smith-Robinson [12] or Cloward approach to access the prevertebral space. Routinely a transverse skin incision is made at the level of C4-C5 or C5-C6 to prepare a working corridor to C2 level [13].

However, these traditional approaches involve dissecting the longus colli muscles as well as for excessive retraction of the vascular structures, trachea, esophagus, and recurrent laryngeal nerve by retractor systems. This hard retraction can damage the surrounding soft tissue. We have advocated that the direct C2-C3 level approach could be a shorter and safer working corridor to the anterior odontoid screw fixation with less soft tissue retraction. Here we present a case report of a 62-year-old man who presented with Type II odontoid fracture and subsequently underwent a direct anterior odontoid screw fixation through a mini-open approach to the C2-C3 level.

## Case Report

A 62-year-old healthy man was in a traffic accident. He presented with severe neck and occipital pain. He was initially evaluated at an outside emergency room and later transferred to our institution. His neurological examination was unremarkable (ASIA grade E). Cervical radiography and computerized tomography scanning demonstrated a Type II odontoid fracture (Figures 1A and 1B) according to the Anderson and D'Alonso classification [3]. Based on the direction of the fracture line extending from anterior-superior to posterior-inferior (Grauer Type II subclass) [14], this fracture still was classified as Type II-B (Figure 1C). MRI has also showed that atlantoaxial ligaments were undamaged.

The imaging findings were discussed with the patient as well as conservative and surgical options for treating his unstable odontoid fracture, and a direct anterior odontoid screw fixation was indicated. General endotracheal anesthesia was used and the patient was placed in a supine position with a folded sheet under the patient's shoulders. A Mayfield head holder was used to fix the head on a radiolucent operating table with the mouth held open with a radiolucent bite block so that AP and lateral fluoroscopy was available throughout the operation (Figure 2). Anatomic reduction of the fragment was confirmed after gentle flexion and extension maneuvers of the head.

A 3.5-cm right transverse skin incision was placed at C2-C3

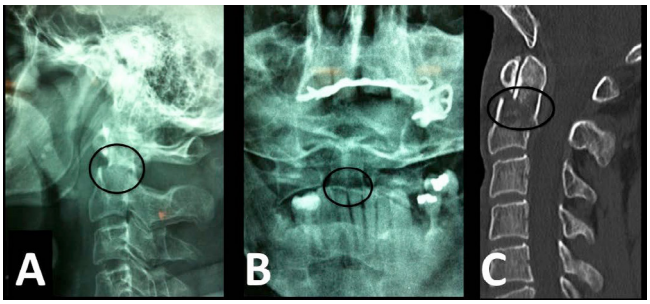


**Figure 1:** (A) Lateral cervical spine radiograph demonstrating a Type II odontoid fracture. (B) The fracture seen with an open mouth view. (C) Sagittal cervical spine CT scan with < 6 mm of dens displacement.

***Corresponding author:** Wuilker Knoner Campos, Neuron - Institute of Neurosurgery, Baia Sul Medical Center, office 419 – 4st Floor. 63 Menino Deus Street, 88020-210, Florianopolis-SC, Brazil, Tel/Fax: +55 48 32240843; E-mail: wuilker@yahoo.com.br

**Received** January 26, 2014; **Accepted** March 13, 2014; **Published** March 16, 2014

**Citation:** Campos WK, dos Santos Sousa D (2014) Anterior Screw Fixation for Odontoid Fracture Using the Direct Approach at the C2-C3 Level: Case Report and Literature Review. J Spine 3: 162. doi:10.4172/2165-7939.1000162

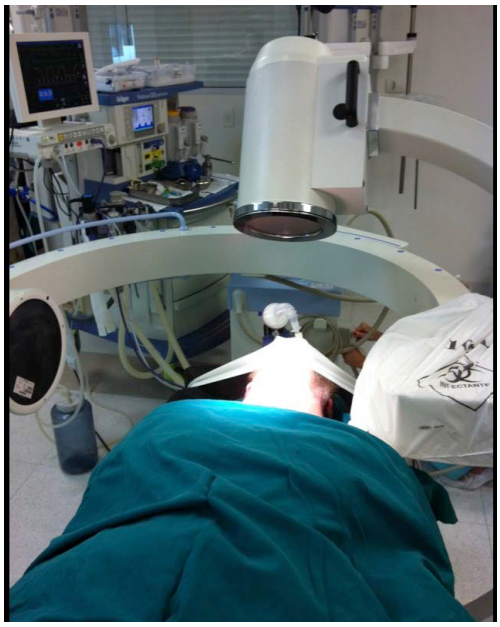

**Figure 2.** Double image intensifier to have lateral and open mouth view of the dens simultaneously available.

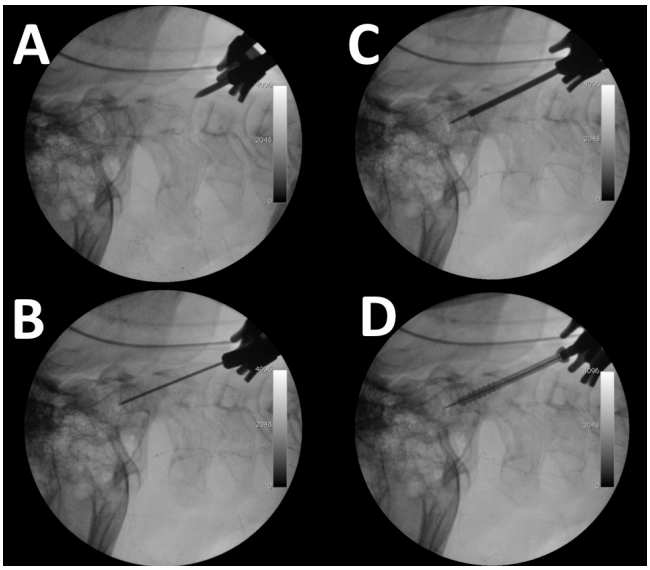


**Figure 3:** Intra-operative fluoroscopic image (lateral view): (A) the initial groove preparing the bed for the screw head; (B) The guide K-wire was advanced into the odontoid with a power drill until the tip of fractured odontoid process; (C) The protection tube over the guide tube was inserted into the C2 body; (D) the cannulated screw was advanced into the odontoid process.

level. Minimal dissection was made to expose the anterior surface of the second and third cervical vertebra by separating planes between the carotid artery laterally and the trachea and esophagus medially. A direct view of the C2-C3 level was allowed after an optimal placement of the specular retractor. A minimal groove was made at the anterior-superior portion of the C3 vertebral body in the midline, followed by minimal annulectomy at the C2–C3 disc. Subsequent a minimal decortication in anterior-inferior edge of the C2 body was performed using a 2-mm drill. In this way, the entry point for the guide wire was allowed to be at the anterior-inferior lip of C2. The K-wire was placed in the desired direction under biplanar fluoroscopy (Figures 3A-C). A cannulated cancellous screw, 40 mm in length and 3.5 mm in diameter, was inserted through the prepared tract, across the fracture line, and to the tip of odontoid process (Figure 3D). Finally the K-wire was removed and we closed the platysma with absorbable sutures and the skin was closed with intradermal sutures.

Neurological examination was performed immediately after surgery and then daily until discharge. Postoperative radiographs (Figure 4) confirmed the good position of the odontoid screw and a Philadelphia neck collar was worn for at least two months. After three months, CT scans (Figure 5) were obtained showing satisfactory union of the fractured dens and therefore the collar was discontinued.

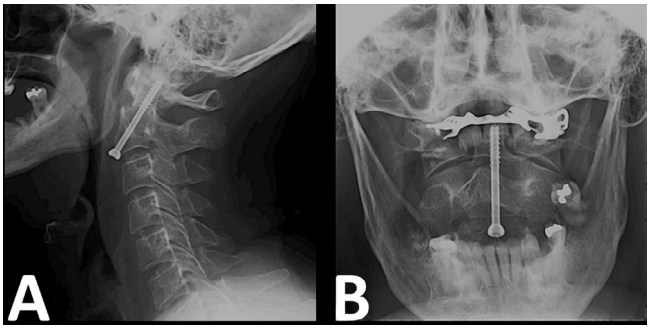


**Figure 4:** Postoperative (A) lateral and (B) open mouth radiographs demonstrating excellent reduction and fixation of the Type II odontoid fracture with a single titanium cannulated lag screw.

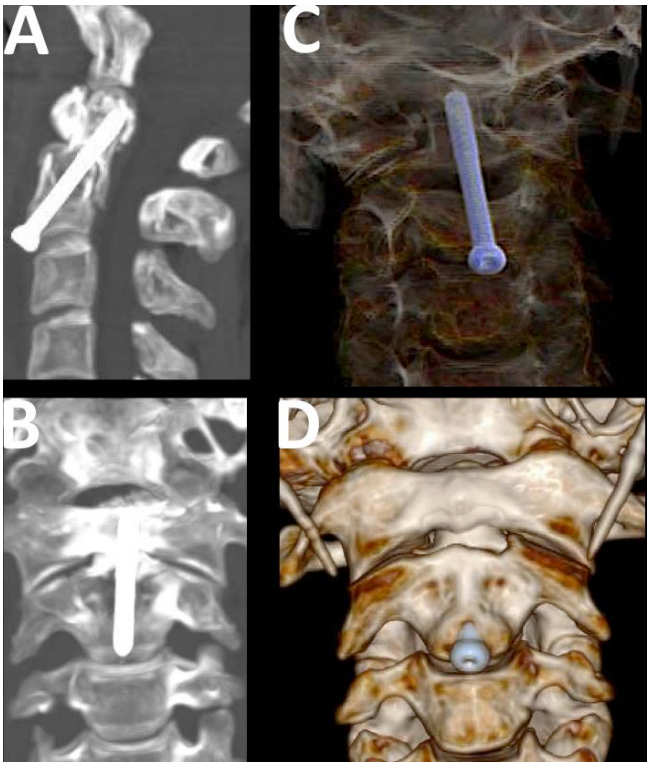


**Figure 5:** (A, B) Sagittal reconstructed CT scan showing adequate placement of the odontoid screw. (C, D) 3D-sagittal reconstruction view 90 days after the operation.

## Discussion

Direct fixation of the odontoid process has been viewed as a method to provide direct fixation of the fracture fragment, eliminating the need for more extensive C1–C2 arthrodesis techniques and allows rapid return to normal lifestyle [15]. This procedure is associated with excellent clinical results [4]. The fusion rate is about 90% when the surgery is performed within the first 6 months of injury, but drops to 25% for remote fractures [4,9]. Curiously, this procedure was first reported independently by Nakanishi in 1980 [16] and Bohler in 1982 [17].

The complications associated with anterior screw fixation are principally related to either hardware failure (biomechanical problems of the screw fixation) or due to the technical demands of the procedure. A 10% hardware complication rate is reported in the literature and the most common complication was screw pullout of the body of C2 [9]. In our case, there are no complications related to hardware failure. The postoperative images also showed precise positioning of the odontoid screw (Figures 4 and 5). Our patient did not have any complications during his admission or follow-up.

On the other hand, the Literature is unclear regarding the approach-related complications. Authors have reported them occur more frequently in the elderly and include postoperative hematoma, dysphagia, esophageal or pharyngeal perforation, airway problems and hoarseness [9,18]. Dysphagia after anterior cervical surgery is common in the initial postoperative period and decreases with time, though most authors neglect it as a transitory complication in their reports. Daylei et al. revealed an incidence of dysphagia of 35% in elderly, with 25% of patients requiring a temporary feeding tube for 4 months or longer [19]. Postoperative airway complications are also reported as an important problem. They include vocal cord dysfunction, tracheostomy, prolonged or repeated intubation, respiratory distress, airway edema, prolonged ventilator use, and aspiration pneumonia [20]. The risk of aspiration pneumonia has been reported to be as high as 19% in elderly patients, increases in these patients with dysphagia [19].

All information above-mentioned about related-approach complications testifies the importance of a softer working corridor during the direct anterior odontoid screw fixation. Nowadays careful attention to surgical detail is essential to avoid potential injury of surrounding soft tissue during anterior cervical approach. Therefore, when a skin incision is made at the lower cervical level (C4-C5 or C5-C6), the required exposure and the relatively blind passage of the screw may be the greatest sources of complications [9]. According to Literature review [4,10,11,21-38], about 80% of authors used these levels as entry point to achieve a work corridor to the odontoid fracture (Table 1). Another 20% of authors reported a higher level of cervical approach (C2-C3 or C3-C4). Like our surgical practice, Lee and Sung [35] first started at the C5-C6 level, then changed to C4-C5 and finally at C3-C4 level. Likewise, we agreed with them about this approach made the working distance up to C2-C3 level much shorter, and the procedure became more convenient. However, there are no studies comparing approach-related complications with cervical levels approach so far.

Besides a shorter working corridor has been achieved in present case, our patient also had a good cosmetic result. He had a 3.5-cm transversal skin incision, compared with the traditional skin incision at C5-C6 level which is 6–7 cm in length [39]. The neck incision was smaller than that in the traditional procedure because the exposure did not need to accommodate a three- or four-blade retractor system, only a specular retractor. Our cosmetic result was comparable to authors that used the anterior screw fixation through the endoscopically assisted system [40]. Regarding the percutaneous anterior odontoid screw fixation [26], a better cosmetic result is achieved. However, the major criticism may be that this technique uses a blind passage of the screw, which can result in damage of the surrounding soft tissue.

**Table 1:** Distribution of cervical spine levels used in 20 studies for approaching to anterior odontoid screw fixation.

| Authors | Year | Cervical Level Approach |
|---|---|---|
| Henaoux et al. [10] | 2012 | C5-C6 |
| Orief et al. [22] | 2011 | C5-C6 |
| Yang et al. [21] | 2011 | C5-C6 |
| Eap et al. [23] | 2010 | C4-C5 |
| Rajasekaran et al. [11] | 2010 | C5-C6 |
| Ozer et al. [24] | 2009 | C5-C6 |
| Collins and Min [25] | 2008 | C5-C6 |
| Srinivasan et al. [40] | 2008 | C2-C3 |
| Chi et al. [26] | 2007 | C4-C5 |
| Hung et al. [27] | 2007 | C5-C6 |
| Fountas et al. [38] | 2006 | C5-C6 |
| Lee and Sung [37] | 2006 | C3-C4 |
| Chibbaro et al. [36] | 2006 | C3-C4 |
| Apfelbaum et al. [9] | 2005 | C5 |
| Lee et al. [32] | 2004 | C5-C6 |
| Hott et al. [28] | 2003 | C5 |
| Dantas et al. [33] | 2002 | C4-C5 |
| Morandi et al. [34] | 1999 | C5-C6 |
| Konstantinou et al. [35] | 1997 | C5-C6 |
| Rainov et al. [30] | 1996 | C4-C5 |
| Chiba et al. [29] | 1993 | C2-C3 |

Finally, we believe that the direct at the C2-C3 level approach to perform an anterior odontoid screw fixation has good advantages. First, it is less invasive than conventional approach because provides a smaller working corridor through the mini-open approach. The use of a smaller working corridor may reduce the incidence of injury to the surrounding soft tissue and consequently approach-related complications. Second, it allows the direct view and access to the C2 body with the possibility of the direct reduction of the odontoid process fracture during the screw fixation. Third, this approach might help to relieve some of the technical demands of preserving the appropriate screw trajectory, especially in patients with barrel chested or obesity. Minimally invasive techniques are becoming more widespread in the surgical specialties. Present mini-open approach to the C2-C3 level might be a safe and feasible option for the traditional approach to treat Type II-B odontoid fracture [41,42].

### References

1. Maak TG, Grauer JN (2006) The contemporary treatment of odontoid injuries. Spine (Phila Pa 1976) 31: S53-60.
2. Hadley MN, Dickman CA, Browner CM, Sonntag VK (1989) Acute axis fractures: a review of 229 cases. J Neurosurg 71: 642-647.
3. Anderson LD, D'Alonzo RT (1974) Fractures of the odontoid process of the axis. J Bone Joint Surg Am 56: 1663-1674.
4. Dickman CA, Foley KT, Sonntag VK, Smith MM (1995) Cannulated screws for odontoid screw fixation and atlantoaxial transarticular screw fixation. Technical note. J Neurosurg 83: 1095-1100.
5. Cho DC, Sung JK (2012) Analysis of risk factors associated with fusion failure after anterior odontoid screw fixation. Spine (Phila Pa 1976) 37: 30-34.
6. Osti M, Philipp H, Meusburger B, Benedetto KP (2011) Analysis of failure following anterior screw fixation of Type II odontoid fractures in geriatric patients. Eur Spine J 20: 1915-1920.
7. Majercik S, Tashjian RZ, Biffl WL, Harrington DT, Cioffi WG (2005) Halo vest immobilization in the elderly: a death sentence? J Trauma 59: 350-356.

8. Chapman J, Smith JS, Kopjar B, Vaccaro AR, Arnold P, et al. (2013) The Aospine North America Geriatric Odontoid Fracture Mortality Study: A Retrospective Review of Mortality Outcomes for Operative Versus Nonoperative Treatment of 322 Patients with Long-Term Follow-Up. Spine (Phila Pa 1976) 38: 1098-1104.
9. Apfelbaum RI, Lonser RR, Veres R, Casey A (2000) Direct anterior screw fixation for recent and remote odontoid fractures. J Neurosurg 93: 227-236.
10. Hénaux PL, Cueff F, Diabira S, Riffaud L, Hamlat A, et al. (2012) Anterior screw fixation of type IIB odontoid fractures in octogenarians. Eur Spine J 21: 335-339.
11. Rajasekaran S, Kamath V, Avadhani A (2010) Odontoid anterior screw fixation. Eur Spine J 19: 339-340.
12. Smith GW, Robinson RA (1958) The treatment of certain cervical-spine disorders by anterior removal of the intervertebral disc and interbody fusion. J Bone Joint Surg Am 40-40A: 607-24.
13. Grosse A, Bohly J, Taglang G, Dosch JC, Kempf I (1991) [Screw fixation of fractures of the odontoid process]. Rev Chir Orthop Reparatrice Appar Mot 77: 425-431.
14. Grauer JN, Shafi B, Hilibrand AS, Harrop JS, Kwon BK, et al. (2005) Proposal of a modified, treatment-oriented classification of odontoid fractures. Spine J 5: 123-129.
15. Geisler FH, Cheng C, Poka A, Brumback RJ (1989) Anterior screw fixation of posteriorly displaced type II odontoid fractures. Neurosurgery 25: 30-37.
16. Nakanishi T (1980) Internal Fixation of the Odontoid Fracture. Cent Jpn J Orthop Traumatic Surg 23: 399-406.
17. Böhler J (1982) Anterior stabilization for acute fractures and non-unions of the dens. J Bone Joint Surg Am 64: 18-27.
18. Andersson S, Rodrigues M, Olerud C (2000) Odontoid fractures: high complication rate associated with anterior screw fixation in the elderly. Eur Spine J 9: 56-59.
19. Dailey AT, Hart D, Finn MA, Schmidt MH, Apfelbaum RI (2010) Anterior fixation of odontoid fractures in an elderly population. J Neurosurg Spine 12: 1-8.
20. Smith HE, Vaccaro AR, Maltenfort M, Albert TJ, Hilibrand AS, et al. (2008) Trends in Surgical Management for Type Ii Odontoid Fracture: 20 Years of Experience at a Regional Spinal Cord Injury Center. Orthopedics 31: 650.
21. Yang YL, Fu BS, Li RW, Smith PN, Mu WD, et al. (2011) Anterior single screw fixation of odontoid fracture with intraoperative Iso-C 3-dimensional imaging. Eur Spine J 20: 1899-1907.
22. Orief T, Bin-Nafisah S, Almusrea K, Alfawareh M (2011) Guidewire breakage: an unusual complication of anterior odontoid cannulated screw fixation. Asian Spine J 5: 258-261.
23. Eap C, Barresi L, Ohl X, Saddiki R, Mensa C, et al. (2010) Odontoid fractures anterior screw fixation: a continuous series of 36 cases. Orthop Traumatol Surg Res 96: 748-752.
24. Ozer AF, Cosar M, Oktenoglu TB, Sasani M, Iplikcioglu AC, et al. (2009) A new transodontoid fixation technique for delayed type II odontoid fracture: technical note. Surg Neurol 71: 121-125.
25. Collins I, Min WK (2008) Anterior screw fixation of type II odontoid fractures in the elderly. J Trauma 65: 1083-1087.
26. Chi YL, Wang XY, Xu HZ, Lin Y, Huang QS, et al. (2007) Management of odontoid fractures with percutaneous anterior odontoid screw fixation. Eur Spine J 16: 1157-1164.
27. Hung YC, Chen SC, Loh TW, Cheng HY, Su CF (2008) Anterior Screw Fixation with Endoscopic System Assisted Method for Rostral Type III Odontoid Fracture. Tzu Chi Med J 20: 232-236.
28. Hott JS, Henn JS, Sonntag VK (2003) A new table-fixed retractor for anterior odontoid screw fixation: technical note. J Neurosurg 98: 294-296.
29. Chiba K, Fujimura Y, Toyama Y, Takahata T, Nakanishi T, et al. (1993) Anterior screw fixation for odontoid fracture: clinical results in 45 cases. Eur Spine J 2: 76-81.
30. Rainov NG, Heidecke V, Burkert W (1996) Direct anterior fixation of odontoid fractures with a hollow spreading screw system. Acta Neurochir (Wien) 138: 146-153.
31. Rao G, Apfelbaum RI (2005) Odontoid screw fixation for fresh and remote fractures. Neurol India 53: 416-423.
32. Lee SC, Chen JF, Lee ST (2004) Management of acute odontoid fractures with single anterior screw fixation. J Clin Neurosci 11: 890-895.
33. Dantas FL, Prandini MN, Caires AC, Fonseca GA, Raso JL (2002) [Management of odontoid fractures using anterior screw fixation: analysis of 15 cases]. Arq Neuropsiquiatr 60: 823-829.
34. Morandi X, Hanna A, Hamlat A, Brassier G (1999) Anterior screw fixation of odontoid fractures. Surg Neurol 51: 236-240.
35. Konstantinou D, Levi ADO, SonntagVKH, Dickman CA (1997) Odontoid Screw Fixation. Barrow Quarterly 13: 1-4.
36. Chibbaro S, Benvenuti L, Carnesecchi S, Marsella M, Serino D, et al. (2005) The use of virtual fluoroscopy in managing acute type II odontoid fracture with anterior single-screw fixation. A safe, effective, elegant and fast form of treatment. Acta Neurochir (Wien) 147: 735-739.
37. Lee SH, Sung JK (2006) Anterior odontoid fixation using a 4.5-mm Herbert screw: The first report of 20 consecutive cases with odontoid fracture. Surg Neurol 66: 361-366.
38. Fountas KN, Machinis TG, Kapsalaki EZ, Dimopoulos VG, Feltes CH, et al. (2005) Surgical treatment of acute type II and rostral type III odontoid fractures managed by anterior screw fixation. South Med J 98: 896-901.
39. Chang KW, Liu YW, Cheng PG, Chang L, Suen KL, et al. (1994) One Herbert double-threaded compression screw fixation of displaced type II odontoid fractures. J Spinal Disord 7: 62-69.
40. Srinivasan US, Dhillon CS, Mahesha K, Kumar PV (2008) Anterior Single Lag Screw Fixation in Type II Dens Fracture – Indian Experience. Indian Journal of Neurotrauma 5: 87-91.
41. Etter C, Coscia M, Jaberg H, Aebi M (1991) Direct anterior fixation of dens fractures with a cannulated screw system. Spine (Phila Pa 1976) 16: S25-32.
42. Hashizume H, Kawakami M, Kawai M, Tamaki T (2003) A clinical case of endoscopically assisted anterior screw fixation for the type II odontoid fracture. Spine (Phila Pa 1976) 28: E102-105.

This article was originally published in a special issue, **Advanced Techniques in Spine Surgery** handled by Editor. Dr. Alessandro Landi, University of Rome Sapienza, Italy