Efficacy of Odontoid Screws in Acute Type II Odontoid Fractures

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Abstract

Background: Several surgical stabilization options are available for odontoid fractures; however, there is no consensus on the best option.

Objectives: This study aimed to assess the efficacy of odontoid screws in acute type II odontoid fractures regarding bony fusion and alignment.

Patients and methods: This cohort study retrospectively reviewed the medical records at our university hospitals from January 2015 to December 2020. We included the data of the patients who underwent odontoid screws for acute type II odontoid fractures. Patients with odontoid fractures type I on the Roy-Camille classification were excluded. A follow-up CT scan of the cervical spine one year after the operation was done to assess odontoid fusion and alignment. The statistical analyses were conducted using SPSS software version 21 (IBM Corp., Armonk, New York, USA).

Results: Our study included 22 cases, 19 males (86.3%). Their average age was 25.9 +/- 4.7 years. There were no other associated cervical spine fractures in any patient. Preoperatively, 21 patients (95.45%) were grade E on the AIS, and one case (4.55%) was grade D. All the patients had an intact transverse ligament. A follow-up CT of the cervical spine after one year shows good bony fusion in 21 cases (95.5%) and a fibrous fusion in one case (4.5%). The odontoid processes were in good alignment in all cases. There were no broken screws.

Conclusion: Odontoid screws appeared to be efficacious for the stability and fusion of acute odontoid fracture type II with good bony alignment.

Keywords: Cervical injury; Fusion; Odontoid fracture; Odontoid screw.

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Introduction

Odontoid (dens) fractures constitute up to 20% of all cervical spine fractures **(Joaquim and Patel, 2015; Löhrer et al., 2012).**
They are frequently seen in elderly patients due to their frequent falls, while motor accidents are a common mode of injury in younger patients **(Pal et al., 2011; Smith, et al., 2010).**
Several surgical stabilization options are available for odontoid fractures; however, there is no consensus on the best treatment management. Posterior atlantoaxial fusion techniques have a high fusion rate; however, they significantly limit neck rotation **(Munakomi et al., 2016; Kim et al., 2011; Yuan et al., 2018).**

The study aimed to assess the efficacy of odontoid screws in acute type II odontoid fractures regarding bone fusion and alignment.

Patients and methods

This study is a descriptive, retrospective, single-arm cohort study. It was reported under the "Strengthening the Reporting of Observational Studies in Epidemiology" (STROBE) principles.
The study has been carried out following the Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans. The collected clinical data was anonymized.

The Research Ethics Committee of the Faculty of Medicine at our university approved this study. We obtained informed consent as required.
We retrospectively reviewed the medical records at our university hospitals from January 2015 to December 2020 to include the data of the patients who underwent odontoid screws for acute type II odontoid fractures. We excluded the patients with odontoid fractures type I on the Roy-Camille classification. In addition, we excluded the patients who did not follow up in the first 12 months after the operation.

The collected data include the following: patients' demographics, comorbidities, preoperative clinical state, associated injuries, postoperative neurologic state, and radiological findings.

The preoperative neurologic state was assessed using the American Spinal Injury Association Impairment Scale (AIS), where **Grade A:** There is no motor or sensory function left below the level of injury. **Grade B:** Sensory function, but not motor function, is preserved below the neurologic level, and some sensation is preserved in the sacral segments S4 and S5. **Grade C:** Motor function is preserved below the neurologic level, but more than half of the key muscles below the neurologic level have a muscle grade < 3. **Grade D:** Motor function is preserved below the neurologic level, and at least half of the key muscles below the neurologic level have a muscle grade of 3 or more. **Grade E:** All motor and sensory functions are intact **(Roberts et al., 2017).**

Polytrauma was defined as craniocervical trauma and one of the following injuries: maxillofacial trauma, chest trauma, abdominal trauma, or orthopedic fractures.
All patients underwent a comprehensive trauma survey, which included a brain, chest, and whole spine CT scan, pelviabdominal ultrasound, and orthopedic images as needed. When odontoid fractures were diagnosed, an MRI of the cervical spine was requested to document the cord status and the integrity of the transverse ligament.

The **Anderson and D'Alonzo (1974)** classification is the most commonly used classification of odontoid fractures. They classified odontoid fractures into three types. A type I odontoid fracture is a

fracture of the tip of the odontoid process and is usually a stable fracture. The type II odontoid fracture is a fracture at the base of the odontoid, below the level of the transverse band of the cruciform ligament. It is an unstable fracture. Type IIa odontoid fractures are type II fractures with comminution at the odontoid base. Type III fractures extend into the vertebral body.

Another classification system is the Roy-Camille classification, which aids more in the management of odontoid fractures as it depends on the direction of the fracture line. In general, anterior oblique fractures are more stable than posterior oblique fractures **(Roy-Camille et al., 1980).**

Roy-Camille classification: Type I is an oblique linear fracture with a forward slope and dens displacement in an anterior direction. Type II is an oblique linear fracture with a backward slope and dens displacement in the posterior direction. Type III is a horizontal fracture line in which the dens displacement can be either anterior or posterior **(Roy-Camille et al., 1980).**

Surgical technique

Under general anesthesia, patients lie supine with a neutral head position. Intraoperative X-ray images (AP, lateral, and open mouth views) using a C-arm were obtained.

An oblique skin incision is made at the anterior border of the sternomastoid muscle. The incision extends from the upper border of C3 to the upper border of C5 vertebrae, with subplatysmal dissection, then opening of the cervical fascia in a plane medial to the carotid sheath and lateral to the trachea and esophagus. The prevertebral fascia is incised to expose the right and left longus colli muscles for midline orientation.

To identify the C2-3 disc, a lateral view X-ray is taken. The anterior central part of the C2-3 disc is removed to expose the lower surface of the C2 vertebrae, where the entry point lies. A sharp awl is used under C-arm verification, then careful drilling is continued to the base of the odontoid, the fracture site, and the odontoid tip. After completing drilling, a self-tapped cannulated lag (half-threaded) screw is applied, with its length measured intraoperatively. It is safer to do unicortical rather than bicortical fixation of the odontoid. A final AP and lateral view are taken to confirm the alignment of the odontoid process.

Postoperatively, patients were transferred to the ICU. Patients were instructed to wear a Philadelphia neck collar for three months. A CT scan of the cervical spine with sagittal reconstruction was done on the second postoperative day.

Patients were followed up in the outpatient clinic after one week, one month, and then every three months for one year. Plain X-ray cervical spine AP (open mouth) and lateral views were done at each visit. A one-year follow-up CT scan of the cervical spine was performed to assess bone fusion and odontoid alignment.

Odontoid fusion was confirmed if bony trabeculae were visible spanning the fracture site on the CT scan's sagittal view of the cervical spine. Otherwise, cases were considered to have a fibrous union.

Statistical analysis

The statistical analyses were conducted using SPSS software version 21 (IBM Corp., Armonk, New York, USA). Quantitative data was described by the mean and range, while qualitative data was described by frequencies.

Results

Our study included 22 cases. The demographics and the comorbidities of the patients are illustrated in (**Table.1).**

The mode of trauma and the associated injuries are listed in **(Table.2).** The patients with associated injuries were

kept in a Philadelphia neck collar until they were fit for general anesthesia. There were no other associated spine fractures in any patient.

Table 1. Demographics, comorbidities and the mode of trauma

Data	n = 22
Average age ± SD	25.9 ± 4.7
range	19 to 39
Gender	
male	19 (86.3%)
female	3 (13.6%)
Co-morbidities	
Hypertensive	1 (4.5%)
Diabetic	1 (4.5%)

SD: standard deviation

Table 2. Mode of trauma and associated injuries

Data	(n = 22)
Mode of trauma	
• Motor vehicle accident	16 (72.7%)
• Fall from a height	6 (27.3%)
Associated injuries	
• Brain edema	2 (9%)
• Brain contusions	2 (9%)
• Pneumothorax	3 (13.6%)
• Fractured shaft femur	1 (4.5%)
• Pelvic ramus fracture	1 (4.5%)
• Other spine fractures	0 (0%)

SD: standard deviation

Preoperatively, 21 patients (95.45%) were grade E on the AIS, and one case (4.55%) was grade D. The Glasgow coma scale (GCS) assessment shows that 19 cases (86.3%) were fully conscious at 15/15, two cases (9%) were at 14/15, and one case (4.5%) was at 13/15. According to Anderson and D'Alonzo's classification, 19 cases (86.3%) were of type II, and three (13.7%) were of type IIa odontoid fractures. On the Roy-Camille classification, 15 fractures (68.2%) were of type II, and seven (31.8%) were of type III.

All the patients had an intact transverse ligament on the MRI cervical spine. The mean operative time was 132 ± 11 min (118–154 min), and the mean intraoperative blood loss was 170.45 ± 39 ml (ranging from 100–250 ml).

Early postoperative CT of the cervical spine shows excellent position and alignment in all 22 cases.

All the patients were discharged in a fully conscious 15/15 state and AIS grade E within one week of the operation.

A follow-up CT of the cervical spine after one year shows good bony fusion in 21 cases (95.5%) and a fibrous fusion in one fracture (4.5%) with good alignment in all cases. There were no broken screws. There were no mortalities.

Preoperative and postoperative radiological images of an illustrative case was shown in (**Fig.1**).

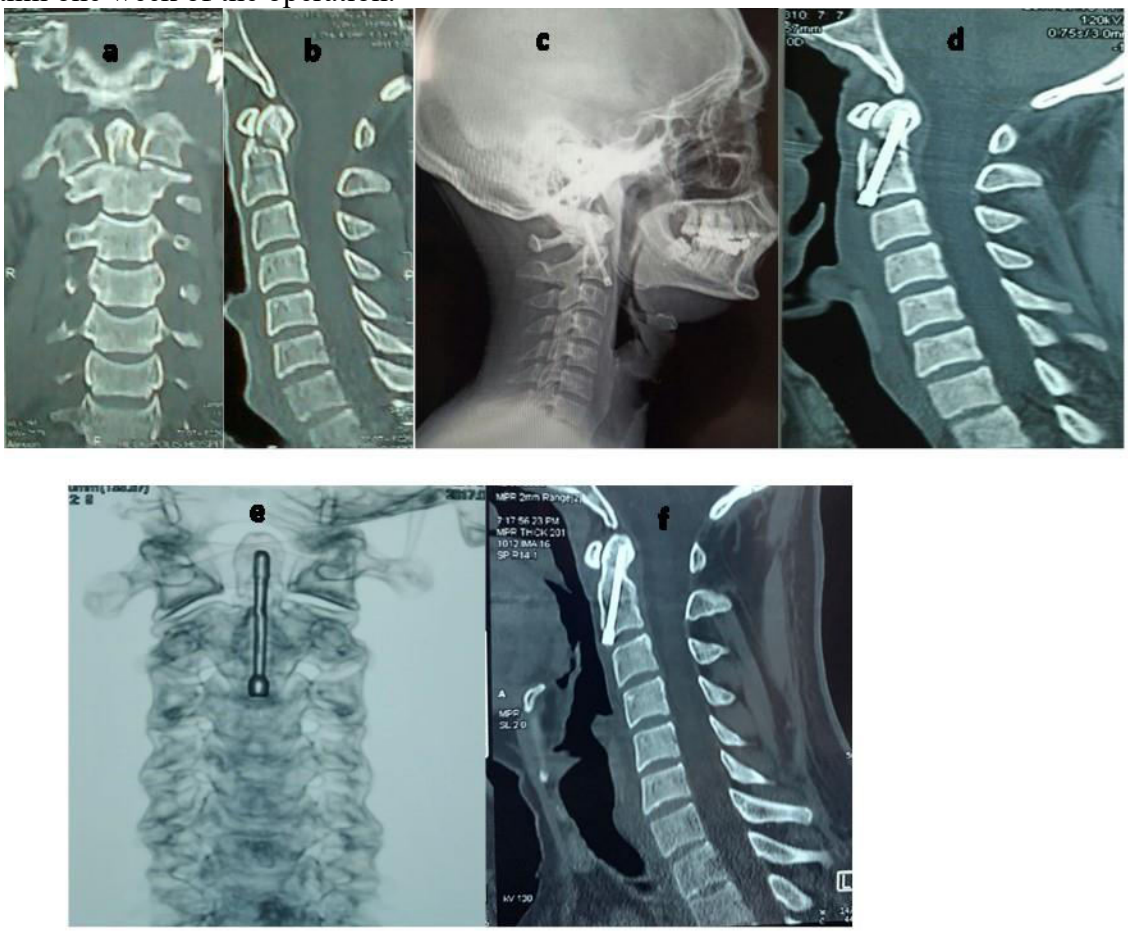

Fig. 1. Shows preoperative and postoperative radiological images of a case.
a, b: the preoperative CT cervical spine coronal and sagittal cuts showing odontoid fracture type II, **c:** immediate postoperative X-ray, **c, d, e:** early postoperative CT cervical spine, and **f:** CT cervical spine sagittal cut one year after the operation showing bony fusion.

Discussion

This study assessed the efficacy of odontoid screws in 22 patients with acute type II odontoid fractures regarding bony fusion and alignment.

The CT of the cervical spine after one year of the procedure showed good bony fusion in 21 cases (95.5%) and a fibrous union in one patient (4.5%). In addition, the odontoid processes were in good alignment in all cases.

The average age of the patients in our study was 25.9 +/- 4.7 years. This age was lower than most in other studies as most of our cases were victims of motor vehicle accidents, which are more common in young patients.

Almost all the studies did not mention postoperative neck collar after odontoid screws. We recommended the postoperative Philadelphia neck collar for three months.

The fusion rate in our study is better than the study done by **Apfelbaum et al. (2000).** They included 147 cases with a fusion rate of 88%. Their lower fusion rate can be attributed to their large number of patients, older age groups, and the inclusion of old odontoid fractures.

We had a low complication rate consistent with many studies **(Munakomi et al., 2016; Apfelbaum et al., 2000; Elkholy et al., 2020; Hou et al., 2011; Yuan et al., 2018; Ashry and Mohamed, 2019).**

We emphasize that the odontoid screw is a safe and accessible procedure that fixes the fractured odontoid while preserving the rotation and mobility of the craniocervical junction.

In our study, we found no cases of broken or pulled-out screws.

Screw pullout, screw migration into the spinal canal, and fracture displacement in osteoporotic individuals have been reported in the literature **(Apfelbaum et al., 2000; Elkholy et al., 2020; Hou et al., 2011; Yuan et al., 2018; Ashry and Mohamed, 2019; Mazur et al., 2011; Lvov et al., 2021).**

Mazur et al. (2011) stated in their review of avoiding pitfalls in anterior screw fixation for Type II odontoid that an odontoid oblique fracture line from posterosuperior to anteroinferior with a parallel screw trajectory is a contraindication to anterior fixation because interfragmentary compression by the odontoid screw cannot occur.

The limitations of this single-center study are the small number of included patients and the retrospective assessment of the odontoid screws.

Conclusion

A single odontoid screw appeared to be effective for the stability and fusion of type II acute odontoid fracture with good alignment.

Declaration of interest: The authors report no conflicts of interest.

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