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Case Report

Orthopaedics Section

Preservation of Atlantoaxial Rotation in Type II Odontoid Fracture: Successful Single Screw Anterior Odontoid Fixation in a Young Adult

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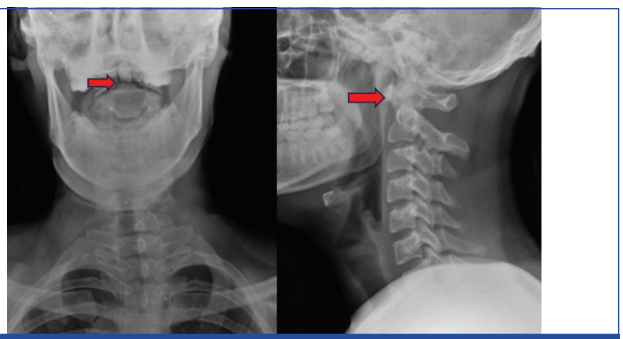
ABSTRACT

Type II odontoid fractures are the most prevalent type of cervical spine fracture in adults, and they are frequently linked with craniovertebral junction instability. Surgical fixation is recommended in young, active people to preserve cervical mobility and limit the likelihood of non-union. Anterior odontoid screw fixation is a well-established method that, unlike posterior fusion treatments, preserves atlantoaxial rotation. Here, a case is presented of a 30-year-old male patient who had a type II odontoid fracture as a result of a motor vehicle accident. A clinical evaluation indicated neck discomfort without neurological abnormalities. Radiological examination, including Computed Tomography (CT) and Magnetic Resonance Imaging (MRI), revealed a displaced fracture across the base of the odontoid process without transverse ligament rupture. The patient had a successful single-screw anterior odontoid fixation. Postoperative imaging verified the proper screw insertion and alignment. Serial radiographs after three months, nine months, and one year after surgery revealed gradual consolidation and radiological union of the odontoid fracture. Single-screw anterior odontoid fixation continues to be a useful surgical option for young adults with type II odontoid fractures, since it provides fracture stability while maintaining important cervical spine mobility. Successful outcomes need careful patient selection and precision surgical technique.

Keywords: Atlantoaxial rotation, Cervical spine trauma, Motion preservation, Spinal fixation, Type II dens fractures

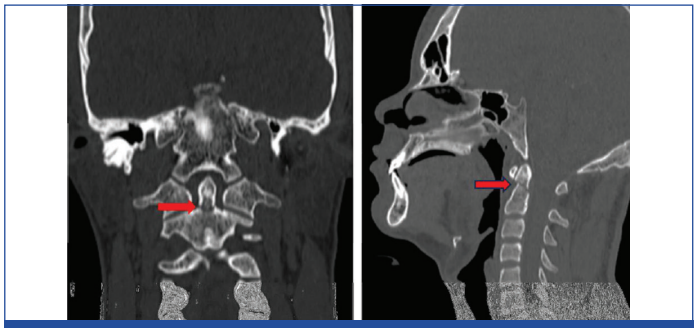
CASE REPORT

A 30-year-old male patient presented to the casualty after a road traffic accident. The patient reported severe cervical pain and restricted Range of Motion (ROM) of the neck. The patient did not report any history of loss of consciousness, vomiting, or limb weakness. On initial assessment, the primary trauma survey was completed and was found to be haemodynamically stable. A rigid (Philadelphia) cervical collar was applied immediately to stabilise the cervical spine and prevent further trauma. Clinical examination the patient exhibited midline bony tenderness over the C1-C2 vertebrae, which was suggestive of no neurological deficits. Motor and sensory functions were intact in all four limbs, and reflexes were found to be normal. Preoperative radiograph of the cervical spine was suggestive of a dens fracture [Table/Fig-1].

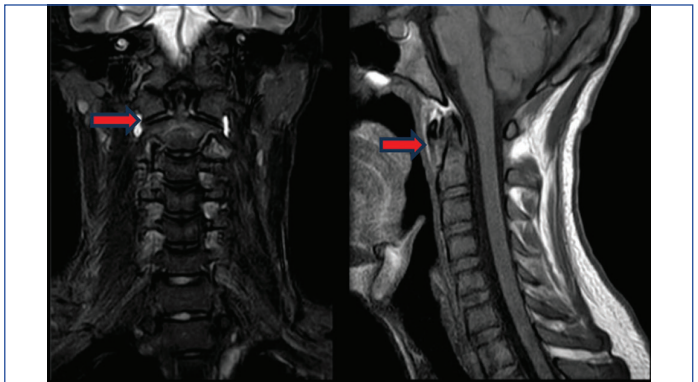


[Table/Fig-1]: Radiographs of the cervical spine (AP and lateral views) demonstrating a Type II odontoid fracture, based on the Anderson and D'Alonzo classification.

A Computed Tomography (CT) scan of the head and cervical spine revealed a fracture of C2's odontoid process (dens), which was consistent with a type II fracture according to Anderson and D'Alonzo classification [Table/Fig-2] [1]. An MRI of the cervical [Table/Fig-3] spine was then performed to look for related ligamentous damage, with a particular emphasis on the important atlantoaxial stabilisers, the transverse and alar ligaments, which were both found to be intact. Given the patient's young age, high functional needs, and favourable fracture shape, the surgical team decided for anterior odontoid screw fixation as an alternative motion-preserving approach.



[Table/Fig-2]: Coronal and sagittal CT images show an Anderson–D'Alonzo Type II odontoid fracture with a transverse break at the base of the dens and mild anterior displacement, providing essential anatomical detail for precise classification and surgical planning.

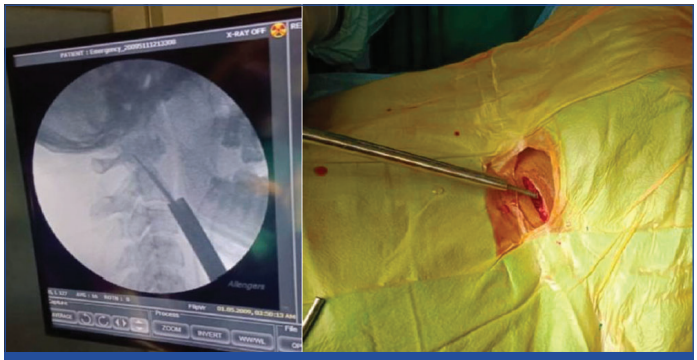


[Table/Fig-3]: Coronal and sagittal MRI images of cervical spine show intact atlantoaxial stabilising ligaments, including the transverse and alar ligaments. The posterior ligamentous complex and anterior longitudinal ligament are preserved, with no evidence of disruption or significant injury.

The patient was positioned supine on a radiolucent operating table, with the neck extended and the C2 axis aligned using a shoulder roll. The jaw was raised to provide for easy access to the C-arm. Fracture reduction was verified using lateral fluoroscopic guidance before skin preparation and draping. Using biplanar fluoroscopy, the screw route was designed from the anterior-inferior cortical edge of C2 to the apex of the odontoid processes. Using the usual Smith-Robinson cervical anterior approach, a transverse incision was made between the C5 and C6 levels, 1.5 cm lateral to the midline. Careful dissection was carried out, with the sternocleidomastoid muscle and carotid sheath retracted laterally, while the trachea, oesophagus, and strap muscles were mobilised medially. The avascular plane between both of these structures allowed safe access to C2's anterior surface for screw implantation.

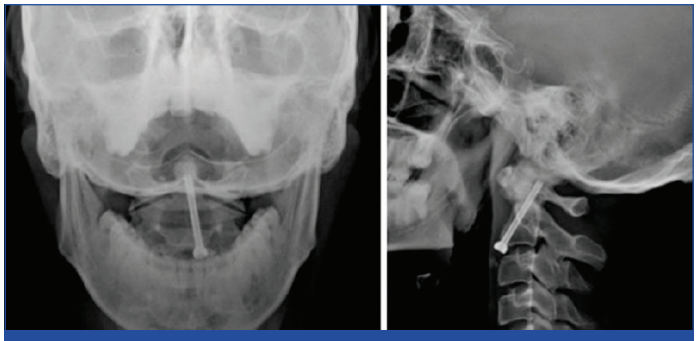
The C2-C3 disc level was located, and a guidewire was advanced under fluoroscopic guidance from the anterior aspect of C2 toward the tip of the odontoid, ensuring a central trajectory.

A cannulated drill was moved over the guidewire, and then a partly threaded lag screw was inserted to compress the fracture [Table/Fig-4]. Fluoroscopic imaging verified the proper positioning of the instruments, and thorough haemostasis was established. The surgical incision was then closed in layers to guarantee perfect anatomical alignment and limit the likelihood of postoperative problems. A soft cervical collar was placed at the conclusion of the treatment to give temporary stabilisation and support throughout the first healing period. Postoperatively, the collar was kept on as part of the immobilisation protocol, and modest neck range-of-motion exercises were started after three weeks, depending on the patient's comfort and clinical tolerance, to gradually restore the mobility while maintaining stability.

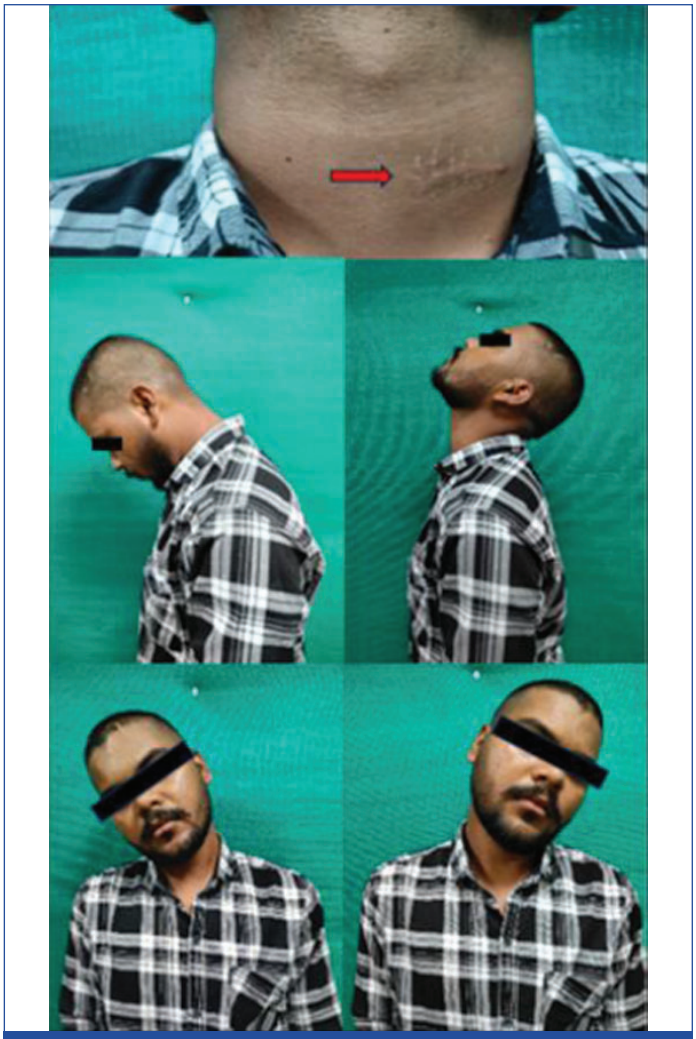


[Table/Fig-4]: Intraoperative images after identifying the C2-C3 disc space, a guidewire was centrally validated and placed under fluoroscopy from the anterior C2 to the odontoid apex.

Postoperative cervical X-ray after one year follow-up showed union at the fracture site [Table/Fig-5]. There were no deficiencies found during the postoperative examination. Early mobilisation with progressive cervical ROM exercises commenced. Follow-up radiographs revealed progressive fracture union, and within a year, the patient had regained full cervical mobility and returned to regular activities [Table/Fig-6].



[Table/Fig-5]: Postoperative Anteroposterior (AP) and lateral radiographs of the cervical spine showing a well-positioned anterior odontoid screw in situ.



[Table/Fig-6]: A one-year follow-up photograph shows a well-healed anterior cervical incision with no scar-related or soft-tissue complications, accompanied by full, pain-free cervical motion and no neurological deficits, reflecting an excellent long-term surgical outcome.

DISCUSSION

Fractures of the odontoid process constitute the most clinically significant C1-C2 injuries, with type II fractures under the Anderson & D'Alonzo classification posing the most difficulty due to their location at the base of the odontoid with a significant risk of non-union and neurological compromise [1]. These fractures are more unstable due to inadequate vascular supply, displacement, and delayed treatment [2,3]. Posterior C1-C2 fusion, while reliable, compromises as much as 50% of cervical spine rotation, a significant functional disadvantage in young, active people [4].

In contrast, anterior odontoid screw fixation stabilises the fracture while allowing atlantoaxial mobility [2,5]. Young patients make excellent candidates because to their strong cortical bone, favourable architecture, and great healing capacity, with union rates surpassing 90% [6,7]. Furthermore, their decreased comorbidity load and fast recovery encourage early movement while lowering the need for extended immobilisation. This approach achieves direct fracture compression and anatomical union while preserving normal cervical biomechanics [2,8]. However, the small zone of safety for screw trajectory and prospective neurovascular hazards necessitates thorough planning and exact execution [9,10].

The presented case is of a young adult male who had a base type of trans-odontoid fracture in a high-speed car collision. The patient arrived with no neurological impairments and had early single anterior screw fixation. Both clinical and radiological results were excellent following surgery. This case emphasises the need of early detection, motion-preserving techniques in young patients, especially intraoperative imaging in achieving safe, correct fixation without significant immobilisation or fusion.

Odontoid process fractures, particularly Type II, are a significant subgroup of upper cervical spine injuries with a substantial risk of non-union if left untreated or improperly stabilised [1,3,11]. The Anderson and D'Alonzo classification (1974) remains the gold standard, with Type II fractures originating at the dens base, an area with limited vascularisation that predisposes to delayed healing [1].

In younger people, these fractures are mainly caused by high-energy trauma, such as car accidents, but in the elderly, they are frequently caused by low-energy falls [3,11]. We present an 18-year-old guy who had a Type II odontoid fracture sustained in a motorbike accident who presented with no neurological impairments, most likely due to an unbroken transverse ligament, exhibiting only localised neck discomfort and restricted movement [4,12].

In a study published by Lee SC et al., it was observed that the younger patients with acute, non-comminuted, anteriorly displaced Type II fractures showed high rates of clinical success in a single-screw AOSF case series, exhibiting dependable union and preserved C1-C2 rotation at short-term follow-up; the authors highlighted fracture age (6 months), minimal gap/displacement, and fracture line orientation as predictors of success. When debating whether single-screw fixation is appropriate for active young adults looking to preserve their mobility, this practical series proved helpful [13]. Another recent multi-case series conducted by Abdelaziz M et al., indicated that there were good radiographic and clinical results with single anterior lag screws of direct anterior lag-screw fixation. All the patients achieved bony or fibrous union with no screw loosening or neurological deterioration, as well as postoperative neck mobility (including rotation) remained intact [14]. In a different case study done by Chandra A et al., rare complications like screw migration (including intracranial migration) and higher reoperation rates were compared with the posterior fusion were reported. These events are uncommon but underscore the need for meticulous technique, appropriate screw length/trajectory planning, and patient counselling about the risk of complications despite the benefit of preserved rotation [15].

The treatment of Type II odontoid fractures is still difficult and controversial. Conservative therapy with stiff external immobilisation may be performed in slightly displaced fractures, but it is associated with a significant risk of non-union, with reported rates ranging from 30 to 50% [14,16,17]. Healing outcomes are adversely affected by fracture displacement greater than 5 mm, angulation beyond 10°, delay in treatment, and advanced age [18]. As a result, surgical stabilisation is frequently favoured, especially in cases of unstable or displaced fractures, especially among young, active persons. Posterior C1-C2 fusion produces fusion rates greater than 95% while sacrificing almost 50% of atlantoaxial rotation [4,6,19]. In young individuals, loss of cervical movement can cause severe long-term functional impairment, thereby rendering motion-preserving strategies more appealing when possible [19].

Trans odontoid screw fixation via anterior approach, proposed by Böhler in 1982, provides a motion-preserving surgical alternative for odontoid fractures by allowing direct fracture compression and anatomical reduction. This procedure preserves the normal biomechanics of the C1-C2 joint and is most effective when performed in young patients with favorable anatomy and undamaged ligamentous structures, as our case demonstrated [19]. Chiba K et al., found that 90-95% unionisation percentages among properly chosen applicants. The benefits of this method include the maintenance of normal atlantoaxial rotation, shorter hospital stays alongside speedier recovery, and the avoidance of problems associated with prolonged external immobilisation, especially in younger persons [5]. Preoperative MRI indicated the transverse and alar ligaments were intact, which supported the decision to use anterior screw fixation. The treatment was completed successfully with a single screw under fluoroscopic supervision, resulting in proper fracture alignment and union. Follow-up revealed that cervical mobility was preserved, demonstrating the technique's effectiveness and functional advantages in suitably selected individuals [7,8].

Despite its advantages, trans odontoid screw fixation via the anterior route is technically challenging and necessitates careful surgical execution. It requires midline anterior cervical access via the Smith-Robinson technique, precise screw trajectory from the anteroinferior edge of C2 to the dens tip, and dependable intraoperative biplanar fluoroscopy to assure adequate alignment and avoid cortical breach. Certain anatomical or clinical issues, such as problematic exposures in patients having short necks or broad chests, comminuted fractures, considerable posterior displacement, chronic non-union, or low bone quality due to osteoporosis, may limit its usage [8,9]. Screw malposition, hardware failure, prolonged non-union, and, in rare cases, pharyngeal or vascular damage are also possible problems. In our instance, none happened, most likely due to early identification, favourable fracture shape, and precise surgical technique.

The patient had a very remarkable surgical recovery, obtaining radiographic union by nine months along with complete functional restoration within a year. These findings are consistent with previous research showing that early anterior screw fixation promotes quicker healing, reduces surgical pain, and preserves cervical ROM, particularly axial rotation. Early mobilisation, focused physiotherapy, and the use of a short-term collar were all part of postoperative care [4,7].

This case emphasises the need for the early radiographic as well as ligamentous evaluation, as well as thorough surgical planning, in optimising outcomes in young patients suffering odontoid fractures, and highlights the benefits of motion-preserving procedures for preserving long-term functional independence.

CONCLUSION(S)

This case indicates the effectiveness of single-screw anterior odontoid fixation as a permanent, motion-preserving surgical treatment for type II odontoid fractures in young, neurologically intact individuals. The positive clinical and radiological outcome emphasises the need of early intervention, comprehensive preoperative imaging (including ligamentous assessment), and rigorous adherence to anatomical and technical standards for safe screw insertion. Anterior fixation allows for direct osteosynthesis while retaining atlantoaxial kinematics, resulting in functional benefits over posterior fusion. Despite its technical difficulty, it produces high union rates with little morbidity in well-chosen patients. Long-term studies are required to solidify its position as the standard of treatment.

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