Full-Endoscopic Anterior Odontoid Screw Fixation: A Novel Technique and Technical Report

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Technical note

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Abstract

Background: Odontoid fractures are common among cervical spine fractures and are categorized into three types. Unstable type II fractures are among the most challenging to treat, and the best treatment approach has been debated. Anterior odontoid screw fixation, a surgical treatment option, yields a high union rate and helps preserve cervical motion; however, there are risks for approach-related complications. Here, we report a novel minimally invasive technique of full-endoscopic anterior odontoid fixation (FEAOF).

Methods: The authors introduce the technique and describe in detail the technical approach of FEAOF for the surgical treatment of type II odontoid fractures.

Conclusions: FEAOF is a feasible and effective option for treating type II odontoid fractures. The procedure is less invasive than other techniques and provides clear direct visualization of the involved structures.

Level of Evidence: Not applicable

Introduction

Odontoid fractures are the most common type of cervical spine fractures, accounting for 9–15% of all cervical spine fractures [1–3]. These injuries frequently lead to many complications, morbidities, and mortalities. According to the Anderson-D'Alonzo classification, high nonunion rates of 15–85% were reported in type II-odontoid fractures [1, 4, 6]. This type of fracture is associated with poor prognosis and is the most challenging for spine surgeons. In unstable type II fractures, the surgical treatment options vary and are currently debatable.

To stabilize these fractures, many techniques have been proposed, including posterior cervical instrumented fusion and anterior odontoid screw fixation. Patients with reducible type II odontoid fractures with Grauer subclassification type II are considered good candidates for anterior odontoid screw fixation [7]. This technique has many advantages over posterior procedures, including a high union rate, immediate stability, preservation of cervical spine motion, and less soft tissue injury [13]. However, there are many serious complications related to the anterior retropharyngeal approach for odontoid fixation. These include possible injury to the pharynx, esophagus, airway, vascular, and neural structures [12]. Surgical approach-related and screw-related complications have been reported in both open and percutaneous techniques [8–9].

In order to minimize these risks, we initiated the use of full-endoscopic surgery for use in anterior odontoid screw fixation procedures. The endoscopic system can help the surgeon visualize the appropriate screw entry point and surrounding structures. Therefore, there is increased screw placement accuracy and reduced soft tissue injury. Here, we report a novel minimally invasive technique of full-endoscopic anterior odontoid fixation (FEAOF).

Surgical Technique

Preoperative planning

Certain prerequisites are necessary to utilize this technique. A recent fracture has a higher likelihood of fracture reduction. The oblique fracture pattern perpendicular to the screw trajectory results in the greatest biomechanical benefit. The patient’s body habitus must allow proper screw trajectory. The presence of anomalies such as barrel-shaped chest, short neck, and cervical or thoracic kyphosis may have an impact on results [6, 8].

Preoperative X-ray or computed tomography (CT) scans are used to measure the length of the screw and the proper angle of the syringe, which is used as a soft tissue protector. The syringe tip cutting angle ranges between 25° and 40° depending on the fracture line (Fig. 1a).

Position, anesthesia, and approach

The FEAOF surgery is performed using the Vertebris System (RiwoSpine, GmbH, Knittlingen, Germany).

Under general anesthesia, the patient is placed in a prone position. The head is positioned over the end of the table and fixed with a Mayfield clamp in an extended position to allow the appropriate trajectory for fixation. A dual fluoroscopic technique is used for anteroposterior (AP) and lateral X-ray images. Anatomic reduction is performed and confirmed via fluoroscopy. A radiolucent bite block is placed in the mouth to allow an unobstructed AP open-mouth view image. After prepping and draping, the tip of a 10-mL polyethylene syringe is cut at the exact degrees that were measured preoperatively. A 3- to 4 cm oblique skin incision is made at the sternocleidomastoid groove at the level of the C4/5 intervertebral disc. Gentle dissection is performed between the carotid sheath (laterally) and medial structures, which include the strap muscles, esophagus, and trachea. Narrow size Langenbeck retractors are used to guard the surrounding structures. The longus coli muscles are identified, and the anterior of the C2/3 intervertebral disc is approached. The beveled syringe is then introduced into the disc space and the endoscope applied through the syringe (Fig. 1b).

Entry point identification

An isotonic saline solution is used as the irrigation fluid. The water pressure and flow are set at approximately 80 mmHg and 0.8 L/min. An appropriate entry point is visualized endoscopically and checked by biplanar fluoroscopy. The superior part of the C2/3 intervertebral disc is cauterized using a 4-MHz bipolar radiofrequency electrocautery and partly removed using various types of endoscopic instruments (Fig. 2a-d).

Drilling and screws fixation

Drilling is performed through an endoscope (Fig. 2e), which is closely monitored by biplanar fluoroscopy. At this point in the procedure, the irrigation fluid flow and pressure are increased for better visualization, which is compromised by bone bleeding. A partially threaded screw is tightened under both fluoroscopic and endoscopic views (Fig. 2f-h). Procedures using the cannulated screw system can also be performed in the same manner. This system decreases bone bleeding from the drilling step. The skin is closed in subcutaneous fashion without retention of the surgical drain after a final bleeding check. Postoperative images are obtained (Fig. 3a-b). A hard collar is applied for 4–6 weeks after surgery.

Discussion

A type II fracture is the most common type of odontoid fracture. However, these fractures have the poorest prognosis; the fracture line occurs through the waist of the odontoid process, often resulting in nonunion [2]. Greene et al. [4] reported that 28.4% of patients who received nonoperative treatment of type II odontoid fractures developed nonunion and required delayed surgical treatment. In fractures at risk for nonunion, such as those in individuals age > 50 years, those with fracture angulation, severe fracture gap, fracture comminution, fracture displacement, or instability, surgical intervention should be considered.

The use of an anterior odontoid screw, an osteosynthetic technique, is a surgical option for type II odontoid fractures with favorable fracture lines. The technique provides immediate stability, improves fracture union over nonoperative treatment, and preserves major cervical mobility [7]. Even with operative treatment using anterior odontoid screw fixation, a nonunion rate of 10%, screw-related complications, suboptimal screw position, and approach-related complications such as dysphagia and hematoma have been reported [10]. To minimize approach-related complications and surrounding soft tissue injury, minimally invasive cervical spine surgery was introduced. Endoscopic-assisted surgery was reported in 2003 by Hashizume et al. [5]; however, the authors used a micro-endoscopic camera system. They found improved visualization allowing a smaller incision, decreased blood loss, and reduced surrounding soft tissue injury compared to the traditional open technique. To the best of our knowledge, our current technique was the first to describe the use of a full-endoscopic system in performing anterior odontoid screw fixation. Apart from its minimally invasive nature, full-endoscopic surgery has many advantages. A continuous fluid irrigation system provides surgeons with a better field of visualization and helps reduce bleeding by local vasoconstriction effect from the lower temperature of the irrigation fluid. A channel of the camera unit is available for drilling or inserting a K-wire and tightening the screw through the instrument (Fig. 4). This technique should be performed by endoscopically trained surgeons. Converting to a traditional open technique must be prompted in any case of unexpected events. Using an orthosis for 4 to 6 weeks postoperatively helps reduce the load to the cervical spine and remains an important step in the anterior screw fixation method. The dens has only half of its original strength immediately after screw fixation and will gain its normal strength when the fracture is fully healed [11].

Conclusion

This novel FEAOF technique is a possible and effective option for treating type II odontoid fractures. Owing to the minimally invasive nature of the full-endoscopic system, direct visualization and less soft tissue compromise are the main advantages of this technique.

Abbreviations

FEAOF = full-endoscopic anterior odontoid fixation

MRI = magnetic resonance imaging

CT = computed tomography

AP = anteroposterior

MHz = megahertz

Declarations

Ethics approval and consent to participate:

Informed consent was obtained from all participants in the study and all procedures were approved by the ethics committee of the Queen Savang Vadhana Memorial Hospital (EC number 30/2020). The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent for publication:

Not applicable

Competing interests:

Author WS and WL have received speaker honorarium from Medtronic company. Author JSK is consultant to RiwoSpine, GmbH, Germany and Elliquence, LLC, USA.

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Authors' contributions:

VK analyze and performed all surgeries. JSK was a project consultant and inspiration for this work. All authors read and approved the final manuscript.

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Availability of data and material:

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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Figures

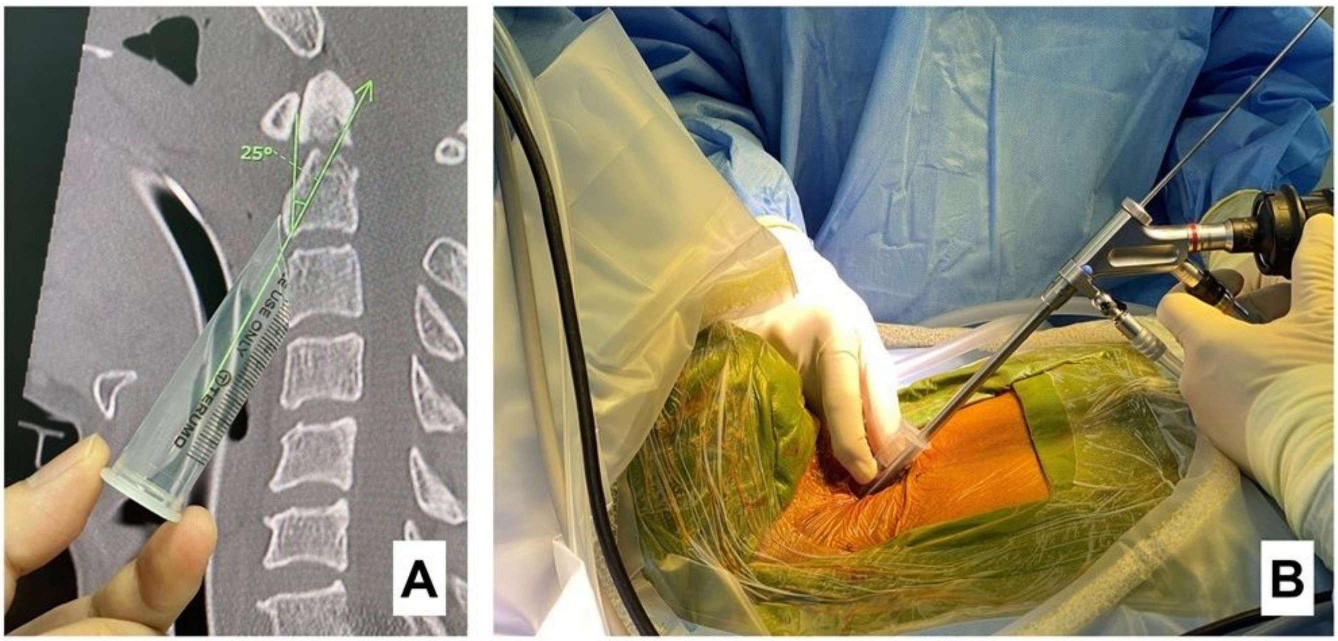

Figure 1

A preoperative preparation of the syringe working sleeve for a full-endoscopic system (1a), the application of syringe working sleeve and the endoscopic system during the procedure (1b)

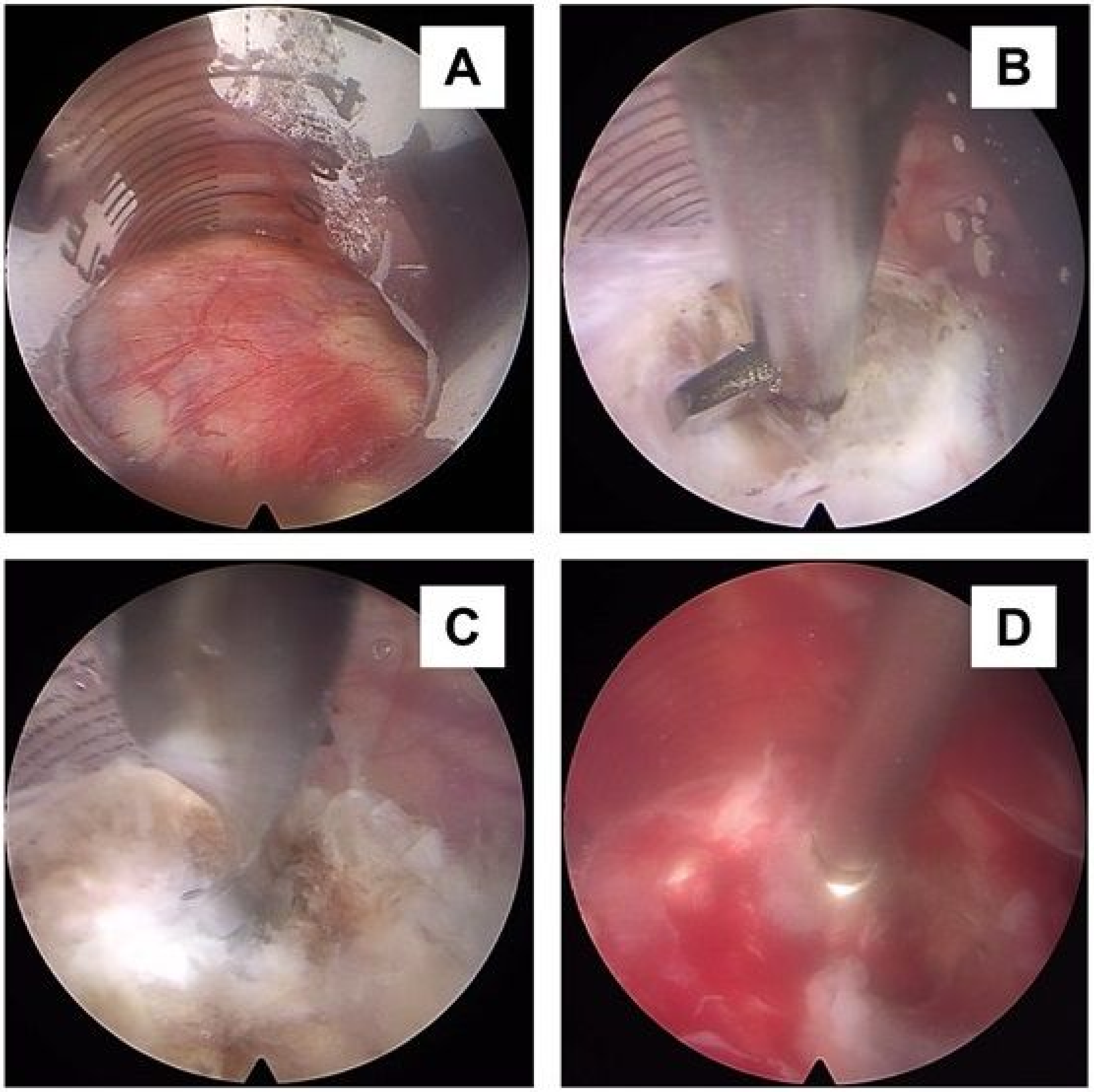

Figure 2

Intraoperative endoscopic views The anterior aspect of C2/3 intervertebral disc (2a), various kinds of endoscopic instruments for identification of a proper screw entry point: a 4-Mz radiofrequency bipolar cautery (2b), a pituitary rongeur for tissue grasping (2c), and a punch forceps for tissue cutting (2d), endoscopic views of entry point drilling (2e), and screw insertion (2f-2h)

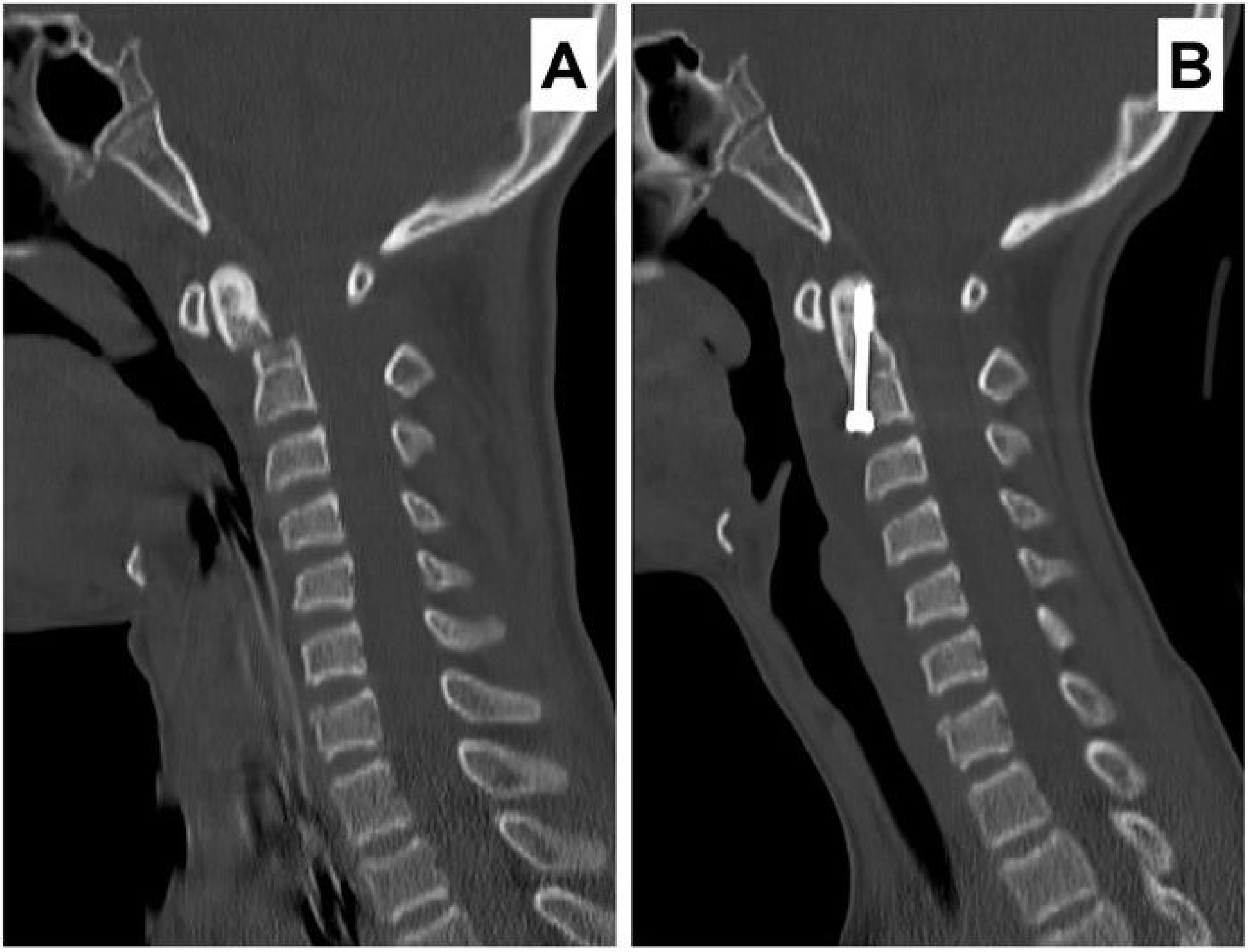

Figure 3

Example of case done by the FEAOF technique: Pre- and 12 months postoperative CT scans showed a fracture reduction and a proper screw placement and union.

Figure 4

Drilling via an endoscopic unit