

## Endoscopic Anterior Odontoid Screw Fixation for the Odontoid Fracture: A Cadaveric Pilot Study

### Abstract

**Introduction:** Anterior odontoid screw fixation technique for specific types of odontoid fracture has been proven to be an effective, yet challenging procedure because of threatened damage to the structures in the vicinity. There are few articles suggesting the role of percutaneous and endoscopic technique as an alternative approach to the standard microscopic way. This is the first cadaveric study using existing “EASY GO” endoscopic system-assisted odontoid screw placement. **Study Design:** This was a cadaveric study. **Objective:** The objective of the study is to use the endoscope as a safer minimally invasive approach than the standard microscopic anterior approach to odontoid. **Methodology:** This is a pilot study on 10 fresh-frozen formalin-fixed adult human cadavers. The cadaver was positioned in a way to simulate reduced odontoid fracture. Tubular dilators were used to dock at C2–3 disk space after identifying the landmarks through the microscopic method. The EASY GO endoscopic system was then introduced, and a handheld drill was used to mark the entry point and pass the K-wire through the planned trajectory. **Results:** No vascular or adjacent vital structures’ injury was observed in any of the cadavers. The initial difficulty in attaining the alignment was overcome by the appropriate positioning of the scope. **Conclusions:** Endoscopic-assisted technique for odontoid screw fixation shall provide a minimally invasive, safe, and easy surgery.

**Keywords:** Endoscopic, odontoid screw, tubular dilators

### Introduction

Anterior odontoid screw fixation technique for specific types of odontoid fracture has been proven to be an effective, yet challenging procedure because of threatened damage to the structures in the vicinity. The varied complications include venous injury (highly variable jugular venous anatomy), neural injury, esophageal and pharyngeal perforation, and tracheal injury. This injury is likely to occur at the time of accessing the appropriate trajectory for screw placement. It is also associated with high risks of screw malposition. Our institutional review of 85 cases of patients who underwent anterior odontoid screw placement by the standard microscopic approach revealed overall morbidity of 11.7%, with dysphagia in 1.1% and one perioperative mortality due to subarachnoid hemorrhage.<sup>[1]</sup> There are few articles suggesting the role of percutaneous and endoscopic technique as an alternative approach to standard microscopic way. The challenging learning curve and the potential

risk for iatrogenic injury with error in the screw trajectory limit the wide clinical application of percutaneous anterior screw fixation.<sup>[2-6]</sup> Utility of minimally invasive approach to increase the safety is the need of the hour. There are few reports which suggest use of endoscope for odontoid screw placement but did not become popular because of lack of reproducibility.<sup>[7,8]</sup> This is the first cadaveric study using existing “EASY GO” endoscopic system-assisted odontoid screw placement.

### Study design

This was a cadaveric study.

### Objective

The objective of the study is to use the endoscope as a safer minimally invasive approach than the standard microscopic anterior approach to odontoid.

### Methodology

This cadaveric study was approved by the institutional ethics review board and

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the financial support was provided by the AO Spine Asia Pacific Group. The project is registered in the Research Section vide project code no N-1963. This is a pilot study on 10 fresh-frozen formalin-fixed adult human cadavers.

The study comprised two steps. The first step of the study was to perform the endoscopic anatomical dissections and identify the important landmarks to reach the odontoid. Step 2 comprised of placement of odontoid screw under image guidance with the use of endoscope.

### Description of the scope

Karl Storz Easy GO II Generation-Tubular System was used for the study. A 0° endoscope which was 10 cm long and 4.7 mm diameter telescope (Karl Storz, Germany) was used to visualize the surgical field inside the tubular retractor, and standard endoscopic instruments were used for the cadaveric dissection. A handheld drill with a long attachment was used to mark the entry point, and the rest of the instruments were same as the ones used for a standard open approach [Figure 1].

### Technique

Each cadaver was positioned in supine, with neck extended to simulate the reduced odontoid fracture. The desired screw trajectory was planned on fluoroscopy just like in

a standard anterior odontoid screw placement [Figure 2]. Transverse skin incision (2.5 cm in length) was made, with the medial border of the right sternocleidomastoid muscle being the lateral margin at C5–6-disc space level. A plane between the neurovascular bundle laterally and the trachea and esophagus medially was dissected bluntly under open vision to ensure minimal tissue handling till we reached the prevertebral fascia [Figure 3]. The tubular retractor with a rounded blunt trocar negotiated in the dissected space and docked at the C2, 3 disc space [Figure 4]. Once the position of the tubular retractor was confirmed on the fluoroscopy to be in the desired target, the Trocar was then removed, and the tubular retractor was fixed in place by means of the endoscope table holder. Now, this placement of tubular retractor will be of advantage in subsequent procedure as it will show clear-close endoscopic view, as well as it will act as a protector for surrounding tissue from various instruments used during the procedure like drilling. The telescope was then fitted and mounted over the top of the tubular retractor [Figure 5]. Final position of the tubular system was then checked with II in both anteroposterior (AP) and lateral fluoroscopy view. The soft tissues overlying the target area are then removed by means of monopolar cautery [Figures 6 and 7].

All the subsequent steps of surgery were the same as in a standard odontoid screw placement with a bicortical purchase. We used the handheld drill system to plan our trajectory and drill the path of the



Figure 1: The setup with the Karl Storz endoscope with the light source attached and handheld drill *in situ*. Note the obliquity of the scope in its final position

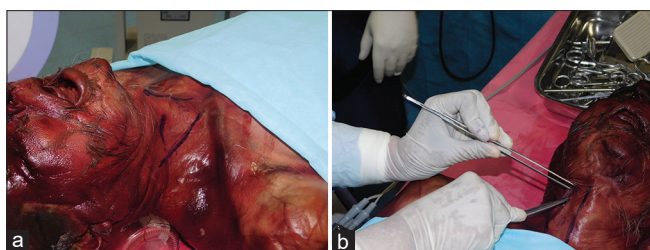


Figure 3: (a) Marking of the skin incision. (b) Blunt dissection being carried out to reach the desired level of C2–3 space

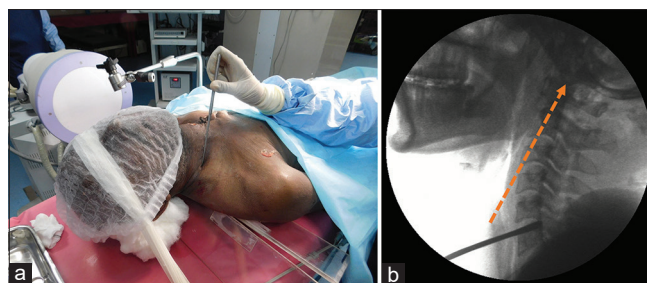


Figure 2: (a) Cadaver positioning and marking of the trajectory on fluoroscopy. The disc space C5–6 is being identified. (b) It shows the intended trajectory and the incision level needed for the same

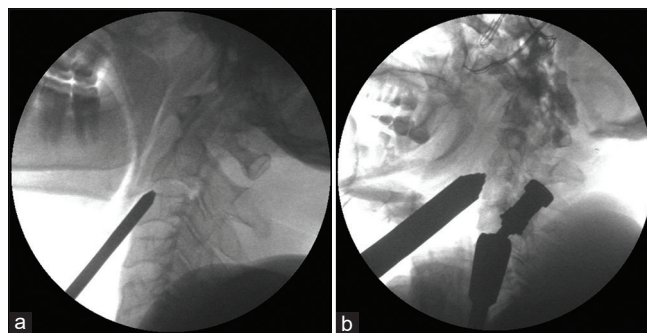
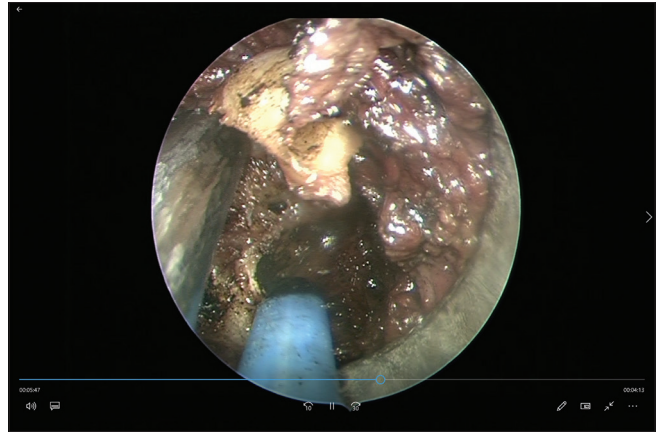


Figure 4: (a) Sequential dilation is being performed using the dilators. (b) The final dilator was the orange dilator used (15 mm) to allow introducing the working tube

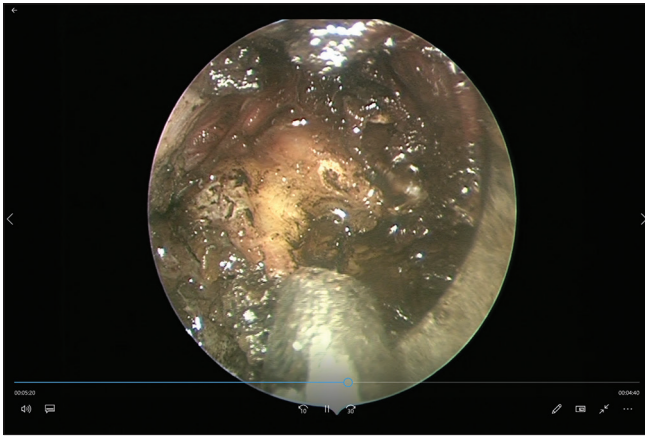




**Figure 5:** The final placement of the scope with the attachments and the alignment with respect to the operating surgeon



**Figure 6:** Monopolar cautery used to dissect out the soft tissue coming into the working tube

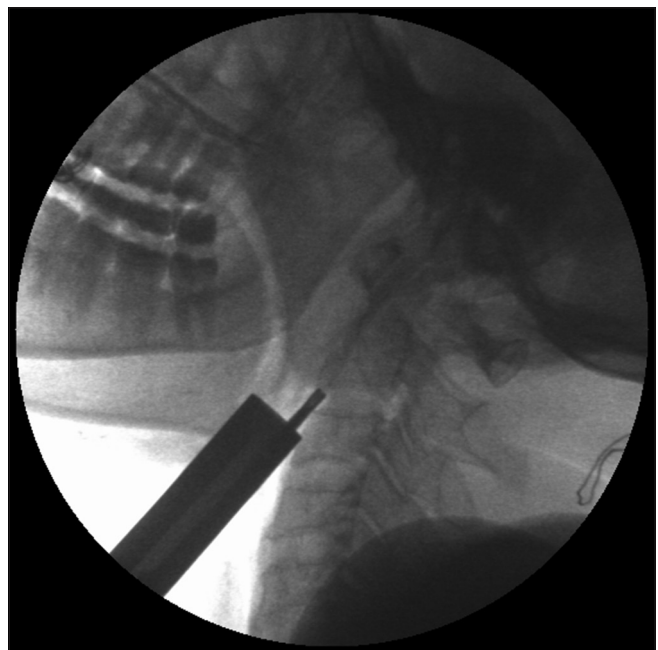


**Figure 7:** Identifying the C2–3 disc space and marking the starting point of trajectory using the handheld drill

intended screw through the dens and odontoid. The K-wire (2.7 mm diameter) was passed through the marked trajectory [Figure 8]. This was confirmed on both AP and lateral views on fluoroscopy [Figure 9]. The whole tract of dissection was then opened and inspected microscopically to assess for any damage to the adjacent vital structures such as veins, trachea, carotids, and esophagus [Figure 10].

In the initial three cadavers, there was a difficulty in docking the tubes and marking the drill entry point [Figure 11]. The final docking level was confirmed on the lateral view, and AP images were most crucial in identifying the midline position of the guide wire [Figure 12]. Subsequent cadavers were easy to dissect and attain the right trajectory on both AP and lateral views.

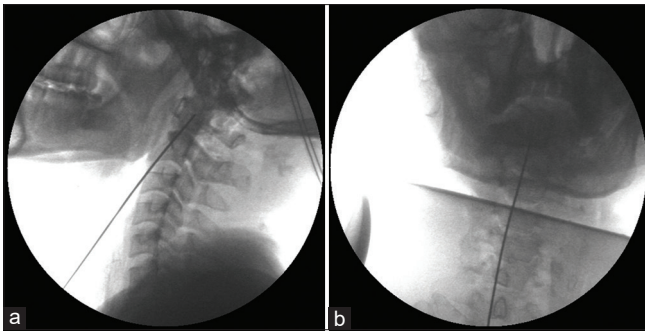
The average time spent on each procedure from the skin incision onward was 2 h in the initial three dissections which was gradually reduced to the least, i.e., 45 min in the last three cadaver dissections. None of the cadavers showed any vascular or neural injury.



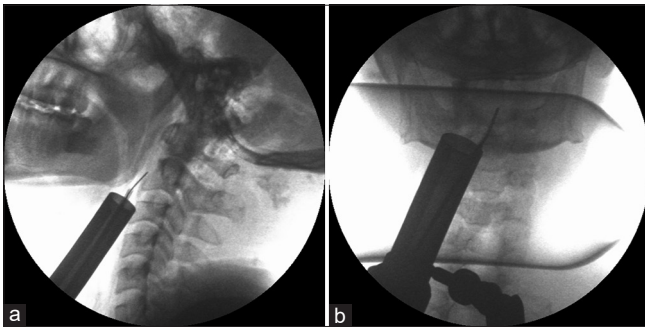
**Figure 8:** Identifying the entry point on fluoroscopy. Both lateral and anteroposterior views were used to mark the center and the direction of the trajectory

## Discussion

Almost 20% of cervical spine injuries form odontoid fracture.<sup>[9]</sup> In patients with high degree of dens dislocation (>4–6 mm), increasing age (>40–65 years), delayed diagnosis, and prolonged tractions, surgery should be offered to the patient. Various treatment options are available for the treatment of these fractures ranging from conservative management with halo, anterior approach with odontoid screw, and various types of posterior fixations depending on patients' clinical details and fracture anatomy. Whenever feasible, anterior odontoid screw is the better option as it preserves cervical neck motion and associated with good fusion. For the first time, anterior odontoid screw fixation technique was reported by Böhler in 1982.<sup>[10]</sup> This approach has stood the test of time and has



**Figure 9:** Marks the final trajectory that the cannulated screw would take on placement. (a) Lateral view. (b) Anteroposterior view

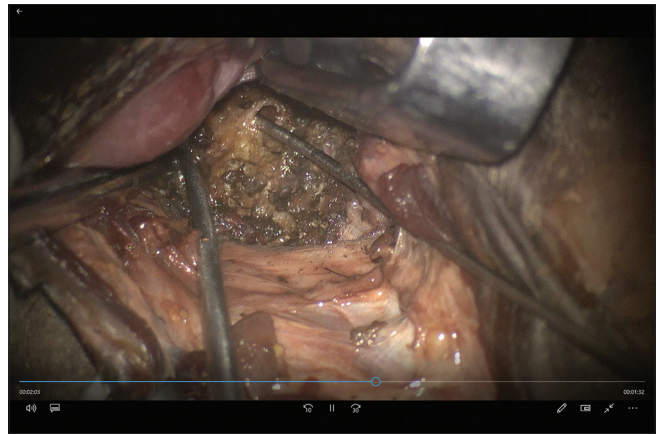


**Figure 11:** (a) Improper placement on the lateral view. Difficulty in identifying the midline led to slippage of the guide wire into the lateral dead space. (b) Achieving the midline orientation was more difficult in the anteroposterior view. For a right-handed surgeon, we intended to go more in the right-to-left direction of the cadaver

the advantage of preserving normal rotation in atlantoaxial joint. Anterior screw placement allows direct osteosynthesis of the odontoid fracture with fusion rates from 85% to 100%. Yet, this technique is not free from complications. Malposition rates of nearly 6% have been described in the literature.<sup>[1,11]</sup> There is a lot of retraction needed to visualize the site of entry point and keep the soft tissues away from the operating field.

However, there has been several other anterior approaches described, all aiming at reducing the tissue dissection while accessing the desired entry point.<sup>[2-8]</sup>

The percutaneous approach and the endoscopic technique have both been explored in the past on cadavers and in certain occasions on patients too. Kazan *et al.* described the percutaneous technique for closed anterior fixation of odontoid fracture by using a telescopic tube system in a cadaveric study.<sup>[2]</sup> Percutaneous procedures are blind and carry an inherent risk of trauma to the adjacent structures, with chances of mispositioning. Hashizume *et al.* have reported that using an endoscope makes anterior screw fixation a safer and less invasive than the classic anterior retropharyngeal approach.<sup>[8]</sup> They used the innovative polyethylene syringe as a tubular retractor in a 76-year-old patient and endoscope as a monitor to guide entry point identification. The procedure is effective in getting proper visualization of the structures



**Figure 10:** Confirming of the guide wire placement under the microscope. The puncture site was adequately positioned under the C2 anterior lip of the lower end plate. Also was found to be equidistant from lateral edges



**Figure 12:** Appropriate placement of the scope could help overcome most of the trajectory issues. The central alignment of the working tube on anteroposterior imaging was the key to correctly place the guide wire

and safeguarding the adjacent tissues. The biggest issue while conducting endoscopic surgery was learning curve and therefore did not gain much popularity. Khattab *et al.* recently described the use of Jamshedi and fluoroscopy for the safe insertion of the odontoid screw.<sup>[6]</sup> The procedure is alike the standard microscopic odontoid screw placement with the assistance of a Jamshedi needle to act as a sleeve for passing the guide wire. This study itself highlights the need for a sleeve for safer insertion of screws and thus justifies the conduct of the current cadaveric study.

This is the first cadaveric study using the EASY GO system and tubular dilators. The endoscope system has well been in use for other spine procedure. There were initial difficulties in obtaining the midline trajectory which was overcome in the later part of the study by efficient placement of the scope. This study is an attempt to satisfy the quest for a safer alternative for odontoid screw placement in terms of minimally invasive approach

with lesser morbidity. Thus, endoscopic procedure provides an alternative route to place anterior odontoid screw under direct vision, safeguarding the adjacent tissues.

### Limitations of the study

This is a pilot study of 10 cadavers. The learning curve involved familiarization with the tube dilator system and the EASY GO endoscope. Translating it into real-life scenario when the pathology is rare may not provide an opportunity to overcome the learning curve. This was a simulation where intact odontoids were used for trajectory planning. Cadavers can be used to simulate the anatomy and plan trajectory; however, in the operating room in the presence of active blood loss, things may not look the same.

### Conclusions

Endoscopic-assisted technique for odontoid screw fixation shall provide a minimally invasive, safe and easy surgery. In contrast to the other surgical approaches, odontoid screw fixation under direct visualization may also reduce the operation time.

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### Conflicts of interest

There are no conflicts of interest.

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