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A New Guide Tube for Odontoid Screw Fixation for Unstable Odontoid Fractures: Report of 6 Case Series

Unstabil Odontoid Kırıklarda Odontoid Vida Fiksasyon için Yeni Kılavuz Tüp: 6 Olguluk Seri

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ABSTRACT

AIM: We describe a modified form of traditional open surgery with a new guide tube. This guide tube permits anterior screwing of odontoid in a shorter time with a more simple technique as compared to traditional open surgery, endoscopic and percutaneous surgeries.

MATERIAL and METHODS: Our series includes 6 patients who were operated for unstable odontoid fracture. We used a new guide tube for anterior odontoid screw fixation. This guide tube was designed by the first author to facilitate the insertion of the K-wire for placement of a cannulated lag screw.

RESULTS: Successful placement of the odontoid screws and immediate spinal stabilization were achieved in all patients. Solid fusion was observed during follow-up time in all patients.

CONCLUSION: This screw insertion technique for odontoid screw fixation provides a minimally invasive, safe and easy surgery in contrast to other surgical approaches.

KEYWORDS: Odontoid fracture, New guide tube, Odontoid Screw fixation

ÖZ

AMAÇ: Bu çalışmada, yeni bir kılavuz tüp ile geleneksel açık cerrahinin değiştirilmiş bir formu tanımlanmıştır. Bu kılavuz tüp geleneksel açık cerrahi, endoskopik cerrahi ve perkütan cerrahi ile karşılaştırıldığında daha basit bir teknik ile daha kısa sürede odontoid anterior vidalama sağlar.

YÖNTEM ve GEREÇLER: Çalışmamız, unstabil odontoid kırık nedeniyle opere edilen 6 hastadan oluşmaktadır. Hastalarda anterior vida fiksasyonu için yeni kılavuz tüp kullandık. Bu kılavuz tüp, kanüllü yaklaştırma vidasını göndermek için, K-telinin yerleştirilmesini kolaylaştırmak amacıyla ilk yazar tarafından dizayn edilmiştir.

BULGULAR: Tüm hastalara başarılı bir şekilde odontoid vidalaması yapılarak spinal stabilizasyon sağlanmıştır. Takip sürecinde tüm hastalarda solid füzyon geliştiği görüldü.

SONUÇ: Odontoid vida fiksasyonu için kullandığımız bu teknik diğer cerrahi yaklaşımların aksine minimal invaziv, daha güvenli ve daha kolay cerrahi sağlamaktadır

ANAHTAR SÖZCÜKLER: Odontoid kırık, Yeni kılavuz tüp, Odontoid vida fiksasyon

INTRODUCTION

Odontoid fractures include 9-15% of all cervical spine fractures in adult population (6, 15). The classification of these fractures described by Anderson and D'Alonzo contain three types. Type II odontoid fractures have fracture lines at the junction of the dens and the body of the axis (1). Treatment of these fractures ranges from external fixation (10) to operative treatment with posterior fusion or anterior screw fixation (3, 14). Conservative treatment includes cervical orthoses, halo vests and jackets. However these methods are poorly tolerated in the elderly and polytrauma patients (4). Also rates of nonunion and pseudoarthrosis are between 18-97.6 percent (3). Posterior arthrodesis of C1 and C2 has high rates of fusion, but this technique reduces the rotation of atlanto-axial joints by 45-50° and flexion and extension of cervical spine by 10-15° (4, 7, 12). Anterior screw fixation of acute odontoid fractures has very high fusion rates from 80 to 100% (4, 7, 15) and preserves C1-2 rotation (4, 13, 15). Therefore, anterior screw fixation has been suggested for the treatment of type II and unstable type III odontoid fractures (4, 8, 12, 13). Since its description by Böhler in 1982 (3), anterior odontoid screwing has been in practice extensively. In addition to classic surgery, new surgical procedures and devices have been used for anterior odontoid screw fixation (2, 4, 5, 7, 8, 12, 15). Dickman (5) has mentioned the use of cannulated screws

with Kirschner wires in 1995. Apfelbaum (2) has designed a drill guide tube system. Kazan et al (8) has described the percutaneous odontoid screw fixation in a cadaveric study. Endoscopic surgery was performed in 2003 by Hashizume (7). Follow up of clinical series with percutaneous odontoid screw fixation have also been reported (4, 12, 15).

This study describes a modified form of traditional open surgery with a new guide tube. This guide tube permits anterior screwing of odontoid in a shorter time with a more simple technique as compared to traditional open surgery, endoscopic and percutaneous surgeries.

MATERIAL and METHODS

Our series includes 6 patients who were operated for unstable odontoid fracture . We used a new guide tube for anterior odontoid screw fixation. This guide tube was designed by the first author to facilitate the insertion of the K-wire for placement of a cannulated lag screw.

***Technical Description*:** The guide tube is 120 mm length with 3.2 mm outside diameter and 1.8 mm inner diameter that permits the advancement of 1 mm diameter K-wire. Proximal part has a handle that helps surgeon to hold and attach the flexible arm system during operation. This guide tube permits 164 degree radial angulation at 82 mm away from the start point and distal part has 31 mm length with a straight trajectory. Guide tube is shown in Figure 1.

Radial angulation provides greater convenience during the correction of spinal alignment, because surgeon can use the guide tube as leverage with the help of its angulation. The distal end of the guide tube is designed to be sharp, so tapping of bone is easier. Straight trajectory of distal part allows the insertion of the K-wire at an appropriate angle from anterior inferior part of the C2 body to the tip of the odontoid.

The guide tube is used with the following additional instruments as shown in Figure 2.

1- A stopping mechanism that permits the K-wire to pass through the odontoid process (till the tip of odontoid) as long as the pre-calculated length which provides security not to go beyond

2- Flexible and cannulated screwdriver

3- Table mounted flexible arm holder

4- Hammer

5- K-wire: 1 mm diameter with a sharp tip

***Surgical Technique*:** Patients are positioned in neutral supine position with slight extension of the neck. Radiolucent gauze is placed in the patient's mouth to keep it open and facilitate anterior views of the odontoid. Flexible arm holder system is mounted to the bed rail contralateral to the surgeon. Handle of the guide tube was attached to flexible arm of the retractor system. A 2,5 cm transverse skin incision is made on the medial border of the right sternocleidomastoid muscle at C4-C5 disc space level. Minimal dissection was made to expose the C4-5 disc level by separating planes between the carotid artery laterally and trachea medially. After reaching the C2-C3 disc level through dissection by palpation, the entry point, anterior inferior edge of the C2 vertebral body is marked under fluoroscopy, and the sharp end of the guide tube is placed. The guide tube is tapped gently with a hammer into the bottom edge of the C2 vertebral body (Figure 3A). Flexible arm of the retractor system is tightened and estimated trajectory of the guide tube is checked under fluoroscopy whether it reaches to the tip of the odontoid. This maneuver must be repeated until the appropriate trajectory is determined by loosening and retightening of the flexible arm of retractor system (Figure 3B).

At this stage, if necessary, spinal alignment is corrected by using the guide tube as a lever arm (Figure 4).

The K-wire is placed through the guide tube. The point where the K-wire must stop is the point of vertebral body starts. Now

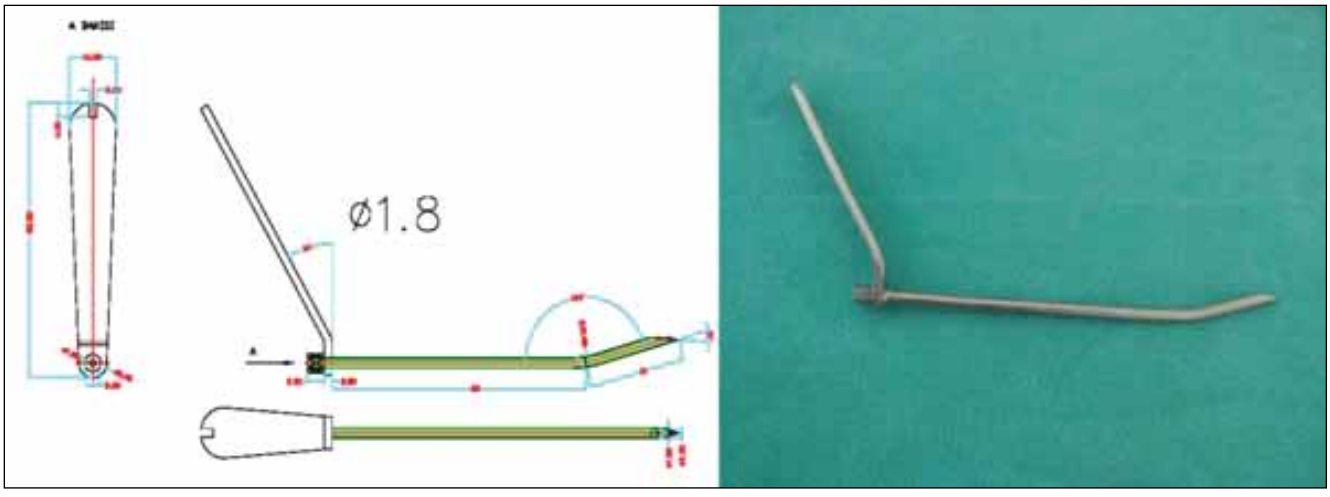

Figure 1: Guide tube that we used for anterior odontoid screw fixation.

Figure 2: The set of application tools used during surgery.

the stopper is applied to a point on the K-wire at a distance from the outer entry of the guide tube, which is same length from the edge of the C2 body to the tip of the odontoid process as calculated previously on preoperative computed tomography (CT). Following this maneuver, K-wire is advanced through the fracture line into the distal fragment of the dens and until it catches and fixes the fractured odontoid process. If the K-wire reaches to the tip of odontoid process, then it means that the length of the final screw should be equal to the length of the K-wire as the stopper indicates. If the estimated length of the K-wire passes beyond or does not reach to the tip of the odontoid process, the length of the K-wire should be tuned as the tip must end at the tip of the odontoid process. After biplanar fluoroscopic views confirm that the K-wire has reached to the tip of the dens through C2 vertebral body (Figure 5), guide tube is removed.

The cannulated titanium lag screw with appropriate length is placed over the K-wire and inserted with the cannulated screwdriver into the fractured fragment. The K-wire should not be removed until the screw approximates the distal fracture fragment of odontoid to proximal C2 body (Figure 6).

RESULTS

We used the new guide tube for anterior odontoid screw fixation in six patients with type II and unstable type III odontoid fractures. Successful placement of the odontoid screws and immediate spinal stabilization were achieved in all patients. The mean operation time was 60 minutes. We did not observe any surgical complications related to technique such as screw malpositioning, and also infection, vascular injury, non-union, mortality or morbidity. After a mean follow-up of 20 months (6-60 months), solid fusion was demonstrated in all patients. Neither screw loosening nor breakage was observed during follow-up time. Figure 7 depicts preoperative and postoperative cervical radiogram. More information about patients are shown in Table I.

Figure 3: (A) Sharp end of guide tube is placed to the bottom edge of the C2 vertebral body under fluoroscopy. **(B)** The flexible arm of the retractor system is tightened.

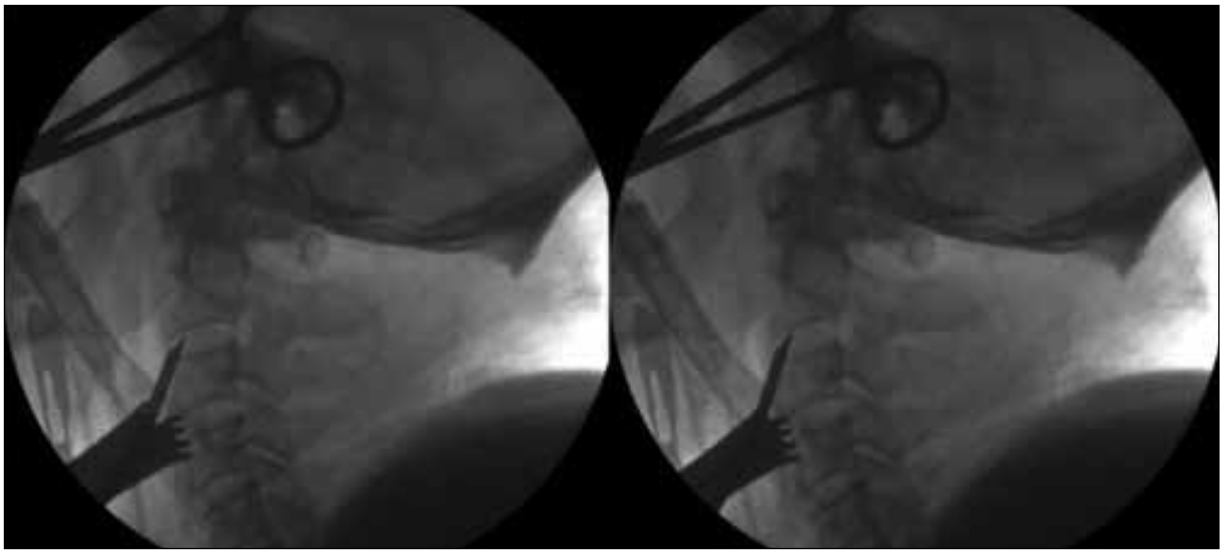

Figure 4: Correction of spinal alignment by using guide tube.

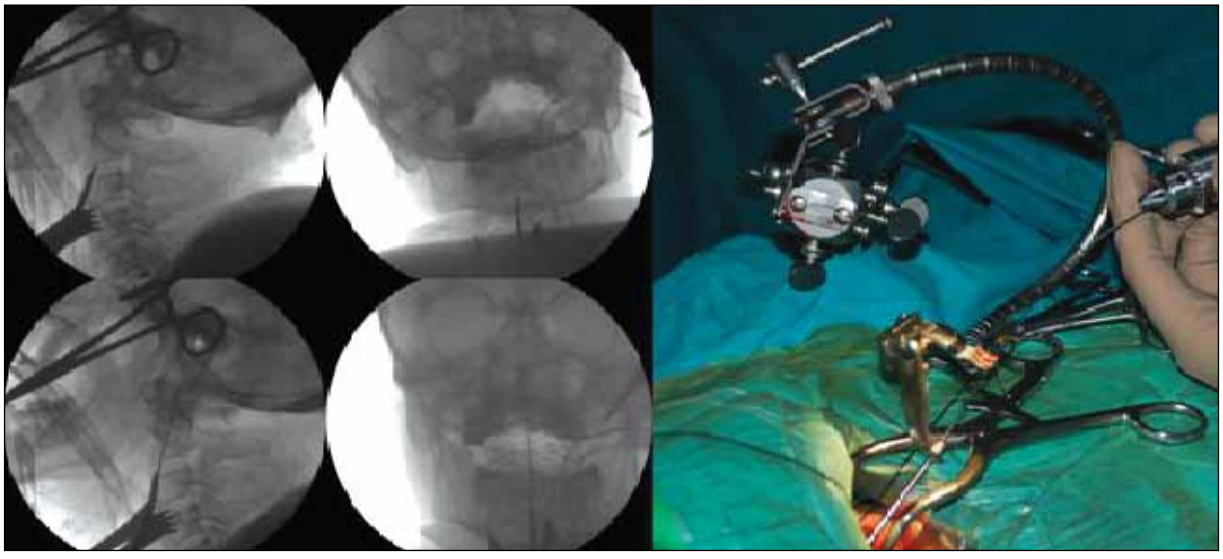

Figure 5: Moving of K-wire across the fracture into the distal fragment of the dens until it reaches to the tip of the fractured odontoid process.

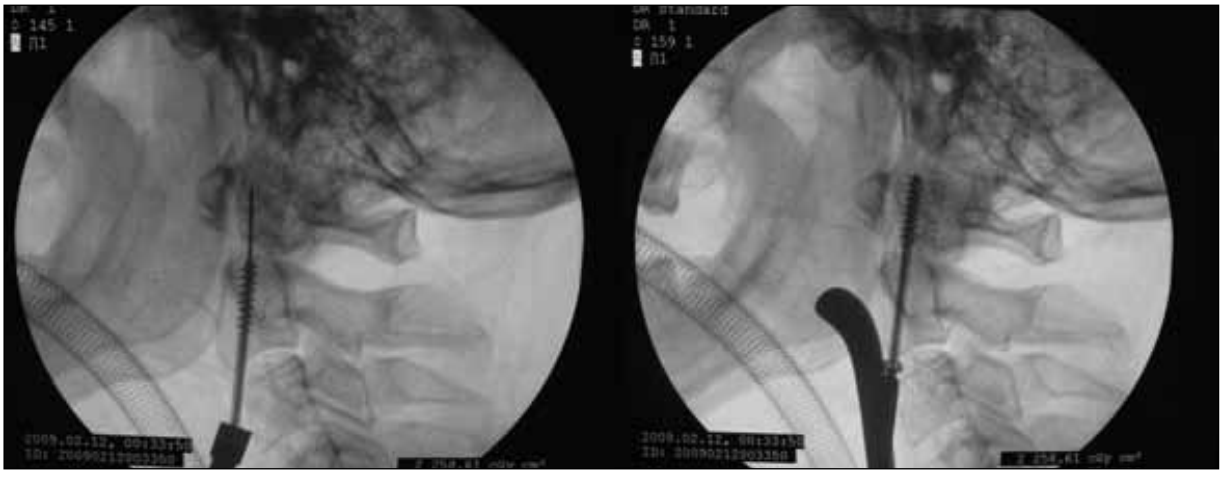

Figure 6: Cannulated titanium lag screw is placed over the K-wire.

Figure 7: Patient 6. Preoperative cervical x-ray shows unstable odontoid fracture (left), and postoperative cervical x-ray shows solid fusion after 6 months (right).

Table I: Characteristics of Patients

Age, Sex	Type of Odontoid Fracture	Follow-up	Result
43, Male	Type II, anterior dislocation	60 months	Solid Fusion
37, Male	Type II, anterior dislocation	13 months	Solid Fusion
67, Female	Unstable Type III, anterior dislocation	12 months	Solid Fusion
28, Male	Type II, posterior dislocation	15 months	Solid Fusion
64, Male	Type II, anterior dislocation	15 months	Solid Fusion
35, Female	Unstable Type III, anterior dislocation	6 months	Solid Fusion

DISCUSSION

Fractures of the odontoid process of C2 vertebra are described 20% of all fresh cervical spine fractures (6, 9). Surgery is recommended in cases with high degree of dens dislocation (> 4-6 mm), increasing age (>40-65 years), delayed diagnosis, prolonged tractions (13). Anterior odontoid screw fixation technique was first reported by Böhler in 1982 (3). In contrast to posterior surgical interventions, this approach has the advantage of preserving normal rotation in atlanto-axial joint (8). Also this technique allows a physiological treatment that enables a direct osteosynthesis of the odontoid fracture with fusion rates from 85 to 100 percent (4, 15). These factors have made direct anterior odontoid screw fixation as a popular technique in treatment of odontoid fractures.

In recent years new devices and new surgical procedures have been used for this purpose (2, 4, 5, 7, 8, 12, 15). Hashizume et al have reported that using an endoscope makes anterior screw fixation a safer and less invasive than the classic anterior retropharyngeal approach (7). But the main obstacle in endoscopic technique is that vision often becomes blurred due to bleeding and surgeon needs more experience (4). Kazan et al. have described a new instrument and a percutaneous technique for closed anterior fixation of odontoid fracture by using a telescopic tube system in a cadaveric study (8). In addition to those reports, Chi (4), Sucu (12) and Wang (15) have reported availability of percutaneous technique in clinic studies. Chi et al. have treated 10 patients with odontoid fracture by percutaneous anterior odontoid fixation under fluoroscopic guidance. Authors have described this method as a safe, useful and minimal invasive technique and it decreases blood loss, postoperative pain and provides much quicker recovery (4). Wang et al. have compared percutaneous and open anterior screw fixation in 42 patients. Although there was no statistical difference in radiation exposure time and clinical outcomes between two groups, operating time and intraoperative blood loss were significantly lower in percutaneous group than open group. Therefore the authors have recommended the use of percutaneous method over open technique. The same

authors have, however done a self-criticism by reporting their technique had a steep learning time and surgeons must first gain sufficient experience on cervical minimally invasive surgery (15). Otherwise damaging of soft tissues, vascular and neural structures might occur during drilling and tapping, because percutaneous procedure is performed without direct visualization (4). In our technique, however, any surgeon with experience of conventional anterior cervical approach can use the guide tube easily with a short learning time, since it is not a blind technique and surgeons can reach the vertebra in a safer way.

Other advantage we present in this paper is the table-mounted retractor system which allows surgeon to stay away from the radiation field. In addition, reaching the C2-3 disc space may be performed by a 2 cm skin incision, and this approach should be regarded as a minimally invasive surgery. A previous anterior neck surgery is an absolute contraindication for percutaneous procedure (4), but it is not with the technique we present here. Shortcomings such as short neck, cervical kyphosis and barrel chest deformity which causes difficulty to give appropriate angles to K-wire on the sternum and clavicle (4), are not big problems with this technique. Our guide tube has a radial angulation and distal part with straight trajectory. So it is easier to move K-wire in an ideal plane for surgeon.

While Wang et al. have used Gardner-Wells tong skull traction for reduction of cervical alignment (15). Sucu et al. have achieved normal alignment through manual flexion and extension of the patient's head (12). Piedra et al. have achieved reduction by a closed transoral and posterior cervical manual pressures (11). Probably the most useful part of our guide tube is to use it as a lever arm which provides significant tool for correction of spinal alignment, so we do not need additional manipulations for reduction.

CONCLUSION

This screw insertion technique for odontoid screw fixation provides a minimally invasive, safe and easy surgery. In contrast to other surgical approaches, odontoid screw fixation with this new guide tube does not require more experience in addition to traditional open surgery, reduces the operation time and radiation exposure during surgery.

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