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C1–2 POSTERIOR STABILIZATION IN ODONTOID FRACTURES

ODONTOİD KIRIKLARINDA C1-2 POSTERİOR STABİLİZASYON

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SUMMARY

Odontoid fractures represent 9–15% of adult cervical fractures. These injuries have high mortality and morbidity rates. Surgery is recommended, particularly for type 2 fractures, because of high non-fusion rates and instability. Ten cases that received surgery at the Uludag University School of Medicine Department of Neurosurgery in 2010 due to odontoid fractures were examined retrospectively. Eight of the patients were men and two were women. The mean age was 54.1 (range: 35–80) years. The etiologies of the fractures were traffic accidents in four cases, falling from a height in four cases, and one case of a sporting accident, while one patient had no history of trauma. In preoperative examinations, there was no neurological deficit for eight patients, but two patients had tetraparesis. All patients received fixation surgery with lateral mass screws. There were no postoperative complications. The advantages of this technique are rotational stability, a low neurological injury rate, and a requirement for low amounts of bone grafts. There was no non-fusion in the long-term follow-up. This study suggests that posterior cervical stabilization with lateral mass screws performed by experienced surgeons is a good treatment alternative for odontoid fractures.

Key words: Lateral mass screw, odontoid fracture, posterior segmental stabilization

Level of evidence: Retrospective clinical study, Level III

ÖZET

Odontoid kırıkları erişkin yaş grubunda servikal kırıkların % 9-15'ini oluşturur. Bu yaralanmalar yüksek mortalite ve morbidite ile beraberdir. Yüksek kaynamama oranı ve instabilite nedeniyle özellikle tip 2 kırıklar için cerrahi önerilmektedir. İki bin on yılı içinde Uludağ Üniversitesi Tıp Fakültesi Nöroşirurji Ana Bilim Dalında odontoid kırığı nedeniyle cerrahi olarak tedavi edilen 10 olgu retrospektif olarak incelendi. Sekiz hasta erkek, 2 hasta kadın idi. Yaş ortalaması 54.1 (En az 35, en çok 80) idi. Olguların 4 (% 40)'ı trafik kazası nedeniyle, 4'ü düşme nedeniyle başvururken 1 hastanın etyolojisinde travma yoktu. 8 hastanın ameliyat öncesi nörolojik muayenesinde defisit izlenmezken, 2 hastada tetraparezi mevcuttu. Tüm hastalara lateral mass vidası ile fiksasyon uygulandı. Hiçbir hastada komplikasyon gelişmedi. Bu tekniğin rotasyonel stabiliteyi sağlamasındaki kuvveti, nöral hasar riskinin düşük olması ve az miktarda kemik greft gerektirmesi üstünlükleridir. Vakalarımızda uzun dönem takipte füzyon olmayan hasta izlenmedi. Lateral mass vidası ile posterior servikal stabilizasyon deneyimli ellerde odontoid kırıklarının tedavisinde iyi bir seçenektir.

Anahtar kelimeler: Lateral mass vidası, odontoid kırığı, posterior segmental stabilizasyon

Kanıt Düzeyi: Retrospektif klinik çalışma, Düzey III

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INTRODUCTION

Atlantoaxial instability can occur due to trauma, infection, tumor, arthritis, congenital anomalies, iatrogenic reasons (odontoidectomy), or rare conditions[2]. Odontoid fractures comprise 9–15% of adult cervical fractures. These injuries have high mortality and morbidity rates. Surgery is recommended, especially for type 2 fractures, due to high non-fusion rates and instability. Surgical methods applicable to this region are still continuing to develop. The most commonly used techniques in recent years are connection of C1 and C2 together with wires, C1–2 transarticular facet screws, and stabilization with C1–2 lateral mass screws.

A surgical method defined by Goel and Laheri in 1994 is the posterior segmental atlantoaxial fusion method with a C1 lateral mass screw and a C2 pedicle screw[7]. This technique was improved by Harms in 2001 by posterior fusion with a C1–2 polyaxial screw-rod system[8,9]. The application of posterior C1–2 fusion is the most significant improvement to posterior fusion surgery of the upper cervical region. The fusion techniques that are applied to this region are complex and require deep knowledge of the surgical anatomy. However, the C1–2 screw-rod system provides nearly 100% fusion[9]. Goel developed this technique and reported 100% fusion and minimal complication rates[10].

In this study, we aim to retrospectively evaluate patients who received posterior fusion surgery in 2010 using a C1–2 lateral mass screw due to odontoid fractures.

MATERIALS AND METHODS

Ten cases treated for odontoid fractures in the Neurosurgery Department of the Medical School of Uludağ University in 2010 were retrospectively evaluated. The complaints of the patients, neurological examinations, presence of complications due to surgery, and presence of stabilization in early postoperative X-rays were examined.

Surgical Technique

Patients received surgery in a prone position, with the head secured in the midline with slight flexion. After a midline skin incision, the spine was revealed from the skull to the C5 level. The C1 posterior arch was explored towards the lateral edges. The muscles were dissected to the C1–2 level, as placement of the C1 mass screw required the C1–2 joint junction to be revealed. During this process, bleeding from the venous plexus was controlled with Surgicel and bipolar forceps. After revealing the border of the C1–2 joint, a unicorticol hole was opened to the inferior border of the C1 posterior arch with a high-speed drill.

The drill was moved to the anterior towards the C1 lateral mass. The screws were placed with fluoroscopy. After revealing the posteromedial part of the pedicle of the C2 vertebra, a burr hole was opened using a drill without any damage to the C2 root. The screws were placed with fluoroscopy. After controlling screw placement at the antero-posterior site, the layers were closed in a way compatible with their anatomies.

RESULTS

Eight of the ten patients included in this study were male and two of them were female. The mean age was 54.1 (range: 35–80) years. While four of the cases (40%) were admitted due to a traffic accident, four were admitted due to falling from a height, one was admitted due to a sporting accident, and the etiology of the fracture of the remaining patient was not known. In preoperative neurological examinations of eight of the patients there was no deficit, while two patients had tetraparesis. Fixation with a lateral mass screw was applied to all patients (Figure-1). There were no complications in any of the patients (Table-1). There was no need for any revision surgery. Stabilization was observed in routine postoperative early cervical lateral X-rays. The mean follow-up period was 13.5 months.

Table-1. Demographic features of the patients

Patient	Gender	Reason	Pathology	Neurological examination	Operation	Complication
47y	M	Traffic accident	Type II odontoid fracture	No deficit	C1-2 lateral mass	Ø
35y	F	Sport accident	Type II odontoid fracture	No deficit	C1-2 lateral mass	Ø
62y	M	Traffic accident	Type II odontoid fracture	Paraplegia		Ø
41y	M	Traffic accident	Type II odontoid fracture	No deficit	C1-2 lateral mass	Ø
58y	M	-	Os odontoideum	No deficit	C1-2 lateral mass	Ø
54y	M	Falling from high	Type II odontoid fracture	No deficit	C1-2 lateral mass	Ø
57y	M	Traffic accident		No deficit	C1-3 lateral mass	Ø
43y	F	Falling	Type II odontoid fracture	Tetraparesis	C1-2 lateral mass	Ø
64y	M	Falling	Type II odontoid fracture	Tetraparesis	C1-2 lateral mass	Ø
80y	M	Falling	Type II odontoid fracture	No deficit	C1-2 lateral mass	Ø

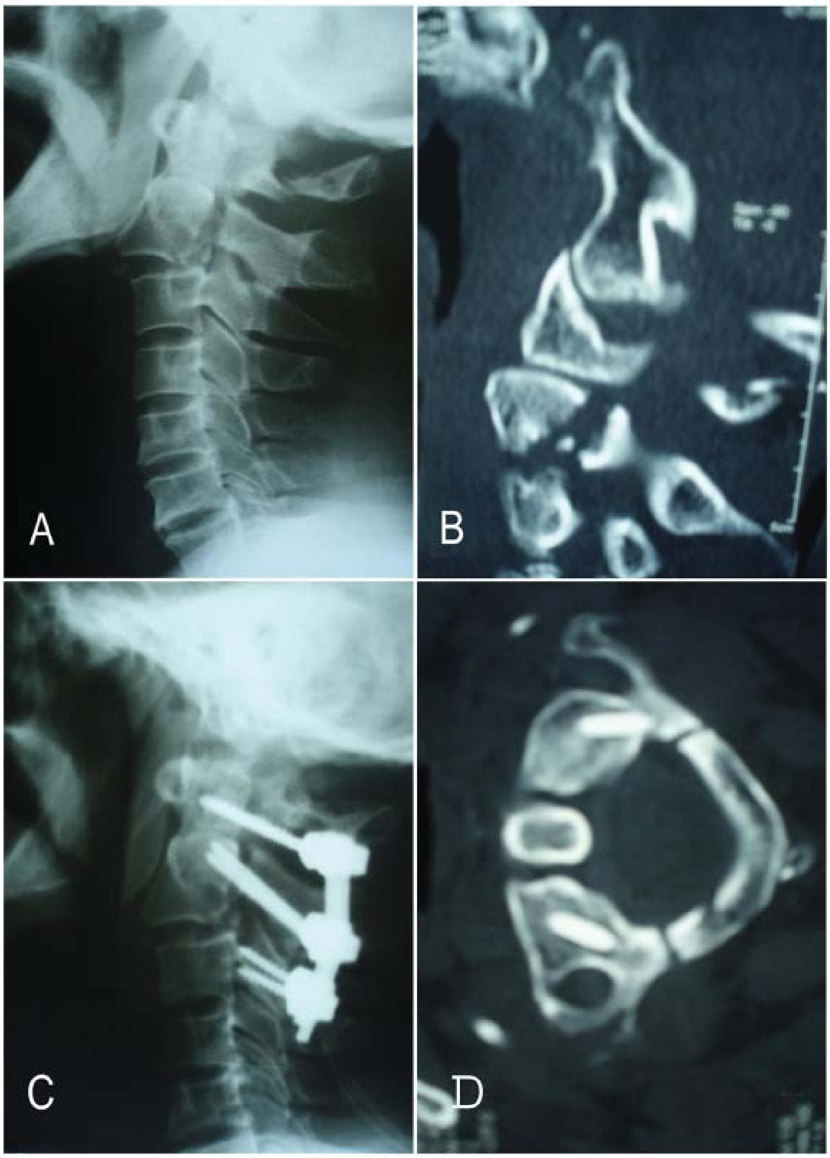

Figure-1. a. Preoperative lateral cervical X-ray, **b.** Preoperative reconstructed computerized tomography **c.** Postoperative lateral cervical X-ray, **d.** Postoperative axial cervical computerized tomography of a male patient aged 57 with a type 2 odontoid fracture.

DISCUSSION

Atlantoaxial instability can occur due to trauma, malignancy, congenital malformation, or inflammatory disease. The best absolute reduction of atlantoaxial subluxation, clinically and radiologically, is provided by stabilization of the C1–2 joint.

While the incidence of subaxial cervical spinal fractures reduces with age, the incidence of odontoid fractures increases[4]. The most common cervical fractures in patients over 70 are odontoid fractures[28,34,38]. Unlike young patients, these fractures are low-energy fractures, caused by events such as falling from a height. The damage mechanism is hyperextension that occurs due to displacement of the odontoid to the posterior.

The treatment of odontoid fractures depends on many factors, such as fracture type, age of patient, and comorbidity of patient[36]. Treatment is still controversial. Odontoid fractures are grouped into four by Anderson and D'Alonzo[1]:

Type 1: oblique fracture at the top of the odontoid projection;

Type 2: fracture at the base of the odontoid projection;

Type 2A: fracture of the base of the odontoid projection with a free bone piece (Hadley);

Type 3: odontoid fractures covering the axis body.

According to this classification, many treatment schemes have been prepared. Classically, type 1 fractures have been treated with conservative methods, while type 3 fractures require anterior or posterior stabilization.

The treatment of type 2 fractures is controversial[12,30,36,38.] In patients who did not receive surgery, the non-fusion rate has been reported to be 35–85%, despite halo vest immobilization[28,38]. Many authors consider patient age to be a risk factor for non-fusion in halo immobilization[3,31,38]. Important factors for non-fusion of type 2 fractures have been reported to include a displacement of more than 4 mm (the most important factor indicating the success of non-surgical treatment), displacement to the posterior, an age of 40 or more, a diagnosis at later than three weeks, and a fracture angle of more than 10° [24,36]. Forward dislocation, gender, and neurological deficits were not found to be related to non-fusion[24,34,36-38]. In odontoid fractures, early surgical treatment can prevent late-onset progressive myelopathy that can develop secondarily to non-fusion[6]. Surgical treatment also prevents complications depending on halo use, such as screw site infection, brain abscess, skin disruption, facet joint stiffness and disruption of the spinal angle[23]. Other authors have also stated that surgical treatment of type 2 fractures significantly reduces mortality in elderly patients[3,31]. Some authors suggest surgical treatment for patients aged over 50 years[38].

Atlantoaxial fixation can be surgically applied using a transoral, anterior retropharyngeal, lateral or posterior approach[17].

Posterior interspinous fusion with sublaminar wires and iliac bone grafts was first defined by Gallie in 1939 [14]. The wiring method is cheap, its long-term results are clear and it does not need fluoroscopy or experience, but it has a high risk of increasing any neurological deficit[19]. This method was then modified with the connection of the bilateral iliac grafts with sublaminar wires by Brooks and Jenkins[5]. In 1991, Sonntag modified the technique by placing the wire under the posterior arch of C1 and around the spinous process of C2, in order to reduce the risk of spinal cord damage at the C2 level[22]. 60–100% fusion rates were reported with this posterior wiring method[11,13]. However, the need for postoperative long-term halo immobilization, the risk of intraoperative damage to the vertebral artery and the spinal cord, and the need for steady vertebral anatomy are disadvantages of this method[23]. Additionally, it is not sufficient for osteoporotic patients, cases with unsteady posterior elements, or when rigid fixation is required[21]. This method is rarely applied for patients with a broken cervical axis secondary to degenerative cervical spondylosis. The transarticular screw technique developed by Magerl and Seemann provides more stability for rotational movement, but shows similar results to wiring for antero-posterior translational movement[15,16]. Another important property of this technique is no requirement for steady posterior elements. Limitations of this technique include anatomical variations, such as a medially-located vertebral artery, severe cervicothoracic kyphosis, or C1–2 subluxation that cannot be redacted[39]. The three-point fixation technique provides better stabilization, where transarticular screws are combined with wiring, but there is a risk of neural damage with this method as the sublaminar wires are passed under the lamina[20,21,39]. The main advantages of the C1 lateral mass and C2 pedicle screwing technique defined by Goel et al. and popularized by Harms et al. are that the risk of damage to the vertebral artery and spinal cord is minimum, there is no need for integrity of the C1 or C2 posterior elements, and there is no need for rigid stabilization such as a postoperative halo-vest[7,18]. Concurrently, polyaxial screw-rod systems can be used for occipitocervical fusion, when necessary. It has been shown that the traction of the C1 lateral mass screws is equal to the traction of the C2 pedicle screw[19]. There can be more bleeding from the vertebral venous plexus, and this can extend the duration of surgery[26].

The anatomy of the C1 and C2 vertebrae shows differences to other all vertebrae. The height and width of the C1 and C2 lateral masses should be calculated in the preoperative period and suitable screws should be prepared before surgery. The venous plexus covers the C1 lateral mass, vertebral artery and the C2 root. In a cadaveric study by Rocha et al., they reported that the middle of the lateral mass was an ideal place for the entry of the C1 screw[29]. The width of the C1 lateral mass was recorded to be 7.7–12.8 mm and the height was 4.3–6.1 mm[29]. Another advantage of the lateral mass technique is that no damage occurs to the C1–2 facet joint. Temporary fixation can also be used in cases that require it, such as rotatory subluxation.

Primary neurological deficits are rare for patients with odontoid fractures, but can be serious, ranging from cranial nerve damage to quadriplegia[25]. In the surgical treatment of odontoid fractures, anterior surgery has the advantage of protecting rotational movement in the atlantoaxial joint. However, this approach has many complications, such as nerve or vessel damage, esophageal and pharyngeal perforation, and airway obstruction[25, 35].

Movement at C1–2 is primarily rotation. Use of a halo-vest has complications such as screw entry site infection, osteomyelitis, nerve damage, dural penetration, BOS leakage, intracranial abscess, dysphagia and the restriction of breathing[25,32]. Elderly patients tend to tolerate halo use more poorly[27].

The pedicle screwing technique is more difficult than other methods and there is a risk of perforating cortical bones[18]. There is also a risk of damage to the adjacent spinal cord and vertebral artery due to their anatomical proximity. Although lateral mass screw placement is close to these anatomical structures, it is accepted as a safer method than other techniques[10].

While Goel suggested bipolar coagulation for venous plexus bleeding occurring around the occipital nerve, Harms and Melcher suggested caudal retraction and control of the bleeding with a tampon[40]. In our study, we preferred to control bleeding using a tampon with Surgicel and rapid screw placement, instead of coagulation. With this method, we tried to reduce any occipital hypo/anesthesia, which can be observed in the postoperative period.

While there was no hypo/anesthesia in any patients, two patients had temporary occipital hypoesthesia. There was no need for blood transfusion for any of the patients.

Some authors have stated that supporting fusion performed using a posterior screw with wiring can give better results[2]. However, the placement of the wires is open to complications. There have been studies stating that the wiring process can cause myelopathy, especially for patients with os odontoideum and rheumatoid arthritis[4]. We did not perform any wiring for patients in addition to the lateral mass screws.

In conclusion, in our study on a small number of cases, we state that the application of posterior cervical stabilization using lateral mass screws by experienced surgeons is a good treatment alternative for odontoid fractures.

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