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Clinical Results of Anterior Odontoid Screw Fixation for Type II Odontoid Fractures

Odontoid Tip II Kırıklarında Anterior Odontoid Vida Fiksasyon Uygulanan Olguların Klinik Sonuçları

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ABSTRACT

AIM: In this study, 31 patients with a diagnosis of Type II odontoid fractures were reported. All patients were treated with anterior transodontoid screw fixation and clinical outcomes were reported.

MATERIAL and METHODS: In this study, the retrospective clinical analysis of 31 patients with traumatic type II odontoid fractures who were treated through anterior transodontoid fixation in Neurosurgery Department at VKV American Hospital between 1998 and 2012 was performed. The age, sex, cause of injury, diagnosis time, neurological examination before and after surgery, follow-up period were evaluated. The neurological status of patients was classified according to the Frankel scale.

RESULTS: In 4 patients, 2 transodontoid screws were inserted. The mean hospital stay was 3.35 days. Posterior occipito-cervical fusion was done in 1 patient due to the lack of fusion in the first operation. No vascular injury, screw malposition, infection, neurologic deterioration, or complications were observed during the peroperative and postoperative stage. The mean postoperative follow-up period was 36 months after surgery. Radiological imaging of patients were performed at the early and late postoperative stage.

CONCLUSION: We found satisfying fusion rates and better patient comfort during the postoperative period. We think that stabilization and fusion through a transodontoid screw is a minimal invasive method.

KEYWORDS: Anterior, Type II odontoid fracture, Minimally invasive, Odontoid screw fixation

ÖZ

AMAÇ: Çalışmada, Tip II odontoid fraktürü tanısı alan 31 olgu bildirilmiştir. Olguların hepsi anterior transodontoid vida fiksasyonu ile tedavi edilmiş ve klinik sonuçları bildirilmiştir.

YÖNTEM ve GEREÇLER: Çalışma, VKV Amerikan Hastanesi Nöroşirürji Bölümü'nde 1998-2012 yılları arasında travmatik tip II odontoid kırığı nedeniyle anterior transodontoid fiksasyon ile cerrahi tedavi uygulanan 31 hastanın retrospektif klinik analizleri yapılmıştır. Tüm olguların yaş, cinsiyet, travma nedeni, teşhis zamanı, cerrahi girişim öncesi ve sonrasında nörolojik muayeneleri, takip süresi değerlendirilmiştir. Olguların nörolojik durumları Frankel skalasına göre sınıflandırılmıştır.

BULGULAR: Dört hastaya 2 adet transodontoid vidası yerleştirildi. Hastanede kalış süresi ortalama 3,35 gün idi. 1 hastada postop takibinde füzyon oluşmaması nedeniyle ikinci bir operasyon ile posteriordan oksipitoservikal füzyon yapıldı. İşlem sırasında ve sonrasında damar yaralanması, vida malpozisyonu, enfeksiyon, nörolojik bozulma gibi komplikasyonlar izlenmedi. Hastalar ameliyat sonrasında ortalama 36 ay takip edildi. Hastaların erken ve geç dönemde radyolojik görüntülemeleri yapıldı.

SONUÇ: Postoperatif dönemde hastaların takiplerinde tatmin edici füzyon oranı ve hasta konforunun daha iyi olduğunu saptadık. Tip II odontoid kırıklarının cerrahi tedavisinde minimal invaziv yöntem olan transodontoid vida ile fiksasyonun yüksek avantajlarından dolayı ilk seçenek olabileceğini düşünüyoruz.

ANAHTAR SÖZCÜKLER: Anterior, Tip II odontoid kırığı, Minimal invaziv, Odontoid vida fiksasyon

INTRODUCTION

Odontoid fractures make up 9-15% of cervical fractures (22, 34, 36). The injury generally occurs as a result of strong flexion and extension movement in addition to axial overload. Flexion generally results in anterior subluxation, while extension results in posterior subluxation (8, 27). Anderson and D'Alonzo classified the odontoid fractures into 3 groups according to their types (3). The most frequently observed type is type II fractures and they are thought to be unstable (3). Cervical orthosis or immobilization with a halo brace are

options in the conservative treatment of stable type I and type III odontoid fractures. However, type II odontoid fractures have the risk of non-union when they are not diagnosed or treated conservatively with external immobilization. These cases may turn into chronic odontoid fractures 6 weeks later (2). In such fractures, spontaneous fusion is rarely observed with conservative treatment and usually requires surgical treatment. The most frequently applied surgical methods are C1-2 posterior transarticular screwing and posterior C1-2 wire fixation with fusion in type II fractures (28). Anterior transodontoid screw fixation, a minimal invasive method, should be the first choice for surgical treatment of type II odontoid fractures. In this study, 31 patients with type II odontoid fractures treated with anterior screw fixation were reviewed.

MATERIAL and METHODS

In this study, the retrospective clinical analysis of 31 patients with traumatic type II odontoid fractures who were treated through anterior transodontoid fixation at the Neurosurgery Department at VKV American Hospital between 1998 and 2012 was performed. The age, gender, mechanism of injury, length of hospitalization, time for surgery, duration of operation, general status, neurological examination, and the length of follow-up for all the cases were evaluated. Patients with pathological fractures secondary to inflammation or tumours were excluded. Plain radiography (X-Ray), computerized tomography (CT) and magnetic resonance imaging (MRI) were performed in all patients preoperatively. All the patients were evaluated with X-Ray and CT after surgery for screw positioning. At the 3- and 12-month follow-up, flexion and extension X-Ray and CT scans were performed to confirm bony fusion.

The neurological status of the patients was classified according to the Frankel scale (15) and divided into 5 groups: 1- motor and sensory total loss below the level, 2- total motor loss and partly preserved senses, 3- motor and sensorial function exist but unable to use motor function, 4- motor function exists but there is abnormal motor function, and 5- neurological examination is normal.

Surgical Procedure

The transodontoid screwing technique was first defined by Apfelbaum (15). All our patients were intubated through fiberoptic nasotracheal tubes in the supine position. Biplanar fluoroscopy and the O-arm were prepared before the operation. For reduction and alignment of the dens, Gardner-Wells traction (2-3 kg) was applied in 4 patients. Transverse skin incision was carried out at the level of the C5-6 disc space. The prevertebral region was approached through blunt dissection, the C2-3 disc level was approached and cervical retractors were placed. Then, 2 mm threaded K-wire was advanced under biplanar fluoroscopy at enough length throughout the midline at the bottom and front edge of C2 vertebra. At the next stage, the place of the screw was prepared using high-speed drill towards the edge of the dens throughout the fracture line. In convenient cases, the same procedures were repeated on the left and right sides of the entrance if a second screw will be necessary. All the processes were performed with the guidance of biplanar fluoroscopy and the O-arm. After drilling the C2 body and dens, 1 or 2 odontoid screws were inserted. The mean operation time was 70 minutes and blood replacement was not needed in the patients. There were no complications during surgery.

RESULTS

The mean age of the patients in the study was 43.75 (between 16 and 78) years and the male/female ratio was 19/12. The mechanism of injury was as follows: 23 cases due to traffic

Figure 1: Preoperative cervical spine x-ray showing Type II odontoid fracture.

accidents (74.2%) and 8 cases due to falling from heights (25.8%). The most frequent symptom observed during the primary examination was neck pain and all the patients suffered from pain. Headache accompanied the neck pain in 6 cases. The mean length of hospitalization was 3.35 days. 2 screws were applied for 4 patients, and 1 screw applied to the others. All the clinical findings are summarized in Table I.

Thirty-one patients with a diagnosis of type II odontoid fractures were treated with transodontoid screws. The patients were followed for a mean duration of 32 months after the operation. A second operation and occipitocervical fusion was performed in 1 patient because of the lack of fusion. Pseudoarthrosis was detected radiologically in one patient, however no surgery was carried out since there were no clinical findings. No complications such as vascular injuries, malposition of screws, infections, neurological problems and non-union were diagnosed during and after the surgery. In the early or late follow-up of the patients, adequate radiological fusion was observed.

DISCUSSION

Odontoid fractures generally occur as a result of major trauma such as traffic accidents and falling from heights. However,

Table I: Patients' Clinical Findings

Patient no.	Age (yrs)	Gender	Cause of injury	Time of diagnosis (days)	Input Frankel score	Length of hospitalization (days)	Follow up (months)	Output Frankel score
1	50	M	TA	19	5	3	33	5
2	53	M	TA	10	5	2	40	5
3	78	F	FD	4	5	4	10	5
4	16	M	TA	1	5	3	26	5
5	27	F	TA	1	5	5	24	5
6	29	M	TA	2	5	2	25	5
7	48	M	FD	1	5	4	48	5
8	36	M	TA	20	5	5	10	5
9	45	K	FD	2	5	3	38	5
10	30	F	TA	1	5	3	22	5
11	34	M	TA	1	5	5	8	5
12	32	M	TA	1	5	2	14	5
13	68	M	TA	1	5	3	62	5
14	72	F	FD	3	5	5	24	5
15	25	F	TA	1	5	2	55	5
16	27	M	TA	1	5	2	38	5
17	17	M	TA	1	5	3	17	5
18	23	M	TA	1	5	3	32	5
19	25	M	TA	7	5	3	23	5
20	46	F	TA	1	4	4	50	5
21	17	M	FD	15	5	4	28	5
22	50	F	TA	3	5	3	20	5
23	50	F	TA	15	5	4	60	5
24	23	M	TA	1	5	2	36	5
25	62	F	TA	1	5	4	48	5
26	17	M	TA	1	5	2	33	5
27	71	F	FD	1	5	5	36	5
28	23	M	TA	30	5	3	48	5
29	44	M	FD	11	5	4	11	5
30	45	M	FD	2	5	2	18	5
31	65	F	TA	5	3	5	44	4

M: *Male,* ***F:*** *Female,* ***TA:*** *Traffic accident,* ***FD:*** *Falling down.*

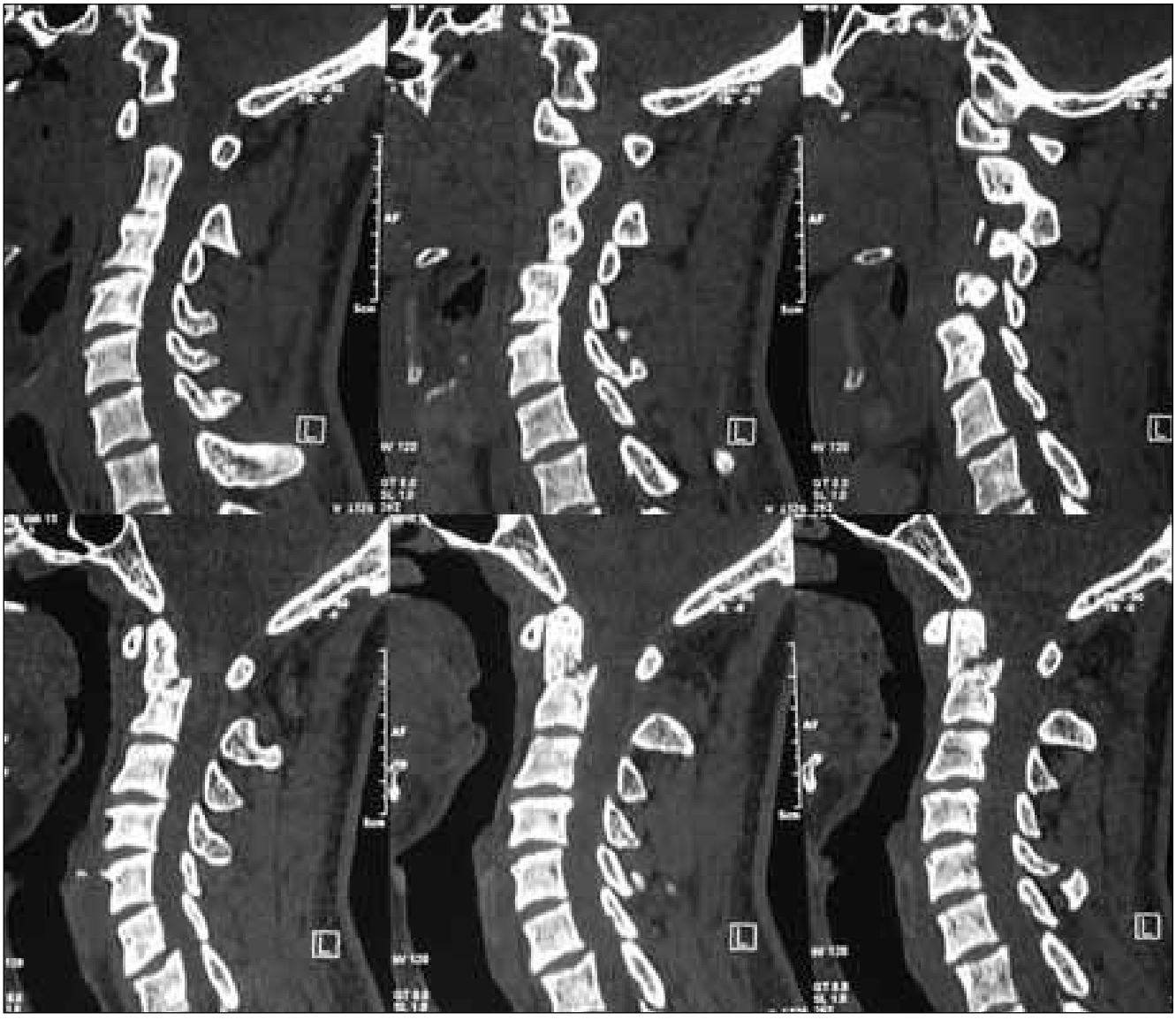

Figure 2: Sagittal cervical spine CT reconstruction showing Type II odontoid fracture.

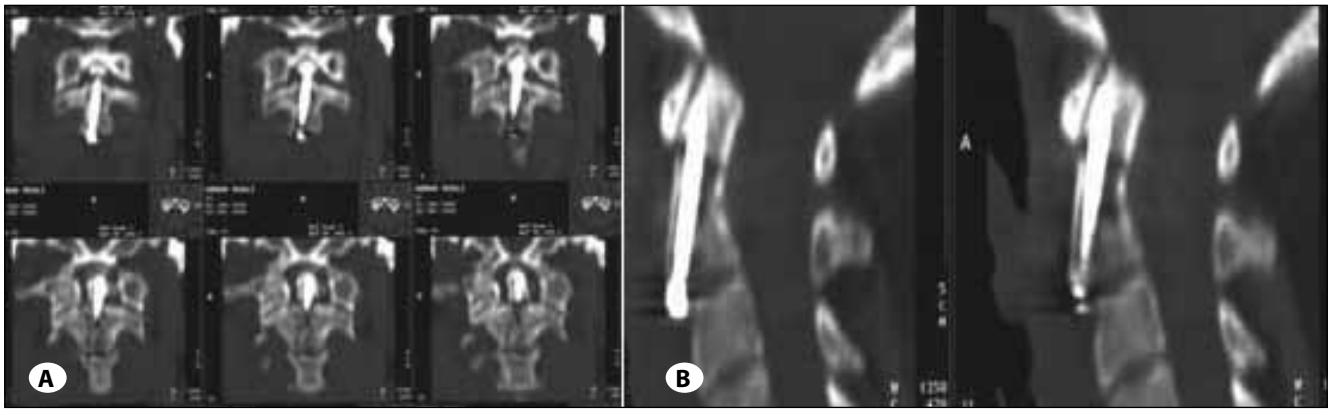

Figure 3: Postoperative cervical spine **A)** coronal and **B)** sagittal CT images showing odontoid fracture fixed with a screw.

such fractures may be observed during later ages as a result of traumas with lower amount of energy. Type II odontoid fractures have morbidity and mortality rates of about 6% (10). In our study, there were 23 cases of traffic accidents and 8 cases of falling from heights. The treatment of type II odontoid fractures is still being discussed of spine surgery. The most important problem is to make the decision to treat. The spinal surgeon has to choose one of the surgical or conservative treatment methods. For patients for whom the surgical treatment is favorable, the most convenient surgical method has to be determined.

In order to detect additional spinal injuries accompanying odontoid fractures, all vertebras and spinal channel should be scanned through imaging methods. In a study carried out earlier, the rate of injuries of other vertebras accompanying the odontoid fractures was reported as 34% (17). Since direct graphs are limited to showing anomalies in the upper cervical region and the pathologies in the cervico-thoracic junction region, the primary imaging method should be computerized tomography (CT) imaging (7,11,32). In the axial scan of CT, transverse fracture line may not be noticed. For that reason, the spine also should be scanned in sagittal and coronal plans. Moreover, magnetic resonance imaging (MRI) should be performed in patients with neurological deficits and in order to observe the continuity of transverse and alar ligaments. All the patients in our study group were scanned with complete spinal imaging.

Richter et al. compared 4 different orthosis types in their biomechanical study they performed on fresh cadavers, and stated that a Halo brace provided a more rigid fixation in

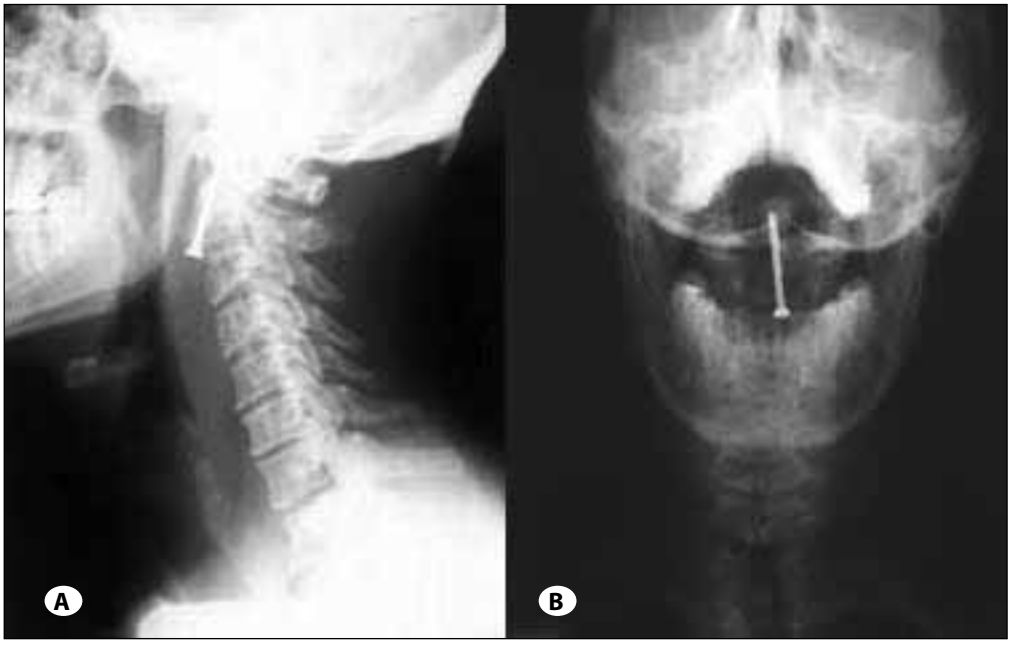

Figure 4: A) Lateral and **B)** anteroposterior x-ray of an odontoid fracture fixed with a screw.

Figure 5: Lateral **A)** flexion, **B)** extension radiographs 9 months after the operation.

unstable upper cervical traumas and it should be regarded as the primary option in conservative treatment (29). However, halo braces have some disadvantages. They may cause some problems such as infection on the site where the nail enters, development of osteomyelitis in the calvarium, loosening in the places where nails are implanted, and injuries of pressure. In older patients, the complication rates of halo braces in some patients may increase to 26%. Moreover, fusion may not be obtained in some patients and this problem occurs in 26% to 80% (14, 26, 31, 33, 35).

The most frequently observed problem in type II odontoid fractures is the difficulty in the formation of fusion. In the chronic Type II odontoid fractures and late-diagnosed cases, the difficulty of spontaneous fusion due to sclerosis that occurs on both sides of the fracture line becomes a significant problem. In such cases, a K wire with a narrow diameter is inserted on the surface of the vertebral column towards the sclerotic odontoid surface and passes the sclerotic band four or five times in order to support the development of fusion by damaging the surface on both sides; thus, fusion may achieved in such late-diagnosed patients (25). If the gap between the fracture and vertebrae is more than 6 mm, this space affects the formation of fusion negatively. Apuzzo et al. found the non-union rates of fractures to be 33% in the cases with dislocations more than 4 mm in their series of 45 patients (6). The dislocation gap of the dens is also an important factor for fusion in patients with a brace. In their series of 107 patients, Hadley et al., reported the non-union rates in patients who had a dislocation over 6 mm as 67% while the rate was 9% for dislocations below 6 mm (5). Moreover, age is another important factor and spontaneous fusion rates decrease after the age of 40 (13,14,16,18,19).

Another surgical approach is bone graft fusion through posterior C1-2 wiring. It has first been used in 1910 when Mixter and Osgood combined the posterior arch of the patient with atlantoaxial dislocation using the spinous process of the axis. Only wiring or fusion methods without using wires were also defined (23, 24). However, external support is required and it carries the risk of translational deformity until the fusion develops. Although satisfying fusion rates have reported, non fusion has been demonstrated in a high percentage of patients after these operations (26).

Another alternative surgical technique is the posterior C1-2 transarticular screwing. Using this method, a stronger stabilization may be achieved. However, normal atlantoaxial rotation is limited with C1-2 fixation after these posterior approaches and pain may occur during neck movements (4,9). Serious complications such as vertebral artery injuries may also occur. As a result, posterior approaches employ problems such as limiting the atlantoaxial rotation and flexion/extension movement of neck, postoperative neck pain, necessity of bone graft for fusion and the risk of vertebral artery damage although they provide a strong stabilization (37).

In recent years, posterior approaches have been substituted with anterior transodontoid screw fixation, a minimal invasive method. This method was first applied by Böhler in 1982 (5). Using this method, stabilization may be achieved with 1 or 2 screws placed in the odontoid. Among our patients, only 4 patients needed 2 odontoid screws while stabilization was obtained with a single screw in all the other cases. In the biomechanical studies reported previously, no differences were found between one screw and two screws (21,30). Through this method, the rate of fusion increases to as high as 80-100% (1,12). Compared to the posterior approach, the most important advantages of this method are the protection of the atlantoaxial joint movements, no need for a bone graft, better postoperative comfort of the patients, and shorter length of stay in the hospital (20). In order to perform anterior screw fixation, it is crucial to have an undamaged normal transverse ligament and provide enough reduction to the fractured sides. In our study, we determined normal transverse ligament with MRI in all the cases where we performed anterior odontoid screw fixation. It is very important to provide necessary reduction of fracture sides in order to support the necessary stabilization and fusion. Peroperative biplanar scopy and the O-arm were therefore used and it was radiologically observed that reduction was obtained in all the patients. The fusion rate was found to be 97% during the 12 months follow-up of the cases in our department.

CONCLUSION

The treatment options in the Type II odontoid fractures are still under discussion. Anterior transodontoid screw stabilization is an option with favorable results. Since the non-union risk is high in cases where the fractured surfaces are apart from each other, it is important to insert the screw after piecing the odontoid surfaces together through manipulations during the surgery. This is a more physiological approach that does not impair the normal functions of the vertebral column. We use the conservative approach as a second option in type II odontoid fracture because this surgical approach has lower morbidity and mortality rates. Since we were able to obtain adequate fusion with this surgical method even in late cases, we advocate anterior surgery. We apply posterior C1-C2 fixation and fusion only when there is an anatomical problem preventing anterior surgery. We found satisfying fusion rates and better patient comfort during the postoperative period. We think that stabilization and fusion through a transodontoid screw is a minimal invasive method and can be used as the primary option in the surgical treatment of Type II odontoid fractures because of its advantages.

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