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ARAŞTIRMA / RESEARCH

Assessment of pedicle screw malposition rates in thoracolumbosacral spine: results of postoperative computed tomography in 100 patients

Torakolumbosakral omurgada pedikül vidası malpozisyon oranlarının değerlendirilmesi: 100 hastanın postoperatif bilgisayarlı tomografi sonuçları

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Abstract

Purpose: The purpose of this retrospective study was to evaluate the screw malpositions of patients who underwent transpedicular screw application in various elective and emergency conditions.

Material and Methods: 100 patients who underwent transpedicular screw application with various spinal pathologies between January 2012 and September 2016 were included in this retrospective study. Anteroposterior and lateral X-rays and thin section spinal computed tomography scans were performed within 72 hours after the operation. The data including age, gender, operation levels, number of screws placed, preoperative and postoperative neurological conditions, complications, number of screw malpositions and revision surgeries of the patients were gathered.

Results: A total of 692 transpedicular screws were applied to 100 cases. 610 (88.15%) of the 692 transpedicular screws placed were evaluated as normal. 82 screws (11.85%) were evaluated as malpositions and 5 of them were revised. According to Gertzbein classification; 20 screws were grade 1, 44 screws were grade 2 and 18 screws were grade 3. 4 patients had anterior perforation, 39 patients had medial perforation, 38 patients had lateral perforation and 1 patient had inferior perforation. There was a dominancy of thoracal levels in screw malpositions.

Conclusion: Thin section CT scans taken postoperatively was found to be the gold standard for detecting screw malpositions. We identified that malpositions were most frequently seen as medial pedicle wall perforations in the thoracal region due to anatomical structure of the pedicles.

Key words: Transpedicular screw, malposition, spinal instrumentation.

Öz

Amaç: Çalışmamızda elektif ve acil şartlarda çeşitli tanılarla opere olarak transpediküler vida uygulanan hastaların, vida pozisyonlarının retrospektif olarak incelenerek vida malpozisyonlarının değerlendirilmesi amaçlandı.

Gereç ve Yöntem: Ocak 2012 ile Eylül 2016 tarihleri arasında çeşitli spinal patolojilerle transpediküler vida uygulanan 100 hasta retrospektif olarak incelendi. Operasyon sonrası 72 saat içinde anteroposterior ve lateral direk grafi ve ince kesit spinal bilgisayarlı tomografi görüntülemeleri yapıldı. Hastaların yaş, cinsiyet, operasyon seviyeleri, yerleştirilen vida sayıları, preoperatif ve postoperatif nörolojik durumları, komplikasyonlar, vida malpozisyon sayıları ve revizyon ameliyatlarını içeren verileri toplandı.

Bulgular: 100 olguya toplam 692 transpediküler vida uygulandı. Yerleştirilen 692 transpediküler vidanın 610'u (%88.15) normal olarak değerlendirildi. 82 vida (%11.85) malpozisyon olarak değerlendirildi ve 5'i revize edildi. Gertzbein sınıflamasına göre; 20 vida derece 1, 44 vida derece 2 ve 18 vida derece 3 olarak değerlendirildi. 4 hastada anterior perforasyon, 39 hastada medial perforasyon, 38 hastada lateral perforasyon, 1 hastada inferior perforasyon vardı. Vida malpozisyonlarının torakal seviyelerde daha çok görüldüğü saptandı.

Sonuç: Ameliyat sonrası alınan ince kesitli bilgisayarlı tomografi taramaları vida malpozisyonlarının belirlenmesinde altın standart olarak kabul edilmektedir. Malpozisyonların pediküllerin anatomik yapısına bağlı olarak en sık torakal bölgede medial pedikül duvarı perforasyonları şeklinde olduğunu tespit ettik.

Anahtar kelimeler: Transpediküler vida, malpozisyon, spinal enstrumantasyon.

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INTRODUCTION

In the last fifty years, many different spinal stabilization and fusion techniques have been performed in the spine pathologies, especially in the degenerative diseases. Today, spinal posterior stabilization and fusion procedures have an important role in neurosurgical practice. The aim of surgical treatment in spinal diseases is to correct spinal deformity, to strengthen spinal column by increasing spinal fusion rate, to provide decompression of neural elements and to facilitate rehabilitation after surgery. For these purposes, transpedicular screw applications are applied in the treatment of many spinal pathologies[1-3].

Transpedicular screw procedure is linked with a wide range of complications including wrong-level surgery, nerve root lesion, vascular injury, dural tearing, surgical site infections and screw malpositions. Transpedicular screw malposition rates ranging from 21.1% to 39.8% have been reported in the literature[4-7].

The main problem at surgery is that a blind technique is used; the surgeon does not see the pedicle. The risk of iatrogenic injury must be minimized as vital anatomic structures surround the pedicle: the dural sac medially, the nerve roots superiorly and inferiorly, and the vascular structures anterolaterally. Further, the accuracy of pedicle screw insertion is crucial for the efficiency and stability of the surgical procedure[1-4].

The purposes of this study were to determine the incidence of screw misplacement, complications, the accuracy and usefulness of computed tomography (CT) scan in evaluation of pedicle screw placement and to define the relation between the symptoms and the CT scan images. The results were compared with published data in the literature.

MATERIALS AND METHODS

After obtaining Cukurova University ethics committee approval, 100 patients who underwent transpedicular screw application with various spinal pathologies between January 2012 and September 2016 in Cukurova University neurosurgery department were included in this retrospective study. Pathologies related with spinal instability including spinal stenosis, traumatic thoracic and/or lumbar fractures, spondylolisthesis, lomber disc herniations, spinal tumors and spinal infections were treated with posterior transpedicular screw application. All procedures were performed by the authors of the study (KMO, NEC, KO, OA). Preoperative anteroposterior and lateral X-ray, thin-section computed tomography (CT) and spinal magnetic resonance imaging (MRI) techniques were applied to all patients. The size of the transpedicular screws were determined separately for each patient and each level by calculating the pedicle diameters and corpus length by the help of CT. In the lomber region, the junction of the transverse process and the superior articular process was accepted as the entry point. In the thoracal region, the junction of the superior articular facet, transverse process and pars interarticularis was accepted as the entry point. In all patients, a single dose of 1 gr cefazolin antibiotic prophylaxis was given preoperatively. Anteroposterior and lateral X-rays and thin section spinal computed tomography scans were performed within 72 hours after the operation. Patients' follow-ups were done with six monthly policlinic controls.

The data including age, gender, operation levels, number of screws placed, preoperative and postoperative neurological conditions, complications, number of screw malpositions and revision surgeries of the patients were gathered. The operations were performed by taking images of the anterior-posterior and lateral plana with C-arm fluoroscopy. Titanium screws were used to minimize imaging artefacts. Postoperative thin section spinal CT was performed for all patients to detect screw malpositions. The Gertzbein classification (measuring the overflow distance of the screw from the bone cortex) was used in determining the screw malpositions[5].

Statistical analysis

The authors performed all the statistical analyses using SPSS for Windows 20.0. Means and standard deviation of every parameter was calculated. For statistical analysis the chi-squared test was used with $p \leq 0.05$ regarded as significant.

RESULTS

One hundred patients were included in the study. Eleven patients (11%) had spinal stenosis, 45 patients (45%) had traumatic thoracic and/or lumbar fractures, 17 patients (17%) had spondylolisthesis, 2 patients (2%) had lomber disc

herniations, 18 patients (18%) had spinal tumor and 7 patients (7%) had spinal infections. Forty three patients were female and 57 patients were male. The mean age of the patients was 49 years (14-81 years). A total of 692 transpedicular screws were applied to 100 cases. The screw quantities applied to the levels are shown in Figure 1. 610 (88.15%) of the 692 transpedicular screws placed were evaluated as normal. Eighty two screws (11.85%) were evaluated as malpositions and 5 (6.10%) of them were revised. According to Gertzbein classification; 20 screws were grade 1, 44 screws were grade 2 and 18 screws were grade 3 (Figure 2). Four patients (0.66%) had anterior perforation, 39 patients (6.39%) had medial perforation, 38 patients (6.23%) had lateral perforation and 1 patient (0.16%) had inferior perforation (Figure 3). None of the patients had superior perforation. Of the 39 patients who had medial malpositions, 24 screws were at the thoracal levels and 15 screws were at the lumbosacral levels.

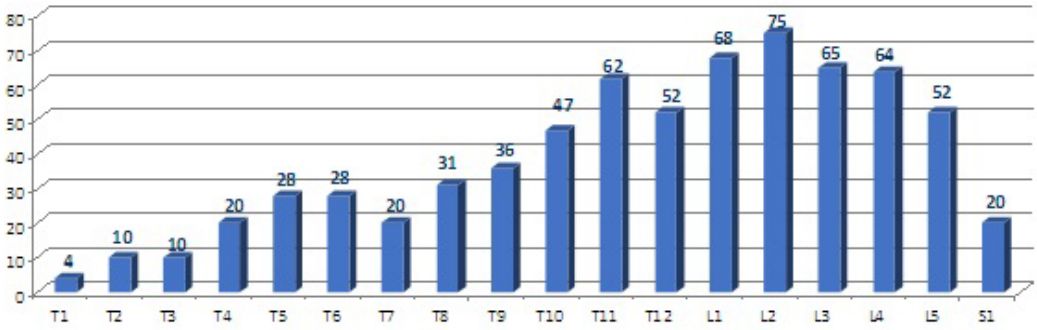

Figure 1. Pedicle screw quantities applied to levels

Table 1. Analysis of pedicle screw malpositions

Perforation	Anterior		Medial		Lateral		Superior		Inferior		Total
	T	LS	T	LS	T	LS	T	LS	T	LS	
Numbers	2	2	24	15	35	3	0	0	0	1	82
Rates (%)	50	50	61.5	38.5	92.1	7.9	0	0	0	100	

T-Thoracal, LS-Lumbosacral

Table 2. Distribution of pedicle screw malpositions by levels

Level	Number of screws	Number of malpositions	Grade 1 (0-2 mm)	Grade 2 (2-4 mm)	Grade 3 (>4 mm)
T1	4	2	1	0	1
T2	10	5	1	3	1
T3	10	2	0	2	0
T4	20	5	1	2	2
T5	28	6	2	4	0
T6	28	6	1	4	1
T7	20	2	0	2	0
T8	31	5	3	2	0
T9	36	4	0	3	1
T10	47	6	3	3	0
T11	62	8	1	4	3
T12	52	10	2	5	3
L1	68	7	0	5	2
L2	75	7	3	3	1
L3	65	2	1	0	1
L4	64	3	1	2	0
L5	52	1	0	0	1
S1	20	1	0	0	1
Total	692	82	20	44	18

T-Thoracal, L-Lumbar, S-Sacral

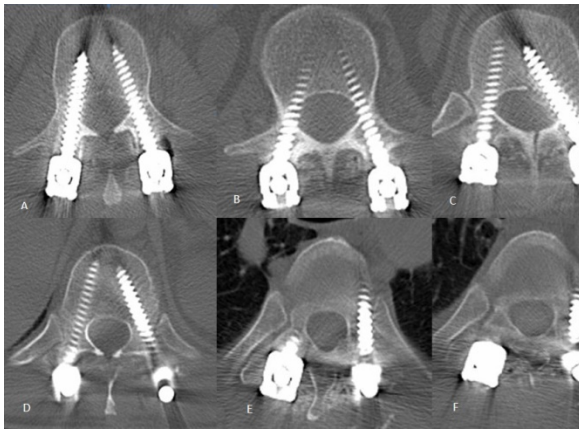

Figure 2. Gertzbein classification: (A) Grade 1 medial malposition (B) Grade 2 medial malposition (C) Grade 3 medial malposition (D) Grade 1 lateral malposition (E) Grade 2 lateral malposition (F) Grade 3 lateral malposition

Of the 38 patients who had lateral malpositions, 35 screws were at the thoracal levels and 3 screws were at the lumbosacral levels (Table 1). Seven patients had wound infection, 4 patients had dura injury and cerebrospinal fluid (CSF) fistula and 5 patients had root compression in 100 cases as complications. Five patients who had root compression underwent revision surgeries. Of the 82 malpositioned screws; 20 screws (%24.4) were Grade 1, 44 screws (%53.7) were Grade 2 and 18 screws (%21.9) were Grade 3 (Table 2).

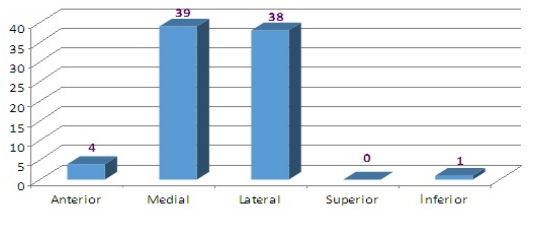

Figure 3. Distribution of pedicle perforations

DISCUSSION

Transpedicular screw stabilization is a widely accepted and used technique in thoracic, lumbar and sacral surgery in various spinal diseases in recent years1-3. This procedure can be performed in all age groups in case of necessity. The advantages of spinal implants include providing stability, maintaining decompression, preventing the progression of spinal deformity and relieving pain by reducing motion. Posterior thoracolumbar fixation techniques provide effective stabilization unless the load carrying capacity of the anterior column is failed. Transpedicular screws are the most powerful posterior fixation system since they hold all three columns[7-10].

Surgeons should be more careful in thoracal transpedicular screw fixation because the thoracal spine has very small pedicle diameters and the spinal cord occupies the majority of the spinal canal. It is necessary to have good anatomical and biomechanical knowledge to avoid complications. The C-arm fluoroscopy does not preclude all screw malpositions, navigation and other intraoperative imaging techniques increase the correct screw placement rates[3,10-14].

Conventional pedicle screw fixation technique is largely associated with personal clinical experience. Transpedicular screw malposition rates ranging from 21.1% to 39.8% have been reported in the literature[4-7]. Castro et al.[4] reported 49 perforations and 5 root lesions in their study including 123 pedicle screws. Gertzbein et al.[5] reported 48 malpositions and 2 minor neurologic complications from 167 pedicle screws. Laine et al.[15] reported 32 malpositions and 1 minor neurologic complication in 152 pedicle screws. Güven et al.6 reported 38 malpositions in 379 pedicle screws. Learch et al.[16] identified 21 malpositions in 74 pedicle screws. In patients who underwent midline laminectomy during the pedicle screw procedure, they did not recognize the screw malposition visually. However, they identified 21 malpositions in the thin section spinal computed tomography. They defined that thin section spinal CT was the gold standard in detecting cortical perforation.

In our study, 82 malpositions (11.85%) were identified in 692 pedicle screws according to postoperative thin section CT scans and 5 minor neurological complications were found. Pedicle perforation is more common in the medial and lateral walls due to the anatomic structure of the pedicle. It is less frequently on the superior and inferior walls[7,10]. Lateral perforation was determined in 38 patients (46.34%), medial perforation in 39 patients (47.56%), anterior perforation in 4 patients (4.87%) and inferior perforation in 1 patient (1.21%). We had none superior perforation in our patients.

Motiei-Langroudi et al.[2] showed that the pedicle screws were the most correct at L3-S1 level with 99% accuracy and it was followed by thoracolumbar junction (T10-L2) with 96.5% accuracy. The upper and middle thoracal region (T2-T9) was the largest site of malpositions. In our study, L3-S1 level was the most correct level with 96.32% accuracy and it was followed by T9-L2 level with 87.38% accuracy. The most malposition rates were identified at T1-T6 level (31.31%) and these ratios were found to be consistent with the literature. Lower malposition rates have been reported in studies performed using intraoperative computed tomography[3,10-12,14]. Kalfas et al.[17] reported 12 malpositions (8%) in 150 pedicle screws. Laine et al.[7] reported a rate of 13.4% with conventional technique and 7.1% with intraoperative CT.

In conclusion, we compared the screw malposition rates of our cases with the literature and obtained results in accordance with the literature. Thin section CT scans taken postoperatively was found to be the gold standard for detecting screw malpositions. Malpositions were most frequently seen as medial pedicle wall perforations in the thoracal region due to anatomical structure of the pedicles.

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