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ORIGINAL ARTICLE

Lumbar Posterior Transpedicular Screw Fixation and Fusion Applications; What We Do Peroperatively with 117 Spinal Instability Cases

Lomber Posterior Transpediküler Vida ile Fiksasyon ve Füzyon Uygulamaları; 117 Spinal İnstabilite Olgusunda Peroperatif Olarak Neler Yapıyoruz?

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ABSTRACT

Objective: In this study, we aimed to share our surgical principles and surgical outcomes in cases of fixation and fusion with lumbar posterior transpedicular screw-rod systems in our clinic.
Methods: 117 patients who underwent posterolateral fusion surgery with lumbar posterior transpedicular screw-rod system between 2014 and 2017 were evaluated retrospectively. Dynamic lumbar radiographs, computed tomography and magnetic resonance imaging were performed in all cases before the operation. All patients were operated with microsurgical principles and internal fixation and posterolateral fusion were performed with posterior interpedicular screw-rod systems. Stabilization systems were evaluated with lumbar X-ray and/or computed tomography on the first postoperative day. In the 1st and 3rd months, lumbar X-rays were repeated.
Results: All these patients, in whom lumbar spinal instability was detected clinically and radiologically, had lower back and/or leg pain and different levels of neurological deficits. Of the cases, 23 were male and 94 were female. The mean age was 53.4 years. According to the Meyerding classification, there were grade I and II spondylolisthesis in 69, and 8 cases respectively, spinal stenosis in 28 cases, burst fracture in 1 case, compression fracture in 3 cases, disc herniation in 11 cases. The mean follow-up period was 28.6 months.
Conclusions: Meticulous case selection, careful preoperative planning and adherence to spinal microsurgery principles will increase the success rate in lumbar posterior internal fixation and posterolateral fusion surgeries.

Keywords: Lumbar spine, Instrumentation, posterolateral fusion, microsurgery

ÖZ

Amaç: Bu çalışmada kliniğimizde lomber posterior transpediküler vida-rod sistemleri ile fiksasyon ve füzyon vakalarında cerrahi prensiplerimizi ve cerrahi sonuçlarımızı paylaşmayı amaçladık.
Gereç ve Yöntem: 2014-2017 yılları arasında lomber posterior transpediküler vida-rod sistemi ile posterolateral füzyon cerrahisi uygulanan 117 hasta retrospektif olarak değerlendirildi. Operasyon öncesi tüm olgulara dinamik lomber radyografiler, bilgisayarlı tomografi ve manyetik rezonans görüntüleme yapıldı. Tüm hastalar mikrocerrahi prensipler ile opera edildiler ve posterior interpediküler vida-rod sistemleri ile internal fiksasyon ve posterolateral füzyon uygulandı. Postoperatif birinci gün lomber grafi ve/veya bilgisayarlı tomografi ile stabilizasyon sistemleri değerlendirildi. Postoperatif 1. ve 3. aylarda lomber grafiler tekrarlandı.
Bulgular: Lomber spinal instabilitenin klinik ve radyolojik olarak tespit edildiği tüm bu hastalarda bel ve/veya bacak ağrısı ve farklı düzeylerde nörolojik defisitler vardı. Vakaların 23'ü erkek, 94'ü kadındı. Ortalama yaş 53.4 idi. Meyerding sınıflamasına göre sırasıyla 69 ve 8 olguda grade I ve II spondilolistezis, 28 olguda spinal stenoz, 1 olguda patlama kırığı, 3 olguda kompresyon kırığı, 11 olguda disk hernisi mevcuttu. Ortalama takip süresi 28.6 ay idi.
Sonuç: Lomber posterior internal fiksasyon ve posterolateral füzyon ameliyatlarında titiz vaka seçimi, ameliyat öncesi dikkatli planlama ve spinal mikrocerrahi prensiplerine bağlılık başarı oranını artıracaktır.

Anahtar Kelimeler: Lomber omurga, enstrumantasyon, posterolateral füzyon, mikrocerrahi

Introduction

Lumbar stabilization of patients with spinal instability by posterior transpedicular screw fixation and posterolateral fusion is a common procedure, often used to provide stability to the unstable spine, to prevent injury to the neurological structures, to reduce the misalignment and deformity, to increase the likelihood of fusion, and to reduce long-term pain. But the indications are not standardized still [1,2]. Radiological diagnosis should not be considered as the sole criterion for surgery; pain and neurological findings decreasing the quality of life are also important parameters [3].

The success of fusion procedures with spinal instrumentation has increased with the development of instrumentation techniques, use of high-resolution radiological examinations, better understanding of bone healing, improvements in pre- and postoperative care, aggressive rehabilitation programs, and improvement

of surgical skills and experience of surgeons [4-7].

The successful implementation of transpedicular screw-rod systems depends on a thorough knowledge of pedicle anatomy, biomechanical properties of the instrumentation, proper patient selection, pre-operative planning and adequacy of operating room equipment.

In this study, we presented our series and experience.

Materials and Methods

117 patients with lumbar spondylolisthesis who had lumbar stabilization and posterolateral fusion with posterior transpedicular screw-rod systems between 2014-2017 were reviewed retrospectively.

Their clinical charts, radiological studies, operative notes and follow-up results were studied. Patients' age, sex, neurological examination findings, number of segments with transpedicular screw fixation, complications, and clinical outcomes were noted. Prolo follow-up criteria was used for assessment of clinical outcome.

All cases had anteroposterior, lateral, and hyperflexion-hyperextension lumbar radiographies, lumbar computed tomography (LCT), lumbar magnetic resonance imaging (LMRI) studies pre-operatively (Figure 1). Additionally, bone scintigraphy was performed in patients who had multiple lesions in the vertebrae by radiological imaging, and bone densitometry was done for patients with suspected osteoporosis.

Pedicle diameters and corpus depths were measured, and transpedicular screw projections were marked for the planned levels on LCT pre-operatively.

All patients were given prophylactic antibiotics 1 dose pre-operatively and 2 doses postoperatively. Surgical gel pillows were placed bilaterally to support and patients were given neutral prone position. Skin was brushed with antiseptic solutions for 5 minutes. In order to see the lumbar lordosis and the position of the vertebrae in the prone position, the images were taken with C-arm fluoroscopy, and compared with the pre-operative radiographs. After the pedicle projections were determined, the facet joint surfaces were decorticated. Using a pedicle drill, a nest was opened in the vertebra corpus by applying gentle pressure in a controlled manner, which would be appropriate to the screw size determined from the lateral of the facet joint. Each hole was checked with a round tip probe. Transpedicular screws were placed in these slots according to pre-operative calculations under guidence of C-arm fluoroscopy (Figure 2). The tip of each screw was placed reaching anterior to the 2/3 of the corpus length. Transpedicular screws were fixed with rigid rods modelled according to the lumbar curve, one transverse connection was used for segment stabilizations of 3 and above. Transverse binders were not used in 2-segments stabilization. No effort was made for reduction.

In all cases, microsurgical principles were applied according to the pathology. In cases who underwent discectomy, intervertebral space was supported with posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF). After facet and transverse process decortication, autogenous bone grafts were placed, and screws were fixed. Spongostan was placed on the dura in laminectomy levels. Patients were transfused 1 unit of erythrocyte suspension.

The patients were mobilized with a lumbar corset supported by steel bars on the same day postoperatively. On postoperative day 1, direct radiological radiographs were taken (Figure 3). In necessary cases LCT was done. The cases used lumbar corset for 3 months. Our clinical results were controlled by Prolo's follow-up scale.

Results

There was a total of 117 cases. Ninety-four (80.3%) of them were female and 23 (19.7%) were male (f/m=4.1) (Table 1). The mean age was 53.4±9.7 (range=19-75) years and 83 cases were 50 years or older (Table 2).

Table 1. Distribution of patients according to sex, age and indications

	Number of patients	%
Male	23	19.66
Female	94	80.34
10-29 years	2	1.71
30-49 years	32	27.35
50 years and older	83	70.94
Meyerding Grade 1	69	58.97
(Listhesis after LDH surgery)	(5)	
Meyerding Grade 2	8	6.84
Spinal stenosis	25	21.37
Lumbar disc herniation	9	7.69
Vertebrae fracture	4	3.42

Table 2: Physical examination results of the patients before surgery

	Number of patients	%
Motor deficits	55	47.01
Reflex alterations	75	64.10
Sensorial alterations	71	60.68
Laseque test positivity	109	93.16
Femoral strain test positivity	15	12.82
Neurogenic claudication	35	29.91

All cases had lower back and/or leg pain at admission and various neurological deficits. Laseque test positivity rate was especially high (93.16%) (Table 3).

Table 3: Distribution of the number of patients with transpedicular screws applied segment

	Number of patients	%
2 segments	13	11.11
3 segments	67	57.26
4 segments	29	24.79
5 segments	8	6.84

There were 69 Meyerding grade I, 8 Meyerding grade II spondylolisthesis cases. Spondylolistehezis was at L3-4 level in 9 cases, L4-5 level in 36 cases, L5-S1 level in 30 cases. Two of the cases had spondylolisthesis at 2 levels. Spinal stenosis was seen in 25 cases (1 case single level, 15 cases 2 levels, 8 cases 3 levels, 1 case 4 levels). Disc herniation was present in 9 cases (2 cases at 1 level, 2 cases at 2 levels, 5 cases at 3 levels) 1 case burst fracture, 3 cases compression fracture (Table 4). The median follow-up period was 28 (range=3-48) months.

Table 4: Complications

	Number of patients	%
Dura injury	2	1.7
Subcutaneous CSF collection	4	3.4
Superficial cutaneous infection	1	0.85
Screw breakage	4	3.4
Re-operation	5	4.27

Thirteen cases had 2-segment, 67 cases had 3-segment, 29 cases had 4-segment and 8 cases had 5-segment transpedicular screw-rod stabilization (Table 5).

Table 5: Clinical outcomes according to Prolo follow-up criteria

	Number of patients	%
Excellent	35	29,91
Good	77	65,81
Medium	4	3,42
Poor	1	0,85

In 2 cases with intraoperative dural damage, dura was repaired primarily. There were no cases of postoperative cerebrospinal fluid (CSF) fistula. However, postoperative CSF collection was observed in 4 cases in which peroperative macroscopic dural damage was not observed. Serial skin aspirations under USG uidance were performed for these cases, and no additional surgical procedure was needed for them. Superficial skin infection developed in 1 patient and treated with appropriate antibiotherapy. No instrument infection was observed. In one postoperative case, the screw was replaced by re-operation, due to misplacement of screw out of the L5 pedicle which was causing radicular symptoms. In 4 cases, screw breakage was seen unilaterally (L5 in 3 cases, S1 in 1) and replaced with new ones by re-operation (Table 6).

Postoperatively, 112 (95.7%) of 117 patients who had various degrees of back and/or leg pain at addmission had no leg pain. Of these, 41 (35.04%) were found to have moderate intermittent lower back pain, which did not prevent them from performing normal daily activities and working. There was 1 patient who had 4-segment stabilization from L3 to S1 with worsened complaints. Medical treatment and physical therapy were applied. But his complaints did not fade. Complaints were thought to be due to rigid stabilization. The transpedicular screw rod system was removed. The patient's complaints decreased. Our results according to Prolo follow-up scale was; excellent in 35 (29.91%) cases, good in 77 (65.81%) cases, medium in 4 (3.42%) cases and poor in 1 (0.85%) case.

Discussion

The first fixation procedure was performed by Hadra in the thoracolumbar spine by using wires in 1889 [8]. The first spinal fusion was performed in 1911 by two different surgeons named Albee and Hibbs. Albee used autologous tibia graft, separated the spinous processes and placed the tibial graft in between them. Hibbs, on the other hand, placed overhanging spinous layers on the laminae [9,10].

Transpedicular screw-rod systems have been found to provide much better segmental fixation compared to other posterior instrumentation systems such as laminar hook-rod or segmental wire-rod [11,12]. However, in cases where the posterolateral fusion is the only intervention, especially in cases with discectomy, the unbalanced distribution of the load on the vertebral column can increase the pressure on the transpedicular screw-rod systems. The findings of some authors support the view that adding interbody fusion gives superior mechanical strength to the vertebral structure. Three-column stabilization provides protection to neighboring mobile normal segments and prevents mechanical pain syndromes [13-15]. In our cases, we performed pre-operative surgical planning considering the stabilization of three columns. We did laminectomy only in the stenotic levels, and discectomy if there was an indication. In cases that we performed discectomy, we applied appropriate support (TLIF, PLIF) materials to the disc space. In addition, the screws were fixed with rigid rods which were given form in a manner that was appropriate to the pre-operative lumbar vertebral alignment. No reduction was applied to any patient unless required. Thus, we observed that postoperative lower back pain was decreased by maintaining the stability of the anterior, middle and posterior colons. This decreased postoperative analgesic use, and allowed earlier mobilization. In addition, we observed that reducing the load on the transpedicular screw rod system reduced the complications of screw-rod systems.

Lehman et al. reported 32 cases with posterior lumbar fusion which were followed for more than 30 years. They found that instability developed above

the fusion segment in about half of the cases and stenosis developed in about one third. However, these adjacent segment degenerations did not correlate with clinical symptoms [16]. Forty-nine cases who underwent posterior lumbar fusion and posterior interbody fusion were followed for five years. It was emphasized that the apparent adjacent segment degeneration was correlated with the clinic and that the development of pseudoarthrosis was a protective factor for adjacent segment degeneration [17]. Although our patients had early follow-up results, no pseudoarthrosis and adjacent segment changes were observed in our cases.

Thanks to instrumental fusion operations, cases can be mobilized in the early period and their return to daily living activities is faster. Patients with short segment stabilization had less pain both in late postoperative and early postoperative follow-up periods. In patients who underwent multisegment stabilization, the postoperative operative pain was more severe. In the late postoperative period, the patients had more pain symptoms due to waist inactivity.

Recently, non-instrumentation decompression has been preferred especially in patients with spinal stenosis. However, the appropriate treatment modality for lumbar spinal stenosis with spondylolisthesis is instrumentation and fusion in addition to decompression [18-20]. Providing the stability of the back and middle columns in particular; ligamentum flavum, facet joints and surgical interventions performed on the discs may impair the mechanical stability of the spine. Furthermore, pedicle systems have important advantages especially in elderly and osteoporotic patients. The best fixation in the osteoporotic vertebra is obtained from the pedicle, lumbar lordosis is preserved or restored, and fusion rates are increased by increasing rotational stability. The patients in our group were generally 50 years of age or older and constituted 71 percent of all patients. Many studies have similar approaches. For example, Fischgrund et al. Compared the rates of instrumentation and instrumentation-free fusion in cases with spinal stenosis and spondylolisthesis and reported that instrumentation increased fusion [21].

Posterior transpedicular screw-rod application have its own advantages and disadvantages compared to other stabilization systems (hook and wire) applied to the lumbar region. Pedicle screws are more effective and advantageous than other instrumentation systems in fixing the spine rigidly. They can be used in laminectomy performed vertebrae. The instrumentation level can be kept shorter and they are appropriate for the instrumentation of the sacrum. Screw-rod systems can additionally provide normal spinal curvature [11,13,14,22-24].

During pedicle screw application; complications such as screw malposition, spinal cord injury, retroperitoneal organ injury, infection, screw breakage and screw stripping, lack of appropriate instrumentation, prolonged operation time, excessive blood loss can be observed [25-30]. The most important complication of pedicle screw application is the incorrect placement of the screw. Radix, dura, cauda equina or spinal cord injury may occur in this case. In order to minimize or eliminate this risk, pre-operative planning should be performed very well and rigorous surgery should be performed. Measurements of each spine to be applied to the transpedicular screw should be calculated on pre-operative LCT and / or LMRI. The screw delivery angles should be determined and ensure that sufficient material is in stock. Surgical technique, experience, use of scopy and anatomical correlation in posterior transpedicular screw applications minimize the possible complications.

Postoperative late complications can be due to the structural features of the instruments used They can be used in laminectomy performed vertebrae and the patient's changing biomechanics. Implant fractures are quite common in that period. They can be used in laminectomy performed vertebrae, These are usually caused by metal fatigue. Again, loosening of implants with screw or hook-rod connection loosening or connection errors due to production may be seen [28,31]. Especially the spinal dura under L5 and below is much thinner. Although there is no mechanical injury, we think it causes CSF leakage and collection. We recommend that the L5 and six dura materin should be controlled with the valsalva maneuver during the operation and if there is any CSF leak, it should be repaired. In addition, we think that it is useful to place the hemovak drainage for drainage away from this area. In Table 6, it is seen that our complications are low in comparison with the series in the literature. In pre-operative preparation, we think that calculating screw lengths, pedicle diameters and screw insertion angles on LCT and LMRI reduce possible transpedicular screw complications. We think that especially pre-operative preparation is very important in surgical success.

The results of posterolateral transpedicular screw-rod application in the literature are variable. In the lumbar spinal stenosis decompression surgery, good and excellent results were reported at 80%. However, in most studies, early and mid-term results are good and in long-term follow-up, the results deteriorate over time and restenosis may develop [31,32]. Turner et al. studied long-term results and reported good and excellent results of in 64% of cases. In the same study, it was reported that good and perfect result rate increased to 85% in the presence of degenerative spondylolisthesis [7,31]. In our study, our good and excellent results are at 95%. This rate is quite high with our study with a mean follow-up of 28.6 months. This success depends on careful and appropriate surgical application, microsurgical application and surgical experience, careful patient selection, good and careful pre-operative preparation. However long-term results should be studied with prospective randomized studies.

Conclusions

Posterior transpedicular fixation and posterolateral fusion applications improve the quality of life. Patients can return to their daily lives and jobs faster. Patient selection is very important. We recommend that pre-operative preparation be performed as carefully as possible. We believe that it will facilitate the operation and minimize the complications related to transpedicular screw systems. We also recommend that all procedures except transpedicular screw rod applications should be performed by microsurgical technique.

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Conflict of interest

The authors declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee (Institutional Review Board of Istanbul Medipol University 16.4.2020/292) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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