Received: 08.08.2012 / **Accepted:** 20.10.2012
DOI: 10.5137/1019-5149.JTN.7122-12.1

Unilateral Percutaneous Pedicle Screw Instrumentation with Minimally Invasive TLIF for the Treatment of Recurrent Lumbar Disk Disease: 2 Years Follow-Up

Rekürren Disk Hernisi Nedeniyle Unilateral Vidalama ve Minimal İnvazif TLIF Yapılan Hastaların 2 Yıllık Takip Sonuçları

Erkin SONMEZ[1], Ilker COVEN[2], Fikret SAHINTURK[1], Cem YILMAZ[1], Hakan CANER[1]

[1]Baskent University, Faculty of Medicine, Department of Neurosurgery, Ankara, Turkey
[2]Baskent University, Konya Training and Research Hospital, Department of Neurosurgery, Konya, Turkey

Corresponding Author: Erkin SONMEZ / E-mail: erkinso@gmail.com

ABSTRACT

AIM: To compare the clinical and radiological outcomes of recurrent disk disease in patients who underwent unilateral and bilateral percutaneous pedicle screw instrumentation with Mis-TLIF.

MATERIAL and METHODS: 10 patients treated with unilateral percutaneous instrumentation plus Mis-TLIF formed Group 1 while the other 10 patients treated with bilateral percutaneous instrumentation plus Mis-TLIF formed Group 2. Clinical outcomes were graded using the visual analog scale (VAS) and the Oswestry disability index (ODI) scores. Peroperative and 2-year follow-up scores were obtained. Postoperative imaging techniques were used for the assessment of fusion, subsidence and spinal alignment.

RESULTS: According to preoperative and postoperative VAS/ODI scores, statistically significant differences were noted in the unilaterally and bilaterally instrumented group. However, a statistically significant difference was not observed between the unilateral and bilateral groups. Radiological evidence of successful arthrodesis was noted in 8 of 10 patients (80%) in the unilaterally instrumented group and in 9 of 10 patients (90%) in the bilaterally instrumented group at the 2 years follow-up. No metal failure, cage migration, vertebral fracture, subsidence or adjacent level disease was experienced.

CONCLUSION: Mis-TLIF with unilateral percutaneous pedicle screw instrumentation is an excellent option in the treatment of selected recurrent disk disease patients.

KEYWORDS: Unilateral, Pedicle screw, Minimally invasive, TLIF, Recurrent disk disease

ÖZ

AMAÇ: Rekürren disk hernisi nedeniyle unilateral/bilateral vidalama ve minimal invazif TLIF yapılan hastaların radyolojik ve klinik sonuçlarının karşılaştırılması.

YÖNTEM ve GEREÇLER: Unilateral enstrumantasyon yapılan 10 hasta grup 1'i oluştururken, bilateral enstrumantasyon yapılan diğer 10 hasta grup 2'yi oluşturdu. Klinik sonuçlar VAS ve ODI skorlarına göre değerlendirildi. Peroperatif ve 2. yıl takip değerleri elde edildi. Radyolojik tetkikler yardımıyla füzyon, çökme ve sagittal dizilim değerlendirildi.

BULGULAR: Preoperatif ve postoperatif VAS/ODI skorlarına göre unilateral ve bilateral grupta istatistiksel olarak anlamlı farklılıklar elde edildi fakat unilateral ve bilateral grup arasında anlamlı bir fark saptanmadı. İki yıllık takip sonuçlarında, başarılı füzyon oranı grup 1 hastalarda %80 iken, grup 2 hastalarda %90 olarak bulundu. İmplant problemi, vertebra kırığı, çökme ve komşu segment hastalığı görülmedi.

SONUÇ: Perkütan unilateral vidalama ile birlikte yapılan minimal invazif TLIF prosedürü seçilmiş rekürren disk hernisi hastalarında başarılı bir tedavi yöntemidir.

ANAHTAR SÖZCÜKLER: Unilateral, Pedikül vidası, Minimal invazif, TLIF, Rekürren disk hastalığı

INTRODUCTION

Recurrent lumbar disk herniation (rLDH) is defined as disk herniation that occurs at the same level, regardless of site (ipsilateral or contralateral) in a patient after a definite pain-free period (at least 6 months) from initial surgery (13). It is the most common complication following primary open diskectomy (13). Treatment of recurrent lumbar disk herniation includes medical management and surgical intervention (20). Surgical techniques include rediskectomy with or without fusion (3,7).

Lumbar spinal fusion is a commonly performed surgical procedure. It is used in a variety of spinal pathologies including degenerative disease, trauma, spondylolisthesis and deformity (20). For the formation of an ideal fusion mass, a mechanically stable spine is needed. This stability could be achieved by the help of spinal instrumentation. Instrumented spinal fusion has several advantages such as no need for external mobilization, early ambulation, improved fusion rate and restoration of sagittal alignment (5). However, implant-related problems, degeneration of the adjacent segments and cost-effectiveness of these systems have forced the surgeons to use less stiff implant options (5,20).

After the innovation of the transforaminal lumbar interbody fusion (TLIF) procedure by Harms and Rollinger, it continued to evolve and minimally invasive TLIF (Mis-TLIF) procedure was described (6,9). Since this procedure reduces the approach-related muscle damage, blood loss, postoperative pain, length of stay in hospital, and postoperative narcotic usage, and allows early ambulation, it is popularized by most of the spine surgeons especially when used with percutaneous pedicle screws (6,10,18).

We conducted a clinical study that compares the results of the unilateral vs, bilateral transpedicular screw fixation with Mis-TLIF in recurrent disk disease patients.

MATERIAL and METHODS

Patient Characteristics

From January 2008 to February 2011, 20 patients with a diagnosis of recurrent disk disease underwent fusion surgery by pedicle screw fixation with Mis-TLIF. The indication for surgery was chronic axial low back pain and lumbar instability unresponsive to conservative treatment (Figure 1A, B).

Patient Selection

Patients were carefully selected after extensive courses of physical therapy and pain management. The inclusion criteria for the study were severe low back pain due to single level recurrent disc herniation, age between 30-55 years and disc height more than 2 mm (Figure 2A, B). Patients with any major psychopathology, metabolic disease or habitual use of anti-inflammatory drugs were excluded from the study. According to these criteria, 20 patients were divided into 2 groups. 10 patients treated with unilateral instrumentation plus TLIF formed Group 1 while 10 patients treated with bilateral instrumentation plus TLIF formed Group 2 (Figure 3A,B). In group 2, contralateral side instrumentation was performed by the percutaneous route (Figure 4A,B). Decompression and instrumentation were performed by the minimally invasive surgical technique in both groups.

Surgical Technique

The patients were placed in the prone position. The paramedian approach was used for access to the spinal segment undergoing fusion. The symptomatic side of the spine was exposed by the minimally invasive expandable retractor system (Proview, Orthofix, USA). Total facetectomy was performed with the help of a high-speed drill and the osteotomes. Following decompression and the implantation of the polyetheretherketone (PEEK) cages, pedicle screws

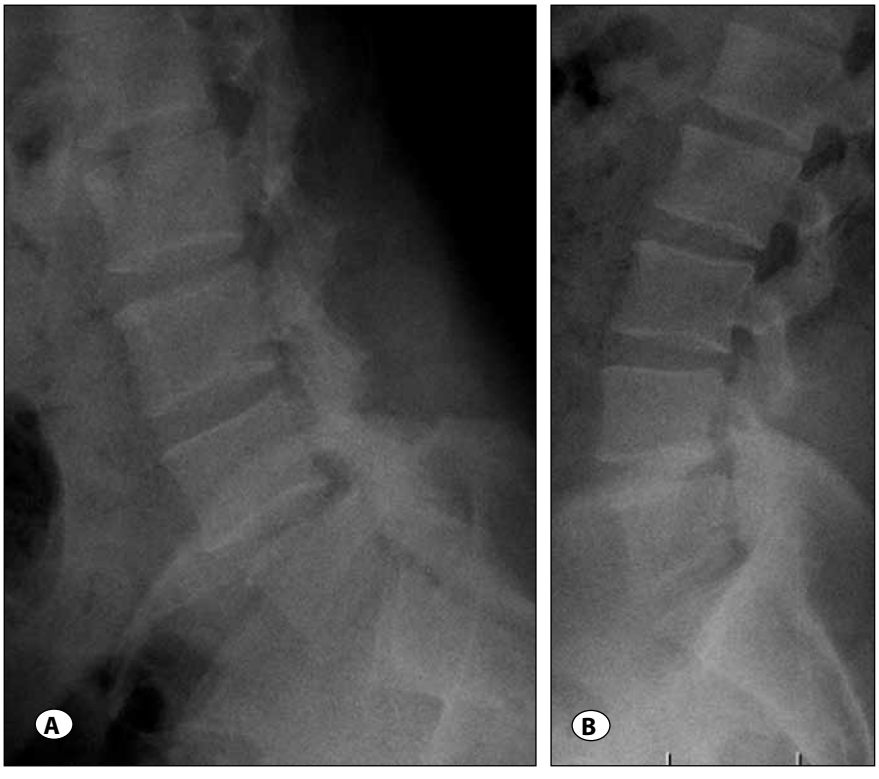

Figure 1: Flexion **(A)** and Extension **(B)** X Ray images demonstrating instability at the level L4-5.

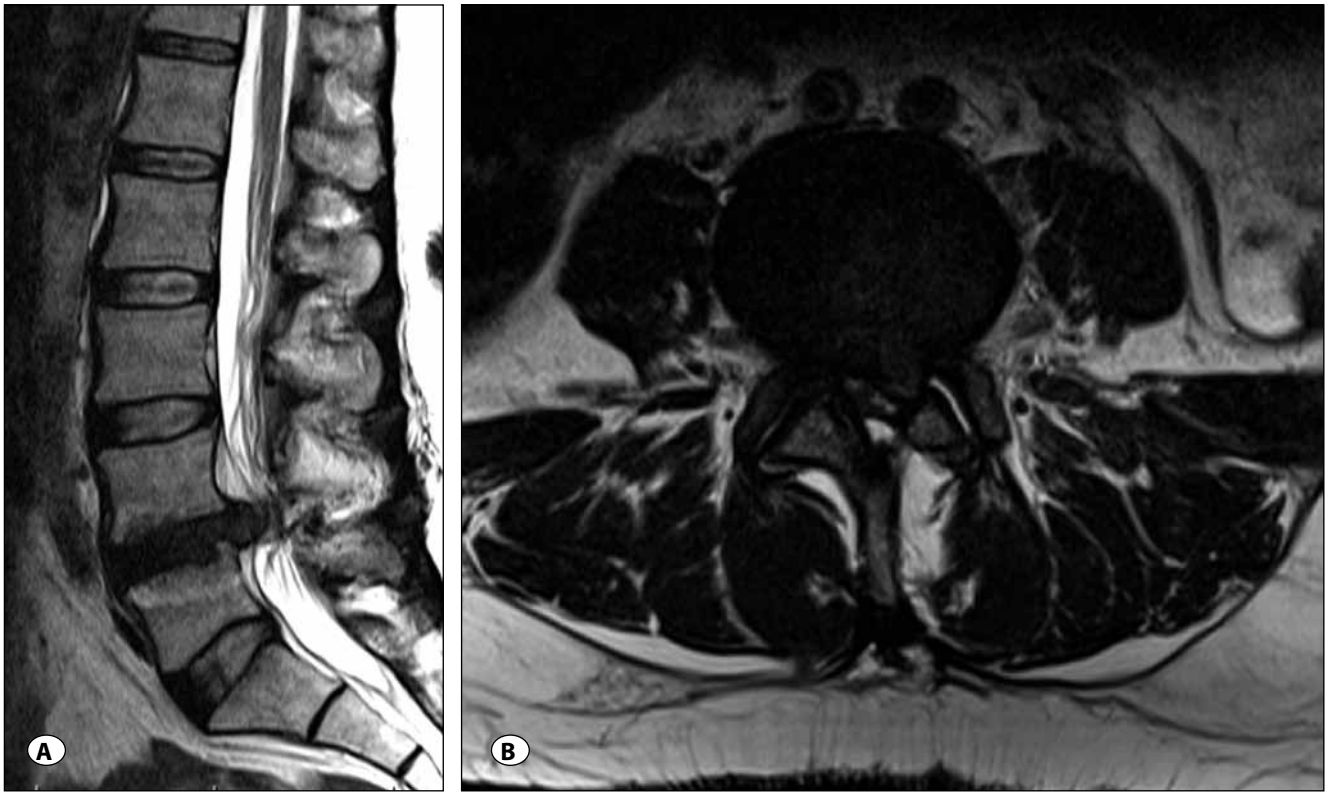

Figure 2: T2 sagittal **(A)** and T2 axial **(B)** MR images showing L4-5 left paracentral disk herniation. Please note the laminectomy defect on the left due to previous disc surgery.

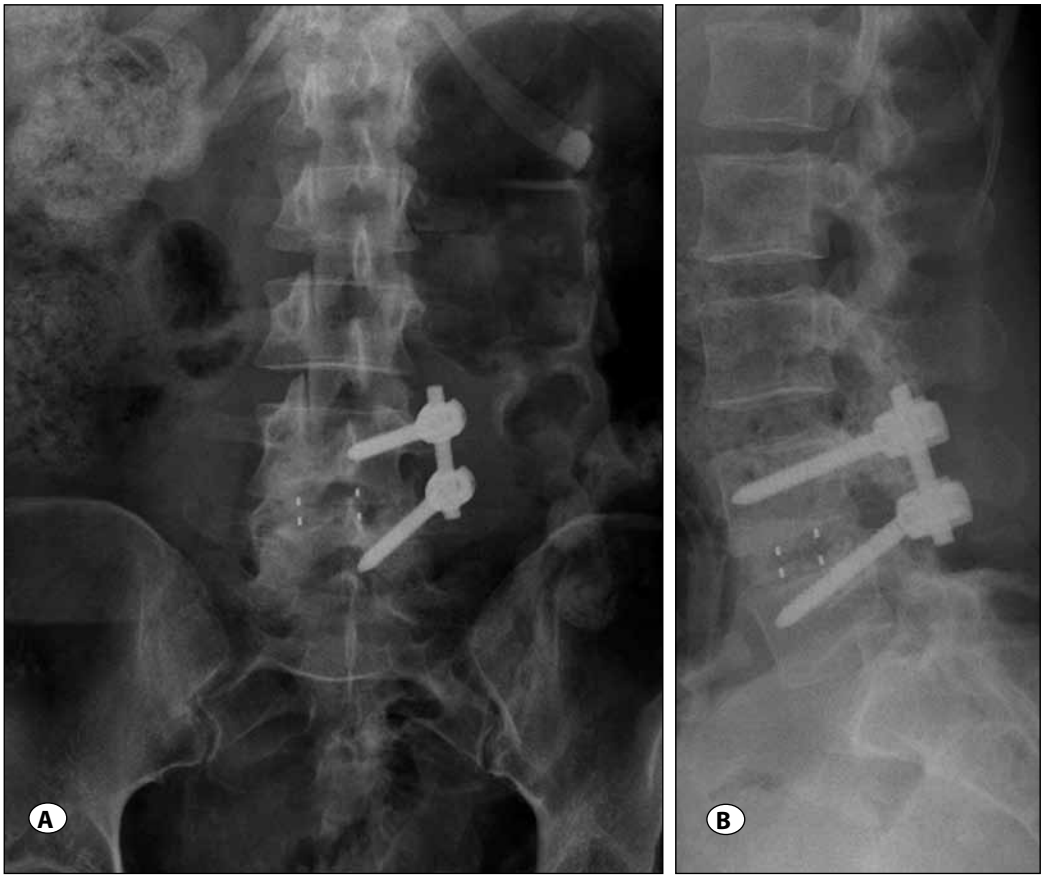

Figure 3: AP **(A)** and Lateral **(B)** X ray images showing unilateral percutaneous instrumentation of L4-5 level with TLIF.

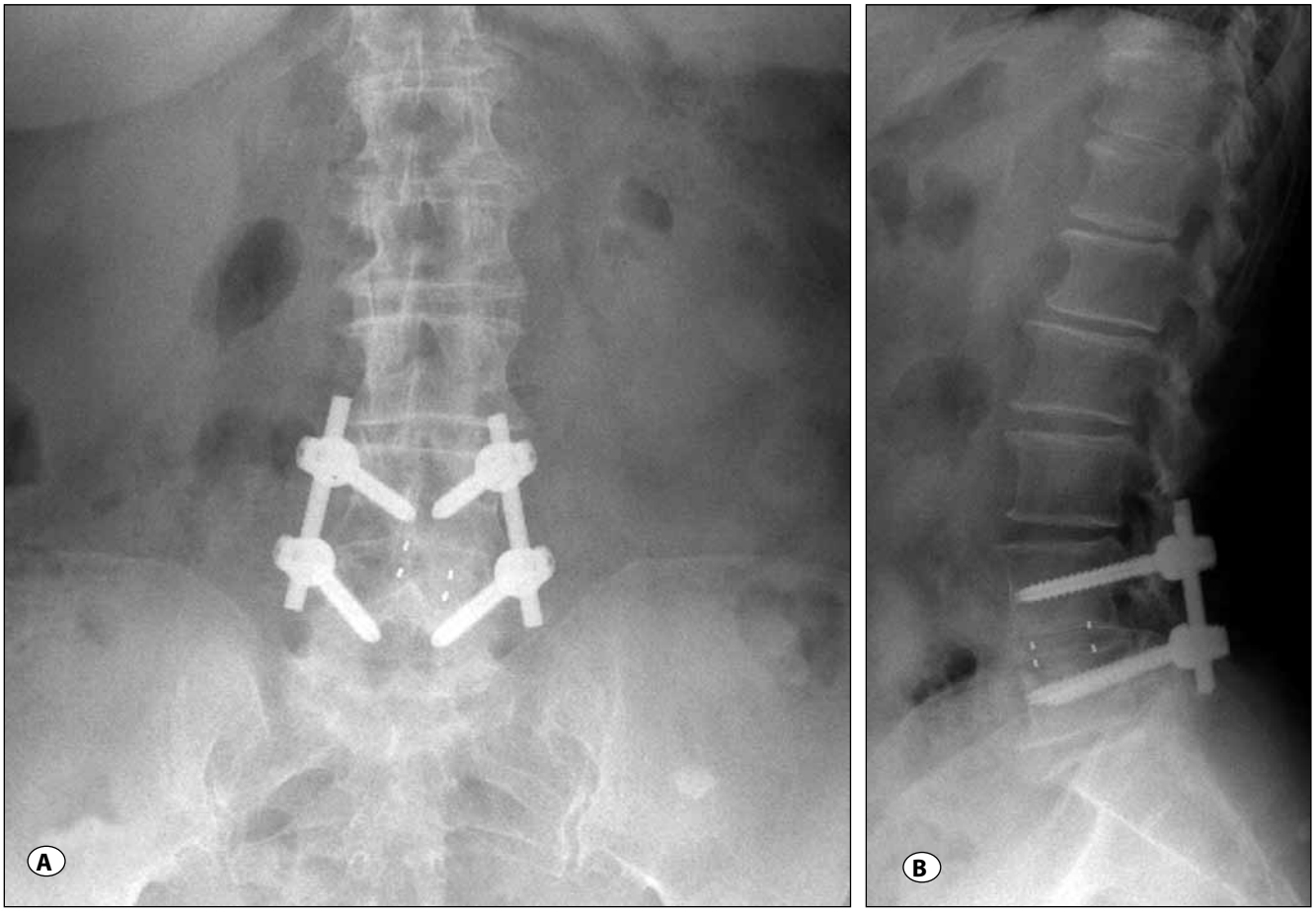

Figure 4: AP **(A)** and Lateral **(B)** X ray images showing bilateral percutaneous instrumentation of L4-5 level with TLIF.

were introduced in a percutaneous manner. All cages and the anterolateral part of the treated disc space were filled with autograft. In group 2 patients, contralateral side instrumentation was also performed by the percutaneous route.

Clinical Assessment

Information from the medical records revealed patient demographics, medical co-morbidities, clinical assessment, surgical time, blood loss, implant information and complications. Postoperative visits were scheduled at 2, 8, and 24 weeks and at 1 and 2 years after the surgery.

Clinical outcomes were graded using the visual analog scale (VAS; score range: 0 to 10, with 0 reflecting no pain); functional outcomes were measured using the Oswestry disability index (ODI) scores. Peroperative and 2 year follow-up scores were obtained. Postoperative imaging techniques were used for the assessment of fusion, subsidence and spinal alignment. Fusion was assessed by plain and dynamic (flexion-extension) X-Rays. Computerized tomography (CT) and single photon emission computerized tomography (SPECT) were obtained in patients with persistent symptoms and/or inconclusive radiographs. Union was defined as solid when there was bony trabecular continuity, less than 4-degree mobility between the segments on dynamic X-Rays, and an intact implant system. Nonunion was defined as a visible gap, graft collapse and motion of greater than 4 degrees (2).

Statistical Analysis

For statistical analysis, an analysis of variance was conducted using the 2 proportions test, independent 2 sample *t* test, χ^2 test, and paired *t* test. A probability value of less than 0.05 was considered significant.

RESULTS

There were 11 females and 9 males in the study. The patients' age in the groups ranged from 30 to 55 years with an average age of 47.3 and 45.6 respectively (Table I). The affected vertebral levels varied from L3 to S1 (Table II). The mean follow-up duration was 2 years, with a range of 1 to 3 years.

In the unilaterally instrumented group, the mean preoperative VAS scores for low back pain and leg pain were 8.5 and 8.45, respectively; they had improved to 1.8 and 2.4 after surgery ($p<0.05$). The mean preoperative ODI score of 69 improved to 31 postoperatively ($p<0.05$). In the bilaterally instrumented group the mean preoperative VAS scores for low back pain and leg pain were 8.4 and 8.6, respectively; they had changed to 1.7 and 2.5 at follow-up ($p<0.05$). The mean preoperative

ODI score of 73 changed to 36 after surgery ($p<0.05$). The differences between the preoperative and postoperative values were statistically significant in both groups (Table III). However, statistically significant difference was not observed between unilaterally and bilaterally instrumented groups.

The mean operation time in the unilaterally instrumented group was 100 minutes while it was 147 minutes in the bilaterally instrumented group. There was a statistically significant difference between the groups ($p<0.05$). The mean intraoperative blood loss among patients in the unilaterally instrumented group was 150 cc whereas it was 165 cc in the bilaterally instrumented group ($p<0.05$). No transfusion was needed in both groups. Staying in hospital in both groups were 2.2 and 2.3 days, respectively ($p<0.05$). A statistically significant difference was not found between the groups in terms of blood loss and duration of hospital stay. Any metal failure, cage migration, vertebral fracture, subsidence or adjacent level disease was not experienced during 2 years of follow-up. Radiological evidence of successful arthrodesis was noted in 8 of 10 patients (80%) in the unilaterally instrumented group and in 9 of 10 patients (90%) in the bilaterally instrumented group at the 2 years follow-up (Table II). The instrumentation system (percutaneous pedicle screw-rod-TLIF cage) in group 1 cost about approximately 2900 Turkish Lira while the system in group 2 cost about 4700 Turkish Lira.

Table I: Patient Demographics

Patient Data	Group 1	Group 2
Age (mean)	47.3	45.6
Sex (M/F)	4/6	5/5

DISCUSSION

Recurrent lumbar disk herniation is a major surgical failure with a reported incidence of 5 to 11% (3,13). The optimal technique for the treatment is controversial. Some surgeons believe that repeat diskectomy is the treatment of choice with clinical results similar to the primary surgery while others believe that fusion is necessary for treating disk reherniation (3,7). Since repeated diskectomy requires the removal of more disc material and/or facet joint, it can increase the risk of segmental instability (3). In a large retrospective follow-up study, Österman et al. reported that patients undergoing multiple revisions after lumbar discectomy had a markedly reduced risk for subsequent operations if the first procedure was a spinal fusion (5.0% vs. 24.9% after discectomy and 27.2% after spinal decompression) (16). Lehmann et al. showed satisfactory results in the 36 patients treated with spinal fusion following previous lumbar disk surgery (15). Therefore, the use of fusion to treat or prevent segmental instability after repeated diskectomy appears to be a reasonable choice in cases of rLDH.

Table II: Peroperative and Postoperative Data

	Group 1	Group 2	p
Operation time (min)	100±7	147±4	<0.05
Blood loss (ml)	150±12	165±18	>0.05
Transfusion	No	No	
Hospital stay (days)	2.2	2.3	>0.05
Screw complication	No	No	
Cage migration	No	No	
Wound infection	No	No	
Subsidence	No	No	
Fusion	8/10	9/10	>0.05
Vertebral Levels			
L3-4	3	3	
L4-5	5	4	
L5-S1	2	3	

Table III: Clinical Follow-up Scores

	VAS				ODI	
	Preop		Postop		Preop	Postop
	Low back	Leg	Low back	Leg		
Group I	8.5±0.8	8.45±0.5	1.8±0.3	2.4±0.4	69	31
Group II	8.4±0.6	8.6±0.7	1.7±0.4	2.5±0.5	73	36

Lumbar fusion could be obtained by both posterolateral and/or interbody fusion techniques (3,19). However, conventional lumbar fusion is associated with significant muscle stripping and retraction that can adversely affect both short- and long-term patient outcomes (6). In contrast, minimally invasive lumbar fusion is performed via a muscle-dilating approach and significantly diminishes the iatrogenic soft tissue injury, intraoperative blood loss, postoperative pain and the duration of hospital stays (10,18).

The minimally invasive TLIF procedure was first described by Foley et al. in 2003 (6). It has since become an increasingly popular method of lumbar arthrodesis. A number of recently published manuscripts have shown the benefits of this novel technique (10,18). Schwender et al. reported 18-month follow-up results of 49 patients that had undergone mis-TLIF surgery. All patients noted significant improvement in their low back pain and radicular pain after surgery. There were statistically significant differences between preoperative and postoperative VAS and ODI scores. The average estimated blood loss was 140 ml while mean hospital stay was 1.9 days. All patients appeared to have solid fusion. The TLIF procedure in minimally invasive fashion was shown to have at least equivalent clinical outcomes compared with conventional open TLIF (18).

The pedicle screw and the rod system is the widely accepted and used system to achieve the most stable and rigid fixation results in patients undergoing fusion surgery (5,19). However, due to the excessive rigidity of the system, this instrumentation is also suspected to cause decreased mineral content in the fixed area and degeneration of adjacent segments (5,19,21). To reduce this rigidity, numerous clinical and biomechanical studies were performed to find the ideal construct (8,12,14,17). Favorable results were reported for lumbar fusion in combination with a unilateral instrumentation system. Goel et al. demostrated a difference in rigidity between the unilateral and bilateral instrumentation in their study. Unilateral instrumentation reduced motion in flexion-extension, lateral bending and axial movements by 40%, 13% and 9%, respectively while bilateral instrumentation reducing by 70%, 65% and 65% (8). Kasai et al. showed that unilateral instrumentation offers only uneven fixation and this results in dispersion of rigidity depending on the direction of bending and rotation (12). Furthermore, Schleicher et al. tested unilateral, bilateral pedicle screws and facet stabilising systems with TLIF. They reported that bilateral pedicle screw instrumentation offers significantly more stability than unilateral pedicle screw instrumentation in the majority of test modes. However, they concluded that all tested stabilization methods could achieve at least the stability of the native segment (17).

Kabins et al. were the first to report a clinical study comparing unilateral vs bilateral instrumentation. They followed the isolated L4-5 fusions using the variable screw system in 36 patients with an average of 25.1 months. They concluded that fusion results with unilateral instrumentation were nearly identical to those of bilateral (11). In their prospective study of 87 patients who underwent unilateral or bilateral instrumentation, Suk et al. demonstrated that unilateral screw fixation was as effective as bilateral screw fixation in lumbar spinal fusion independent of the number of the fusion segments or pedicle screw systems (19). In their prospective, randomized study on 82 patients with degenerative lumbar spondilolisthesis having undergone posterolateral fusion with unilateral or bilateral instrumentation, Fairen et al. found that unilateral instrumentation was as effective as bilateral instrumentation when performed in addition to 1 or 2 level posterolateral fusion (5). Our study is different since these studies are open surgeries lacking interbody fusion, and instead 1 or 2 levels are fused posterolaterally. Deutsch et al. and Beringer et al. reported results similar to our study (1,4). In their prospective study on 34 patients with an average follow up of 9 months, Deutsch et al. reported that mis-TLIF in conjunction with unilateral pedicle screw instrumentation was an effective treatment for axial low back pain in appropriately selected patients (4). Beringer and Mobasser also concluded that unilateral percutaneous pedicle screw instrumentation for the mis-TLIF procedure provided excellent clinical results and was an option in selected patients (1).

Patient selection in our study was based on an individual's history, physical examination and radiological examination. Only rLDH patients with signs of lumbar instability were included. Revision spinal surgery was more challenging than primary surgery, owing to the insignificant anatomical planes and perineural scarring. However, TLIF provided a facilitated approach through facetectomy to enter the unscarred virgin tissue without demanding dissection or excessive retraction of scarred nerve root or dura. We did not encounter any dural laceration or nerve root injury in our study. Blood loss, operation time and hospital stay was consistent with the existing literature (1,4,6,10,18). Fusion rates for open and Mis-TLIF procedures in which bilateral pedicle screw instrumentation is used have been noted to be 90-100% (6,10,18,19,21). In their unilateral percutaneous pedicle screw for Mis-TLIF study, Beringer and Mobasser also reported their fusion rate as 100% on sixth month control (1). Our fusion rate is lower than this value. We can speculate that this difference could originate from the disuse of recombinant human bone morphogenic protein (rhBMP) for interbody fusion in our study. Since the national social security company in Turkey did not allow the use of rhBMP, we only used cage plus local autograft for interbody fusion. In contrast to the existing literature, we did not observe any screw malposition, cage migration, subsidence or wound infection (1,4).

Unilateral pedicle screw instrumentation with Mis-TLIF offers several advantages over the standard open PLIF or TLIF operations (1,4). Less surrounding tissue injury and blood loss potentially allows for less postoperative pain and a quicker recovery. Economic benefits may be realized with lower cost of decreased surgical implant numbers, shorter hospitalization and earlier return to work. Although there are many potential benefits of the Mis-TLIF procedure, the

technique does have its drawbacks and limitations. Mis-TLIF is technically more demanding than open TLIF because of the smaller working area and the need for longer and bayoneted surgical instruments. Furthermore, the surgeon should accurately interpret AP and lateral fluoroscopic images to safely insert percutaneous screws (6,18).

CONCLUSION

The limitations of this study are its small sample size and the selected nature of the cohort. It will also be better to increase our follow-up period over several years. Mis-TLIF with unilateral percutaneous pedicle screw instrumentation is an excellent option in the treatment of selected recurrent disk disease patients. The unilateral approach preserves the contralateral musculature, and allows less complications, and earlier mobilization and return to daily life.

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