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TRANSFORAMINAL LUMBAR INTERBODY FUSION AS REVISION SURGERY FOR PATIENTS PREVIOUSLY TREATED BY DISCECTOMY OR INSTRUMENTATION OF THE LUMBAR SPINE

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ABSRACT

Purpose: Transforaminal lumbar interbody fusion (TLIF) is a surgical method that allows stable fusion of the anterior spinal column and restoration of disc height and lumbar lordosis. The aim of this study was to evaluate the clinical and radiological data of the patients who underwent lumbar discectomy, posterior instrumentation and laminectomy or TLIF surgery and who applied to our clinic with the complaint of discogenic back or leg pain and investigate the effectiveness of procedure.

Material and Methods: Between the years 2012-2016, patients who underwent TLIF procedure were analyzed retrospectively. Inclusion criteria; patients undergone surgery due to any disc pathology from the lumbar region, complaints that did not respond to a minimum of 6 weeks of conservative treatment, patients undergoing revision surgery with two levels or more TLIF procedure with posterior instrumentation and a follow-up period longer than 2 years. Radiological and clinical data of 13 patients who met these criteria were examined for the study.

Results: The study group consisted of 11 women and 2 men. The mean follow-up period was 39.3 months (range 26-58). The mean age was 62.2 (range 56-71). 7 patients had previously undergone lumbar discectomy, 4 patients had posterior instrumentation and laminectomy, 2 patients had posterior instrumentation and TLIF procedure. The dominant complaint was back pain in all patients. There were also complaints of varying rates of radicular pain and combinations of neurological deficit. Indications for revision surgery; lumbar degenerative disc disease, recurrent lumbar disc herniation, lumbar spinal canal stenosis, segmental instability and spondylolisthesis with two levels and higher. A total of 77, mean 5.9 (±1.4) pedicle screws were placed. A total of 32, average 2.4 (±0.5) levels of TLIF were applied. In 8 (61.5%) patients, pedicle screws was augmented with cement. The mean operative time was 378.8 min, and the mean amount of blood loss was 684.6 ml. The mean amount of autotransfusion and allogeneic blood transfusion was 569.2 ml. Mean duration of hospital stay was 4.6 days. One patient had dural tear during the operation. In one patient, the wound drainage that started in the postoperative 10. day was healed with wound debridement and antibiotic treatment. None of the patients had proximal or distal adjacent segment fracture, implant failure, nonunion or loss of correction during the follow-up. Complete neurological recovery was observed in all patients except the patient who was admitted with a 6-month history of foot drop.

Conclusions: TLIF is a safe and effective procedure for the treatment of spinal pathologies in revision surgery. Elimination of spinal stenosis and instability, decompression of nerve roots, restoration of intervertebral disc heights, restoring lumbar lordosis, neutralization of global spinal balance and pain relief are possible.

Key words: Interbody fusion, TLIF, low back pain, spinal stenosis, complications

Level of evidence: Retrospective clinical study, Level III.

INTRODUCTION

Transforaminal lumbar interbody fusion (TLIF) is a method that allows stable fusion of the anterior spinal column and restoration of disc height and lumbar lordosis. It has been successfully applied in the treatment of symptomatic spinal diseases, especially degenerative disc disease (DDD) and spondylolisthesis for approximately 30 years [(3)]. The need for interbody fusion arose from the importance of the anterior spine column instability. In each spine segment, 80 % of compression, torsion and distraction loads

are delivered through the anterior column. Therefore, in order to increase the quality and stability of segmental fusion, the anterior column must be included in the fusion [23].

The TLIF procedure is also used as a revision surgery in patients who have had lumbar discectomy or decompression for some reason and have new or remaining complaints after surgery [24]. Because, circumferential fusion is more prominent in patients with previous laminectomy for stability and bony fusion. The aim of this study was to evaluate the clinical and radiological data of the patients who underwent lumbar discectomy, posterior instrumentation and laminectomy or TLIF surgery and who applied to our clinic with the complaint of discogenic back and leg pain and investigate the effectiveness of procedure.

MATERIAL AND METHODS

Between the years 2012-2016, patients who underwent TLIF procedure were evaluated retrospectively. The inclusion criteria were: patients who had undergone surgery due to any disc pathology from the lumbar spine, patients who did not respond to a minimum of 6 weeks of conservative treatment, patients undergoing revision surgery with two levels or more TLIF procedure with posterior instrumentation and a follow-up period longer than 2 years. The content of conservative treatment was considered as the use of physical therapy, lifestyle activation and anti-inflammatory, analgesic and antidepressant drugs. Indications for revision surgery; lumbar degenerative disc disease, recurrent lumbar disc herniation, lumbar spinal canal stenosis, segmental instability and spondylolisthesis. Patients who underwent primary surgery, Patients who underwent primary surgery, surgery using interbody fusion techniques other than TLIF, TLIF for the reasons other than the indicated indications (trauma, tumor, etc.) and those who received single level TLIF were not included in the study. One of the 18 patients who met the inclusion criteria was lost in follow-up, and 4 patients were excluded from the study because the follow-up period was less than 2 years. Radiological and clinical data of the remaining 13 cases were examined for the study.

Lumbar anteroposterior (AP), lateral and dynamic lateral X-rays, magnetic resonance imaging (MRI) and computed tomography (CT) were performed routinely for preoperative radiological examination. Neurological examination and lower extremity EMG were performed for neurological status evaluation. The evaluation of segmental instability was made according to the criteria described by White and Panjabi on lateral dynamic radiographs [25]. Accordingly, > 3mm shift, > 3mm translation or > 10degree angulation was accepted as unstable.

All surgical procedures were performed by the senior author (MT). Six patients had different degrees of neurological deficits in preoperative physical examination. Preoperative dual energy x-ray absorptiometry (DXA) and bone density measurements (bone mineral density, BMD) were performed in all patients with osteoporosis on preoperative radiographs. Patients with a T-score of -2.5 and below in the anterior-posterior and lateral images were accepted as osteoporotic and pedicle screws were augmented with cement at all or selected levels. In all instrumented levels, bilateral pedicle screws (Legacy, Medtronic, Memphis, TN) were placed.

The TLIF approach was performed with a midline posterior open incision. The fascia was incised, the paravertebral muscles were dissected with the help of Cobb elevator and electrocautery. The appropriate level was determined by fluoroscopy. All implants were removed in patients who had previously undergone posterior instrumentation. Bilateral pedicle screws were placed at all levels. Laminectomy and bilateral facetectomies were completed. Total discectomy was performed. The disc distance was distracted and local autogenous bone graft and interbody cage were placed into the level. After hemostasis and irrigation wound was closed. A more detailed description of the technique has been made in many studies in the literature [12,14,26].

All patients were mobilized in the first postoperative day. Intermittent pneumatic compression cuffs were used for the first three days. AP and lateral radiographs were taken at 6 weeks, 6 months and 2 years after discharge. All radiographs were examined for loss of correction, nonunion, adjacent segment disease and screw loosening or fracture. The presence of 1 mm or more radiolucent area on the screw bone interface was considered screw loosening. The formation of trabecular bone bridges, lack of implant failure, and less than 3 degrees of segmental movement were considered as definitive fusion indications. [16]. All patients were evaluated with Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) at 6 weeks, 6 months and 2 years.

Statistical analysis was performed using IBM SPSS (IBM Corp., Armonk, NY) for Windows. The mean VAS score, ODI score and standard deviations were calculated using the Friedman test and the Wilcoxon Sign test and compared with each other. $P < 0.05$ was considered as statistically significant.

RESULTS

The study group consisted of 11 women and 2 men. The mean follow-up period was 39.3 months (range 26-58). The mean age was 62.2 years (range 56-71). 7 patients underwent lumbar discectomy, 4 patients underwent posterior instrumentation and laminectomy, 2 patients underwent

posterior instrumentation and TLIF procedure. The dominant complaint in all patients was low back pain. There were also complaints of varying rates of radicular pain, back pain, and combinations of neurological complaints. The mean time from revision surgery to primary surgery was 42.3 months (range 11-83). In addition to lumbar DDD, spinal stenosis was detected in 9 (69.2 %) patients, segmental instability in 5 (38.4 %) patients, recurrent disc herniation in 5 patients (38.4 %) and spondylolisthesis in 4 (30.7 %) patients. The demographic data of the patients are summarized in Table-1.

A total of 77, mean 5.9 (±1.4) levels posterior instrumentation were performed. A total of 32, an average of 2.4 (±0.5) levels TLIF procedure was applied (Table-2).

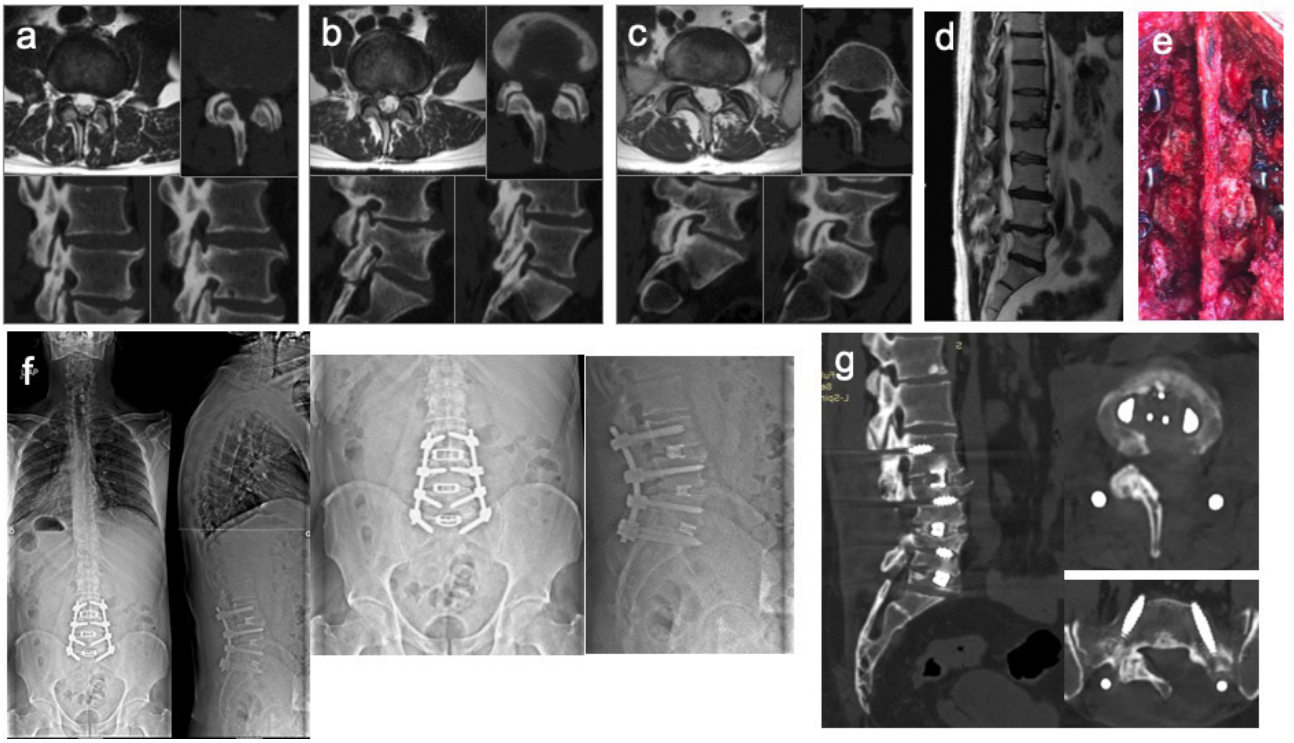

Figure-1. 48 years old male patient. Two years ago, a consecutive three-level laminectomy was performed at L3-L4 **(a)**, L4-L5 **(b)** and L5-S1 **(c)**. Sagittal MRI images shows the degenerative disc disease and herniations **(d)**. Facet joint hypertrophy in the laminectomy levels are seen in clinical view **(e)**. Follow-up AP **(f)** and Lateral **(g)** X rays of the patient. TLIF procedure was performed for three consecutive levels. The fused segments are seen on CT images in follow up **(g)**.

Table-1. Patients demographic data.

Gender F/M (%)	11 (%84), 2 (%16)
Mean age (years)	62.2 ± 4.7
Duration after previous sugery (months)	42.3 ± 18.8
Follow up (months)	39.3 ± 9.8
Pervious surgeries:	
Lumbar discectomy	7 (%53,8)
Posterior instrumentation and laminectomy	4 (%30,7)
Posterior instrumentation and TLIF	2 (%15,3)
Revision Diagnosis:	
Spinal stenosis	9 (%69,2)
Segmental instability	5 (%38,4)
Recurran disc hernia	5 (%38,4)
Spondilolisthesis	4 (%30,7)

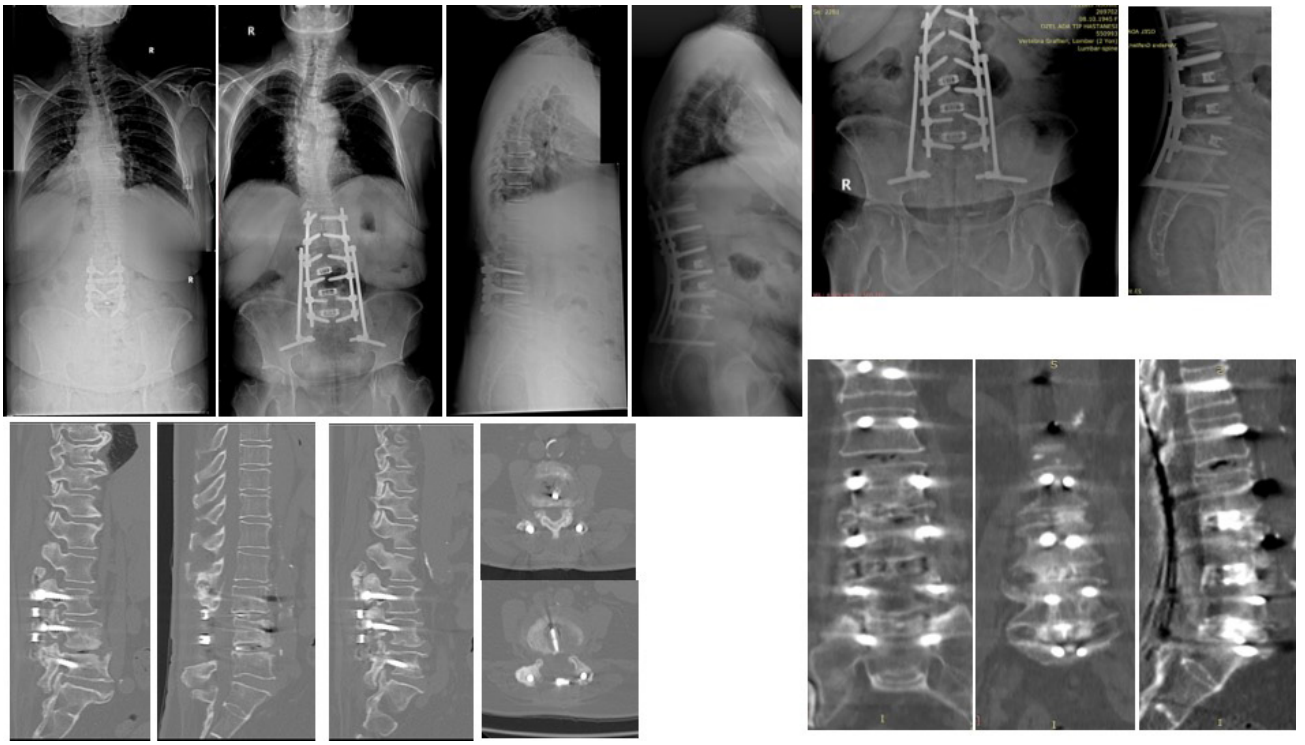

Figure-2. 68 years old female patient. She had a pervious TLIF surgery at L3-L4 and L4-L5 levels. Loss of lumbar lordosis and sagittal spinal balance are seen on preoperative X rays. TLIF procedure was performed at L3-L4, L4-L5 and L5-S1 levels. The fused segments are seen on CT images in follow up.

Table-2. Posterior instrumentation and TLIF levels.

Patient no	Posterior instrumentation	TLIF
1	L2-iliac	L4-L5, L5-S1
2	L3-S1	L3-L4, L4-L5, L5-S1
3	L2-L5	L3-L4, L4-L5
4	T10- iliac	L3-L4, L4-L5, L5-S1
5	L1-L5	L2-L3, L3-L4, L4-L5
6	L1-S1	L4-L5, L5-S1
7	L1- S1	L3-L4, L4-L5, L5-S1
8	L2- iliac	L4-L5, L5-S1
9	L1- iliac	L3-L4, L4-L5, L5-S1
10	L2-S1	L3-L4, L4-L5
11	L2- iliac	L3-L4, L4-L5, L5-S1
12	L1-S1	L4-L5, L5-S1
13	L2- iliac	L4-L5, L5-S1

In 8 (61.5 %) patients, screws were augmented with cement. The mean operative time was 378.8 min, and the mean amount of blood loss was 684.6 ml. The mean amount of autotransfusion and allogeneic blood transfusion was 569.2 ml. The mean duration of hospital stay was 4.6 days (Table-3).

The VAS score was 8.2 (7-10) preoperatively, and it was 2.6 (1-4) at the postoperative 6th week, 2.1 (0-4) at the end of the 6th month and 1.9 (0-4) at the last follow-up. ODI was 46 % (32-64 %) preoperatively, 24.8 % (0-38 %) at the end of the postoperative 6th week, 22.9% (0-34%) at the end of the 6th month, 23.2 % (0-36 %) at the last follow-up. There was a statistically significant decrease in preoperative and final follow-up VAS and ODI scores (P <0.0001) (Table-4).

Table-3. Patients clinical data.

Operating time (min)	373,8 ± 78
Intraoperative blood loss (ml)	684,6 ± 339,9
Amount of transfusion (ml)*	569,2 ± 256,2
Duration of hospital stay (day)	4.6 ± 1.1
Complications	
Dural tear	1 (%7,6)
Wound infection	1 (%7,6)

* Sum of autotransfusion and allogenic blood transfusion.

Figure-3. 59 years old male patient. He had a pervious lumbar discectomy surgery at L4-L5 and L5-S1 levels. MRI shows reherniations at same levels. TLIF procedure was performed at L4-L5 and L5-S1 levels.

Tablo-4. Preoperative and postoperative VAS ve ODI scores.

VAS	
Preoperative	8.2 (7-10)
Postoperative 6th week	2.6 (1-4)
Postoperatif 6 th month	2.1 (0-4)
Latest	1.9 (0-4)
ODI	
Preoperative	%46 (%32-64)
Postoperative 6th week	%24,8 (%0-38)
Postoperatif 6th month	%22,9 (%0-34)
Latest	%23,2 (%0-36)

Complete neurological recovery was observed in all patients except the patient who was admitted with a 6-month history of drop foot in the preoperative period. This patient was mobilized with an ankle foot orthosis.

One patient had dural tear during the operation. Fascia graft was used for primary repair with 5-0 nonabsorbable suture, fibrin glue was placed and closed. The patient was taken to bed rest for 3 days and no postoperative leakage or wound complications were observed. In one patient, a wound drainage occurred in the postoperative tenth day. Methicillin resistant S. aureus was detected in the culture. Wound debridement was performed and the infection was completely healed after 3 months of treatment with appropriate antibiotics. Radiographic examinations revealed solid bone fusion in all patients. Proximal or distal adjacent segment fracture, nonunion, implant failure or loss of correction were not observed.

DISCUSSION

In this study, we evaluated the clinical and radiological results of 13 patients who underwent surgical revision with two or more levels of TLIF procedure. In spinal revision surgery, circumferential fusion is the most precise method to achieve stability and bony fusion. For this reason, especially in revision surgeries, TLIF stands out as a salvage procedure. The aim of our study is to investigate the effectiveness of TLIF method in clinical and radiological terms.

With circumferential fusion, a more clinically stable bony fusion mass is obtained when compared with anterior or posterior fusion alone [19]. Today, many techniques are used to obtain interbody fusion. The most commonly used TLIF procedure was first described by Harms and Rolinger [8]. As an alternative to posterolateral fusion (PLF) and posterior lumbar interbody fusion (PLIF), it has begun to be used in increasing rates and has become widespread [1,9,20]. Compared with PLIF, TLIF procedure has many advantages; it provides a larger bone fusion area, a complete approach for medial and lateral decompression and restores the intervertebral height [2]. In addition, the complication rates are lower compared to PLIF procedure, because retraction of the dural sac and nerve roots is not necessary, does not form an epidural scar, and the amount of intraoperative blood loss is less [5,7,21].

Scheufler et al. analyzed the patients who had percutaneous TLIF procedure due to degenerative lumbar instability. They reported good results in single or multi-level applications [15]. Hsieh et al. compared the anterior lumbar fusion with the TLIF procedure, found that ALIF was better than for TLIF in providing foraminal height, restoration of local disc angle and lumbar lordosis, but at the end of two years there was no clinically significant difference between the two groups ($p < 0.05$) [10]. In a study by Starkweather et al. comparing posterior lumbar fusion with TLIF, it was found that pain was significantly decreased in TLIF patients at sixth week compared to the other group. In the same study, interleukin IL-6, which is an indicator of nerve regeneration and recovery in the TLIF group, was found to be high [18]. Ploumis et al. compared ALIF and TLIF and did not detect biomechanical differences between the two techniques [13]. Chen et al. have detected fusion in all patients in whom TLIF procedure was augmented for recurrent lumbar disc hernias [4].

With the technologic development of instrumentation techniques and medical devices, TLIF procedure has been applied with minimally invasive technique and in the literature, this technique has advantages such as less blood loss, less soft tissue damage, smaller wound incision and shorter hospital stay [3]. However, although similar fusion rates have been reported, the duration of the operation is longer with minimally invasive technique, higher radiation exposure occurs and a higher rate of neurological deficit is observed due to the learning curve [11,17,22]. Since the patients in this series have had previous surgeries with one or more lumbar levels, open surgical technique is preferred by the senior author in our clinic. In patients who are scheduled for revision surgery with two or more levels of TLIF whether they are discectomy-related hemilaminectomy, or instrumentation and total laminectomy, access to the discectomy site is more limited, and the risk of dura injury and iatrogenic neurological deficit is higher.

Revision surgery may be defined as secondary operations in patients who have previously been operated with one of the same level or levels as discectomy, hemilaminectomy, laminectomy, posterior instrumentation and fusion. All patients in our series had previous surgeries in another center consisted of lumbar discectomy, laminectomy, posterior instrumentation or TLIF. Lumbar degenerative disc disease and accompanying spinal stenosis, instability, adult scoliosis and spondylolisthesis were detected in radiological investigations due to discogenic and radicular symptoms. In all patients, interbody fusion with TLIF was performed in the lumbosacral zone, depending on the disc pathologies in the relevant segments of the patient, resulting in adequate bony fusion from both anterior and posterior column. It has been shown in the literature that pedicle screws with cement augmentation in osteoporotic spine increases attachment and stability in screw bone interface [6]. In this study, the screw augmentation of 8 patients were performed with cement. We think that the absence of adjacent segment fracture, implant failure, nonunion or loss of correction in our series is also related with pedicle screw augmentation with cement in osteoporotic patients. Complete neurological recovery was observed in all patients except the patient who was admitted with a 6-month history of drop foot. Neurological recovery rates indicates the effectivity of the procedure on the decompression of neural structures.

The most important limitation of this study is the lack of a control group and retrospective design. The second limitation is relatively few patients and the short follow-up period. Randomized prospective controlled trials with large series with longer follow-up are needed.

CONCLUSION

The results of this study indicates that TLIF is a safe and effective procedure for the treatment of spinal pathologies in revision surgery. Elimination of spinal stenosis and instability, decompression of nerve roots, restoration of intervertebral disc heights, restoring lumbar lordosis, neutralization of global spinal balance and relieving pain can be achieved. In addition providing circumferential fusion with avoiding anterior surgery is an important advantage.

Conflicts of interest: There are no conflicts of interest in connection with this paper, and the material described is not under publication or consideration for publication elsewhere.

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