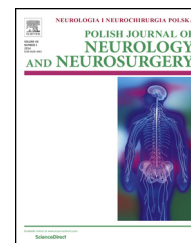


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Original research article

Unilaterally posterior lumbar interbody fusion with double expandable peek cages without pedicle screw support for lumbar disc herniation



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ABSTRACT

Objectives: Posterior lumbar interbody fusion (PLIF) is usually bilateral procedure, and it is combined with posterior by bilateral pedicle screw support or with fixation. The purpose of this retrospective study was to compare the surgical outcomes of simple discectomy and PLIF without pedicle screw support in patients with lumbar disc herniation (LDH).

Patients and methods: 60 patients with single segment LDH were operated between February 2010 and June 2013. 40 patients were treated with simple discectomy (Group 1) and 20 patients were treated with PLIF using double expandable polyetheretherketone (PEEK) cages without instrumentation (Group 2) unilaterally. Pain and function were evaluated by the visual analog scale (VAS) and Oswestry disability index (ODI) before and 18 months after surgery. Besides, PLIF patients were evaluated with computerized tomography (CT) scan of lumbar vertebra for the evaluation of the height of the disc, instability and fusion.

Results: Both leg and low back pain VAS scores were significantly improved 18 months after surgery in both of the groups ($p < 0.001$). Significant decrease in VAS low back pain scores was seen in group 2 when compared to group 1 ($p < 0.001$). Height of the intervertebral disc space was preserved and no instability was detected in group 2. No recurrence and 80% fusion rate was achieved in group 2.

Conclusion: This study showed that unilateral PLIF intervention with double expandable PEEK cages without pedicle screw support would be sufficient in the management of single segment lumbar disc herniation in patients whom are thought to have lumbar stabilization.

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1. Introduction

Lumbar disc herniation (LDH) is one of the most common reasons for back and leg pain. Surgical management is considered in patients unresponsive to conservative treatment. Excision of the herniated nucleus pulposus with lumbar discectomy is still the most effective treatment option in this disease. [1,2]. Although discectomy has successful clinical outcome in the early period, its success rate decreases to 40–80% in the long term due to residual low back pain and recurrence disc herniation [3–5]. To avoid residual low back pain and recurrence of disc herniation, combination of interbody fusion with discectomy is advised [6,7]. The necessity and efficiency of utilizing fusion after simple discectomy in patients with single segment lumbar disc herniation is still controversial [3,5,8–11].

Various techniques like transforaminal lumbar interbody fusion (TLIF), anterior lumbar interbody fusion (ALIF), posterior lumbar interbody fusion (PLIF) and interbody cage devices have been described for fusion [1,5,12–14]. PLIF was first defined by Cloward for lumbar disc herniation [8]. Autograft, allograft, interbody cages are used for fusion in PLIF technique. Recently, expandable interbody cages are being used in PLIF. The advantages of expandable interbody cages in preservation of the intervertebral disc, height of the foramina and segmental lordosis have been shown [15,16]. Its other advantages are providing mechanical support and increasing the surface area for bone fusion. Its efficiency has been evaluated a few number of studies [15]. PLIF is usually a bilateral procedure. It is combined with posterior bilateral pedicle screw supporter with fixation. On the other hand, it is well known that unilateral facetectomy has not cause important instability [6,17,18]. Is posterior fixation with pedicle screws necessary for PLIF in unilateral facetectomy performed patients?

In this retrospective study, the clinical outcomes of bilateral lumbar expandable tool locked polyetheretherketone (PEEK) cage application without fixation via unilateral approach for PLIF and simple discectomy in patients with single segment lumbar disc disease who did not have prominent radiological instability were compared. Radiological findings in PLIF patients were also presented.

The purpose of our study is to evaluate the adequacy of PLIF with expandable PEEK cages without the support of the pedicle screw in patients with single level lumbar disc herniation with preserved intervertebral disc height and comparison of this technique with standard discectomy procedure according to clinical and radiological responses.

2. Materials and method

2.1. Patient selection

60 patients who were operated for lumbar disc herniation in our neurosurgery department from February 2010 to June 2013 were enrolled in the study. 40 patients underwent simple discectomy (Group 1). Unilateral PLIF application without posterior fixation with pedicle screw was performed to the

remaining 20 patients (Group 2). Hospital archives and PACS were retrospectively analyzed. The inclusion criteria was; being 20–60 years old, back and unilateral leg pain unresponsive to at least 2 months of conservative treatment, single segment unilateral disc herniation seen on magnetic resonance imaging (MRI) and the presence of dynamic X-ray imaging preoperatively. Patients with preserved intervertebral disc height were enrolled in this study. Patients who had instability on the preoperative dynamic X-ray imaging of the lumbar region, presence of multilevel lumbar disc herniation, history of previous surgery were excluded from the study.

2.2. Surgical procedure

All patients underwent surgery under general anesthesia in the prone position. 40 patients underwent simple discectomy procedure (Group 1). After proper skin preparation followed by nearly a 5 cm skin incision, paravertebral muscles were dissected unilaterally. Partial hemilaminectomy was performed. Then, ligamentum flavum was excised. Simple discectomy was performed by clearance of disc tissue pressuring the neural tissue. The operation was terminated after ensuring the relief of neural tissue. After unilateral facetectomy, aggressive discectomy was performed and the endplates were shaved with the help of a curette on the symptomatic side in the PLIF group (Group 2). The expandable PEEK cage (CK Group, Tr, Turkey) supported with autograft and allograft bone grafts was placed in the intervertebral disc space. After the first cage was expanded it was pushed to pass the midline. Its placement was visualized with the fluoroscope then the second cage was placed on the same side and it is expanded (Fig. 1). The cages were carefully selected according to the height of the intervertebral disc space. Ultimate care was taken to avoid probable neural damage.

2.3. Outcome measures

Age, gender, level of surgery, durations of surgery and hospital stay were recorded for each patient. All of the patients had follow-up visits on the 2nd week, 12th and 18th months postoperatively. All of the patients underwent direct X-ray imaging in the early postoperative period and on the 12th month. PLIF patients were evaluated with CT scan of lumbar vertebra for the evaluation of the stability and fusion on the 12th month. The height of intervertebral disc space, lumbar axis and fusion rates were recorded based on CT imaging.

Oswestry disability index (ODI) scores and visual analog scale (VAS) pain scores were evaluated preoperatively and on the 18th months follow-up after surgery. The VAS pain score was measured by asking the patient to locate the severity of the pain on a horizontal line and score it on a scale of 0 to 10, with 0 representing no pain and 10 representing the most severe pain. The Oswestry low back pain disability questionnaire is an international tool in which disability is scored as follows: 0 to 20, minimal disability; 20 to 40, intermediate degree of disability; 60 to 80, disabling pain; and 80 to 100, bedridden with severe pain.

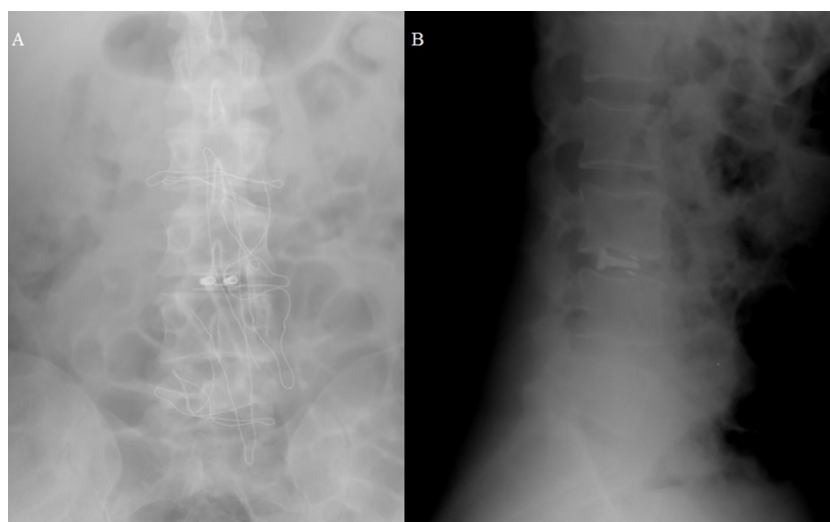


Fig. 1 – On the postoperative 1st day control posteroanterior (A) and lateral (B) lumbar direct graphics of 44 years old male patient, the position of cages was seen at L3-4 intervertebral disc space.

2.4. Statistical analysis

R 3.2.1. Software was used for the statistical analysis. Descriptive statistics were represented with mean and standard deviation for continuous variables; they were represented with frequency and percent for quantitative variables. Independent samples *t*-test and Mann Whitney *U* tests were used for comparisons of continuous variables between 2 groups for normal and non-normal distributed variables. Similarly paired samples *t*-test and Wilcoxon test were used for dependent variables. Pearson and Yates chi-square tests were used for comparisons of categorical variables. For all statistical comparisons with a *p* value below 0.05 assumed as statistically significant.

3. Results

The demographical characteristics of 40 patients with simple discectomy and 20 patients with PLIF are shown in [Table 1](#). There was no statistically significant difference between the groups in terms of age, gender and the level of affected area ([Table 1](#)). In the simple discectomy group, 4 patients had L3-4 disc herniation, 21 patients had L4-5 disc herniation and the remaining 15 patients had L5-S1 disc herniation. In the PLIF group, 3 patients had L3-4 disc herniation, 10 patients had L4-5 herniation and 7 patients had L5-S1 disc herniation.

The preoperative and postoperative VAS and ODI scores are shown in [Table 1](#). There was no statistically significant

Table 1 – Baseline characteristics and outcomes of the patients.

	Group 1	Group 2	<i>p</i> Value
Patients	40	20	
Mean ages (years)	31 (24–59)	33.5 (24–58)	0.48
Male (n, %)	24 (60%)	12 (60%)	1.0
Female (n, %)	16 (40%)	8 (40%)	
Involved segments (n, %)			
L3-4	4 (10%)	3 (15%)	
L4-5	21 (52.5%)	10 (50%)	0.86
L5-S1	15 (37.5%)	7 (35%)	
Leg pain (VAS)			
Mean preop	7.46 ± 0.86	7.35 ± 0.80	0.66
Mean postop	2.47 ± 0.63	2.44 ± 0.58	0.86
Low Back pain (VAS)			
Mean preop	6.90 ± 0.99	7.25 ± 0.56	0.15
Mean postop	3.83 ± 0.90	2.77 ± 0.71	<0.001
ODI			
Mean preop	54.65/100 ± 11.02	57.10/100 ± 9.89	0.41
Mean postop	14.95/100 ± 4.55	14.60/100 ± 4.06	0.32
Operation time (min)	56.63 ± 7.71	86 ± 7.12	<0.001
Postoperative hospital stay (days)	2.0 ± 0.51	2.55 ± 0.69	0.02

VAS, visual analog scale; ODI, Oswestry disability index.

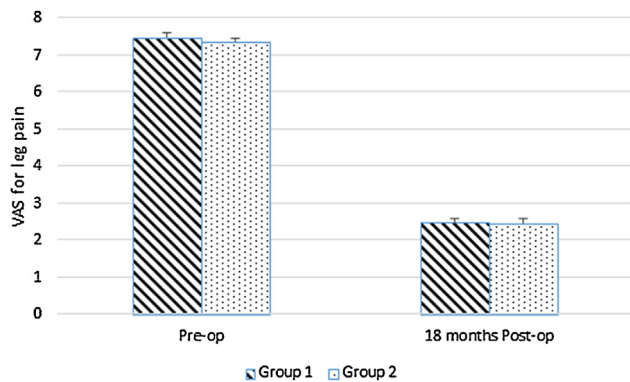


Fig. 2 – The mean pre-operative and post-operative VAS scores for leg pain before surgery and 18 months after surgery. Significant decrease recorded in both groups after surgery ($p < 0.001$). Comparison of group 1 and group 2 showed no significant differences ($p = 0.860$). Pre-op, Pre-operative; Post-op, Post-operative.

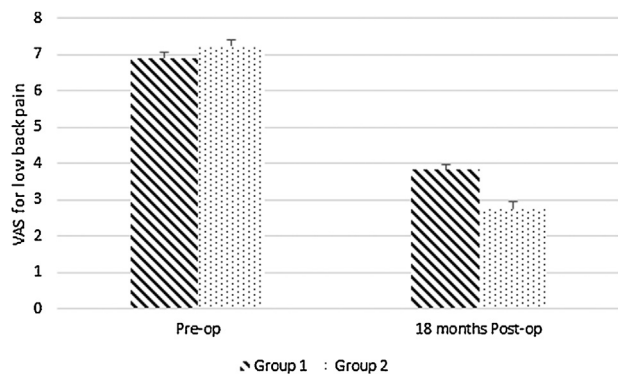


Fig. 3 – The mean pre-operative and post-operative VAS scores for low back pain before surgery and 18 months after surgery. Significant decrease recorded in both groups after surgery ($p < 0.001$). Compared to group 1, the VAS was significantly decreased in group 2 ($p < 0.001$). Pre-op, Pre-operative; Post-op, Post-operative.

difference between preoperative leg and low back pain VAS scores ($p = 0.66$ and 0.15 respectively). On the postoperative 18th month follow-up, significant decreases in back and leg pain were seen in both group 1 and group 2 ($p < 0.001$ and < 0.001 respectively). A statistical analysis was carried out, revealing no significant difference between the groups in relation to the postoperative 18th months mean leg pain VAS scores ($p = 0.86$) (Fig. 2). On the other hand, statistically significant decrease in VAS low back pain scores was seen in group 2 when compared to Group 1 ($p < 0.001$) (Fig. 3).

No statistically significant difference was observed between the preoperative ODI scores of the groups ($p = 0.41$). Statistically significant decrease in ODI scores was seen in both of the groups postoperatively ($p < 0.001$). There was no statistically significant difference for postoperative ODI scores in groups ($p = 0.32$) (Fig. 4).

The average operation time was 56 min in group 1. It was 86 min for group 2. Average hospital stay was 2 days in the first

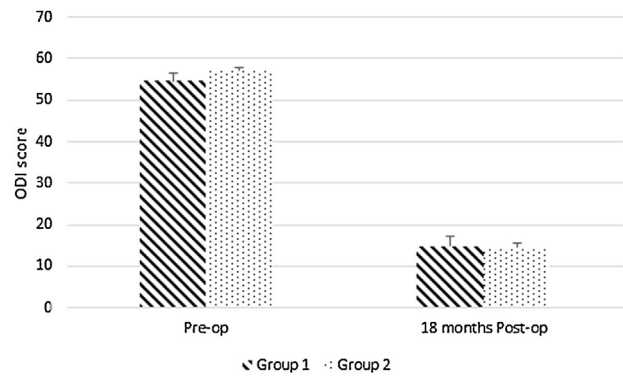


Fig. 4 – The mean pre-operative and post-operative ODI scores before surgery and 18 months after surgery. Significant decrease recorded in both groups after surgery ($p < 0.001$). Comparison of group 1 and group 2 showed no significant differences ($p = 0.324$). Pre-op, Preoperative; Post-op, Postoperative.

group. It was 2.5 days in the second group. The patients in group 2 were mobilized with corset for two months. There were statistically significant differences for operation time and average hospital stay between two groups ($p < 0.001$ and 0.02 respectively).

No serious complication and neurological injury were observed in both of the groups during the operation and in the postoperative period. Superficial surgical site infection was observed on the postoperative 10th day, in one of the patients in Group 1, which was treated with antibiotics. Two patients in the group 1 had recurrence (5%). No recurrence was recorded in the group 2.

Height of the intervertebral disc space was preserved in all of the patients in group 2 according to the comparison of pre-op and one-year control CT images ($p = 0.08$). Development of fusion was observed in 16 (%80) patients in group 2 as visualized on CT imaging (Fig. 5). Radiological instability was not observed on control CT images of group 2.

4. Discussion

PLIF procedure and its role in the treatment of lumbar disc herniation was first defined by Cloward [8]. Current PLIF procedure usually consists of neural decompression with discectomy and laminectomy followed by the placement of the appropriate sized cages into the intervertebral disc space. The purpose of this procedure is the prevention of lumbar lordosis, the height of intervertebral space and narrowing of foramina of the vertebrae. The removal of the facet joints during the placement of the implant causes iatrogenic instability. This could be prevented by the application of pedicle screw. This increases the neural and muscular injury risk causing additional cost. Even though supporting the interbody fusion with pedicle screws is known to be an effective method to increase fusion rates, there are a number of studies showing that fusion does not have any effect on clinical improvement [19–21]. There are no reports of

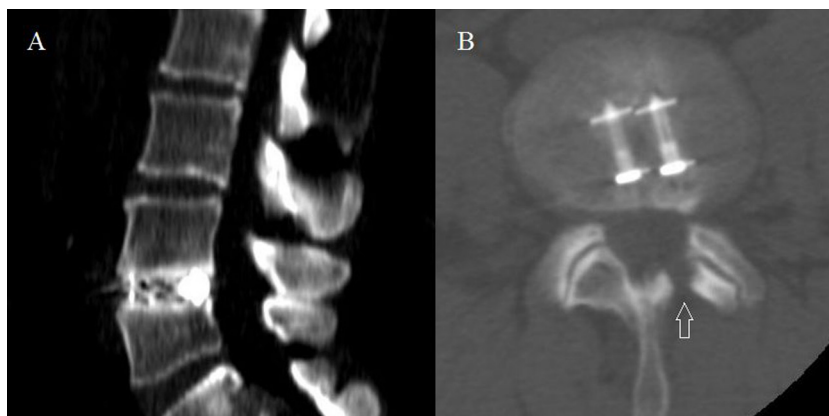


Fig. 5 – On the postoperative 12th month sagittal (A) CT image of 42 years old female patient, development of fusion and prevention of height were seen at L4-5 intervertebral disc space. On the axial CT image (B), the position of cages was seen.

segmental instability after unilateral facetectomy without fixation [18].

A cadaver study described that the disruption of posterior stabilizing elements including the lamina, posterior longitudinal ligament and intervertebral disc during discectomy resulted in significant destabilization in all of the test parameters, especially flexion-extension. The utilization of PLIF alone, decreases mean angular displacement and percentage of range of motion (ROM) restoring stiffness to near intact levels [22]. Lund et al. reported that stand-alone cages are inefficient in spinal segmental stabilization [23]. The better results in ROM for rotation, can be explained by expanding the disc space and putting more tension to the annulus by expandable cages [22,23]. Another disadvantage of using the cage on its own is the possibility of flat back syndrome or neighboring segment degeneration caused by the long-term effects of decrease in lordosis. The utilization of screws supporting the cage could help solve this problem [22,24,25].

In a prospective study done by Kotil et al., TLIF application without pedicle screw in patients with single level lumbar disc herniation without instability was found to be as effective as pedicle screw application [6]. The advantages of TLIF application were reported to be less invasiveness, avoidance of radiological artifacts, shorter hospital stay, shorter duration of operation, lower costs, avoidance of the complications of pedicle screws and sufficient fusion rates [6].

In our study it was observed that by the utilization of two expandable tool locked PEEK cages parallel to each other into the intervertebral disc space with the unilateral approach, angular displacement in vertebral bodies could be avoided. The placement of two cages increased the surface area aiming to increase the rate of fusion. On the 12th month postoperative follow-up 80% fusion was seen radiologically. The fusion rates in patients with posterior fixation are 89–100% [6,19–21,26,27]. The clinical improvement and radiological stability rates in our study are comparable to patients who underwent fusion. As previously reported, fusion rates are not fully correlated with clinical improvement [6,19–21,26,27]. We observed that, intervertebral disc height was preserved in all patients in group 2. In the light of these results, we believe that

preservation of the intervertebral disc height is another important factor like fusion, for clinical improvement. The size of the cage that would be placed into the intervertebral disc space following radical discectomy has grave importance. Goh et al. concluded that large cages manage to restore the torsional stiffness of the facetectomized functional spine units [28]. No segmental instability was observed in any of the patients in group 2. Long term follow-ups of these patients could provide more information about this possible complications.

The cost of PLIF application with 2 expandable tool locked PEEK cages is 800 USD, while addition of 4 pedicle screws increases the cost to 1500 USD. With the utilization of unilateral cage placement, possible neural injury due to pedicle screw placement is prevented. Since this method is done from one side only, bilateral dissection of the muscles is not necessary thus more rapid healing is expected.

Adjacent segment disease is another probable problem after lumbar fusion surgery. Its reported incidence is 5.2–29% [29–31]. In our study, radicular symptoms were not observed in any of the patients who underwent PLIF thus MRI was not needed. It is also reported that all adjacent segment disease cases are not symptomatic [5]. It is not possible to comment on adjacent segment disease according to records in our study.

In lumbar disc herniated patients, better results of low back pain have been reported during the postoperative period in fusion groups than discectomy groups [12,13,32]. Improvement in VAS and ODI scores was observed in both of the groups in our study. Leg pain in both simple discectomy and PLIF patients improved significantly but there was no significant difference between the groups. Although significant improvement in low back pain was seen in both groups: the improvement in patients in groups 2 was statistically more significant than group 1.

Recurrent disc herniation is another important factor affecting the long-term outcomes in patients with lumbar disc herniation. Its incidence is reported to be 7.3–18% [4,5,12]. In our study two patients in the simple discectomy group had recurrence (5%). MRI was performed because of radicular pain that started at the postoperative 12th month in the first patient and 14th month in the second patient. Ipsilateral recurrent

lumbar disc herniation was recorded at the same level in both patients and redo operations were performed. It is probable that this rate could increase in long term follow-ups. No recurrence was recorded in patients that underwent PLIF. Rish proposed spinal fusion as a part of the first operation for lumbar disc herniation [12]. Satoh et al. reported that recurrent disc herniation could be prevented with PLIF [5]. They pointed out that massive herniation and the presence of segmental instability are indications for fusion [5]. We believe that, PLIF procedure without instrumentation is superior to simple discectomy for the prevention of recurrent disc herniation, in patients with preserved intervertebral disc height.

5. Conclusion

PLIF with expandable PEEK cage is an appropriate method to maintain the height of the disc in single level disc patients. Unilateral neural decompression and fusion can be achieved with the unilateral approach in patients with single sided pathologies. In addition to significant clinical improvement in back and leg pain, it is effective in safe keeping the lumbar axis. Additional muscle injury is prevented, as it is not supported with bilateral pedicle screw. Potential neural injury with the utilization of pedicle screws is thus prevented. Its low complication and high success rates make this procedure a novel approach in patients with single segment lumbar disc herniation with preserved intervertebral disc height. Despite of these positive results, long-term follow-up results of these patients and studies with more patient volume are needed to achieve more reliable results.

Conflict of interest

None declared.

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None declared.

Ethics

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals.

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