CLINICAL ARTICLE

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Clinical Comparison of Posterolateral Fusion with Posterior Lumbar Interbody Fusion

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Objective : The purpose of this study is to compare the outcomes of two methods for stabilization and fusion : Postero-Lateral Fusion (PLF, pedicle screw fixation with bone graft) and Posterior Lumbar Interbody Fusion (PLIF, cage insertion) for spinal stenosis and recurred disc herniation except degenerative spondylolisthesis.

Methods : Seventy one patients who underwent PLF (n=36) or PLIF (n=35) between 1997 and 2001 were evaluated prospectively. These two groups were compared for the change of interbody space, the range of segmental angle, the angle of lumbar motion, and clinical outcomes by Prolo scale.

Results : The mean follow-up period was 32.6 months. The PLIF group showed statistically significant increase of the interbody space after surgery. However, the difference in the change of interbody space between two groups was insignificant (P value= 0.05). The range of segmental angle was better in the PLIF group, but the difference in the change of segmental angle was not statistically significant (P value=0.017). Angle of lumbar motion was similar in the two groups. Changes of Prolo economic scale were not statistically significant (P value=0.193). The PLIF group showed statistically significant improvement in Prolo functional scale (P value=0.003). In Prolo economic and functional scale, there were statistically significant relationships between follow-up duration (P value<0.001), change of interbody space (P value<0.001), and range of segmental angle (P value<0.001).

Conclusion : Results of this study indicate that PLIF is superior to PLF in interbody space augmentation and clinical outcomes by Prolo functional scale. Analysis of clinical outcomes showed significant relationships among various factors (fusion type, follow-up duration, change of interbody space, and range of segmental angle). Therefore, the authors recommend instrumented PLIF to offer better clinical outcomes in patients who needed instrumented lumbar fusion for spinal stenosis and recurred disc herniation.

KEY WORDS : Lumbar spine fusion · Spinal stenosis · Postero-lateral fusion · Posterior lumbar interbody fusion.

Introduction

Degenerative lumbar spondylosis is a common cause of a lower back pain. Herniated intervertebral disc is a cause of radiculopathy, and spinal stenosis is a cause of neurogenic intermittent claudication and radiculopathy[1,8,15,26]. Surgical intervention is recommended for spinal stenosis with symptoms[4,8,10]. The purpose of surgery is the decompression of the neural elements to relieve symptoms of claudication and to maintain the spinal stability[1,4,8,10]. Concomitant instrumentation has been recommended to prevent progression of spinal instability after decompression and to reduce the post-operative back pain[1,8,20,24]. Recently, the spinal fusion implants and instruments have been developed.

There are considerable debates among spine surgeons regarding instrumented pedicle screw fixation (Postero-lateral Fusion; PLF) and/or interbody cages fixation (Posterior Lumbar Interbody Fusion; PLIF) and other fixation methods also should be used when decompressive laminectomy and foraminotomy are performed to relieve neural compression and to maintain spinal stability. Authors evaluated the clinical outcomes after PLF or PLIF for spinal stenosis and recurred disc herniation by pre-operative and post-operative clinical and radiological data in seventy one patients.

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Materials and Methods

Between January 1997 and December 2001, 726 patients underwent lumbar fusion for degenerative diseases in our hospital. Of the 726 patients, 102 patients had instrumented fusion surgery for symptomatic lumbar stenosis and re-herniated disc disease. Patients with degenerative lumbar spondylolithesis were excluded from this study. Of the 102 patients, 71 patients participated in clinical and radiological follow-up for more than 24 months. Of the 71 patients, 36 patients underwent PLF (lumbar pedicle screw fixation with bone graft), and 35 patients underwent PLIF (lumbar cage insertion). The patients' medical records were thoroughly reviewed, including their age, sex, whole body weight, and height for obesity (Ideal body weight ratio).

Table 1. Prolo Economic and Functional Rating Scale

Score	Description
Economic status	
E1	Complete invalid
E2	No gainful occupation (including ability to do housework or continue retirement activities)
E3	Able to work but not at previous occupation
E4	Working at previous occupation on part-time or limited basis
E5	Working at previous occupation with no restrictions of any kind
Functional status	
F1	Total incapacity (or worse than preoperative)
F2	Mild-to-moderate level of low back pain and/or sciatica (or pain same as preoperative but able to perform all daily tasks of living)
F3	Low level of pain and able to perform all activities except sports
F4	No pain, but has had one or more recurrences of low back pain or sciatica
F5	Complete recovery, no recurrent low back pain, and able to perform all previous sports activities

Table 2. Summary of Patient Data

	PLF (mean)	PLIF (mean)
Age	29-72 (54.4)	26-70 (47.6)
Sex		
Male	20	20
Female	16	15
Disease		
Stenosis	34	20
Recurred disc	2	15
Obesity (IBW ratio, %)	76.9-130.2 (94.6)	69.4-131.0 (95.5)
Follow-up (month)	16-54 (32.6)	21-56 (29.7)
Symptom & sign		
Low back pain	34	35
NIC	22	29
SLR	25	11

PLF = posterolateral fusion ; PLIF = posterior lumbar interbody fusion ; IBW = ideal body weight ; NIC = neurogenic intermittent claudication ; SLR = straight leg raising sign

Clinical outcomes were evaluated using the Prolo economic and functional rating scale (Table 1)[16]. Radiological data were evaluated on pre-operative and follow-up lateral lumbar dynamic radiographs. Change of interbody space was measured by Farfan[7,12] method on neutro-lateral radiography. Range of segment motion (difference of extension and flection) of fusion level was measured by Dupuis method[6,19] : the angle between tangent lines to the superior endplates of two adjacent vertebrae. Angle of lumbar motion (difference of extension and flection) was measured by Cobb method[9,19] : the angle between tangent lines to the superior end plates of vertebrae L1 and S1.

Statistical analysis was assessed using the chi square test and multiple linear regression.

Results

Patient data

The PLF group was consisted of 36 patients with the mean age of 54.4 years (29~72 years of age), 20 men and 16 women. One patient had fusion at L2/3, 8 patients at L2/3/4, 21 patients at L4/5, 6 patients at L4/5/S1. Thirty-four patients underwent fusion due to lumbar stenosis, 2 patients due to recurred disc herniation. The mean follow-up period was 32.6 months. Thirty-four patients had pre-operative lower back pains, 22 patients had neurogenic intermittent claudication, and 25 patients had SLR positive sign.

The PLIF group of 35 patients with the mean age of 47.6 years (26~70 years of age) were 20 men and 15 women. Two patients had fusion at L3/4/5, 22 patients at L4/5, 6 patients at L4/5/S1, 5 patients at L5/S1. Twenty patients underwent fusion due to lumbar stenosis, 15 patients due to recurred disc herniation. The mean follow-up period was 29.7 months. Thirty-five patients had pre-operative lower back pains, 29

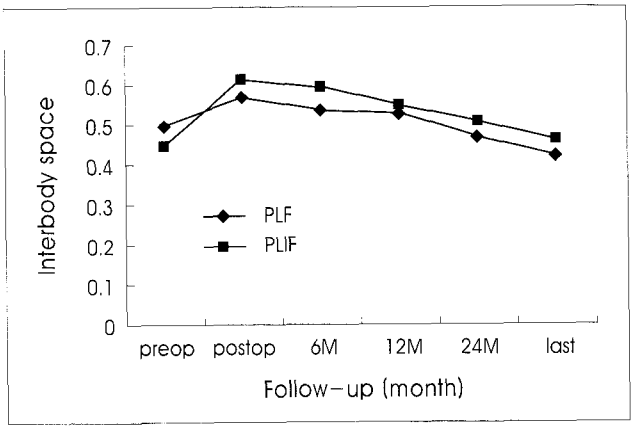

Fig. 1. The change of interbody space in the posterolateral fusion(PLF) group and the posterior lumbar interbody fusion(PLIF) group. In all groups, interbody space increased immediately after surgery, and decreased gradually in follow-up period. The PLIF group shows statistically significant improvement after surgery. But, the difference in the maintenance of interbody space between two groups is insignificant (P value=0.0317).

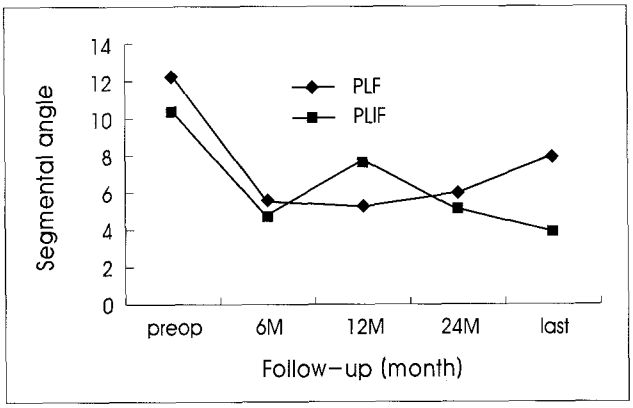

Fig. 2. The change of segmental angle in the posterolateral fusion(PLF) group and the posterior lumbar interbody fusion(PLIF) group. In all groups, segmental angle reduced after 6 months postoperatively. At last follow-up period, segmental angle was increased in th PLF group, but it reduced in the PLIF group. The PLIF group shows statistically significant improvement after surgery. But, the difference in the change of segmental angle between two groups is insignificant (P value=0.017).

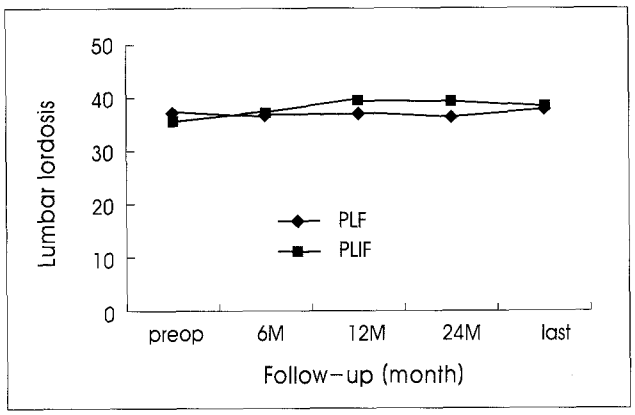

Fig. 3. The change of lumbar lordosis in the posterolateral fusion(PLF) group and the posterior lumbar interbody fusion(PLIF) group. Change of lumbar lordosis is similar in the two groups, and the difference is not statistically significant (P value=0.468).

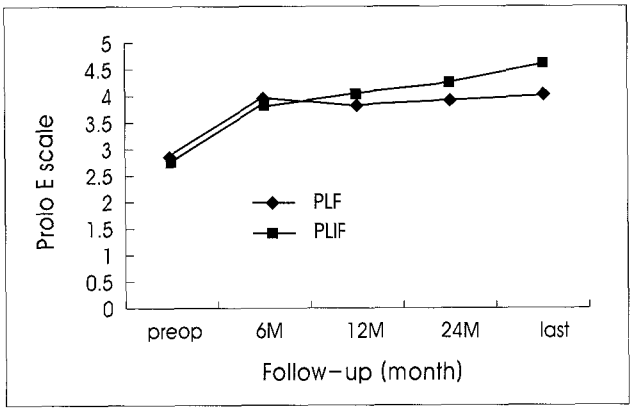

Fig. 4. The change of Prolo economic scale in the posterolateral fusion (PLF) group and the posterior lumbar interbody fusion(PLIF) group. Change of Prolo economic scale is better in the PLIF group, but the difference is not statistically significant (P value=0.193).

patients had neurogenic intermittent claudication, and 11 patients had SLR positive sign (Table 2).

Changes of interbody space

The PLF group showed a preoperative interbody space of 0.490, which increased to 0.570 (16.3% correction) immediately after surgery. The PLIF group showed a pre-operative interbody space of 0.448, which improved to 0.609 (35.9% correction) immediately after surgery. At the last follow-up assessment, the interbody space was 0.420 (26.3% reduction) in the PLF group and 0.459 (24.6% reduction) in the PLIF group (Fig. 1). The PLIF group showed statistically significant increase of the interbody space. The difference in the loss of correction between two groups was insignificant (P value= 0.0317).

Changes of segmental angle

The PLF group showed a pre-operative segmental angle of 12.3°, which reduced to 5.57° (54.7% correction) immediately after surgery. The PLIF group showed a pre-operative segmental angle of 10.4°, which reduced to 4.76° (54.2% correction) 6 months after surgery. At the last follow-up assessment, the segmental angle was 7.92° (42.2% increase) in the PLF group and 3.96° (16.8% reduction) in the PLIF group (Fig. 2). The difference in the correction of segmental angle between the two groups was not statistically significant. The maintenance of segmental angle was better in the PLIF group, but the difference was not statistically significant (P value=0.017).

Changes of lumbar motion

Pre-operative lumbar lordosis was 36.41° in the PLF group and 35.38° in the PLIF group. Post-operative lumbar lordosis was 36.32° in the PLF group and 36.80° in the PLIF group. At the last follow-up assessment, the lumbar lordosis was 37.56° in the PLF group and 37.96° in the PLIF group (Fig. 3). The changes of lumbar lordosis were similar in the two groups. The difference in changes of lumbar lordosis between two groups was not statistically significant (P value=0.468).

Table 3. Relationships between various factors and changes of Prolo economic scale

Factors	P values
Age	0.8170
Fusion type	0.1930
Obesity	0.6280
Follow-up duration	<0.0001
Interbody space	0.0010
Segmental angle	<0.0001

Table 4. Relationships between various factors and clinical outcomes according to Prolo functional scale

Factors	P values
Age	0.3900
Fusion type	0.0003
Obesity	0.0703
Follow-up duration	<0.0001
Interbody space	0.0010
Segmental angle	<0.0001

Changes of Prolo economic scale

Pre-operative Prolo economic scale was 2.83 in the PLF group and 2.76 in the

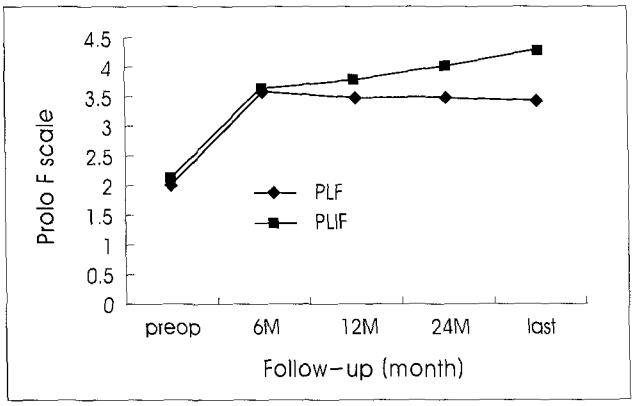

Fig. 5. The change of Prolo functional scale in the posterolateral fusion (PLF) group and the posterior lumbar interbody fusion(PLIF) group. The PLIF group shows statistically significant improvement in Prolo functional scale (P value=0.003).

PLIF group. At the last follow-up assessment, Prolo economic scale was 4.02 in the PLF group and 4.57 in the PLIF group (Fig. 4). The changes of Prolo economic scale were better in the PLIF group, but the difference was not statistically significant (P value=0.193) (Table 3).

Changes of Prolo functional scale

Pre-operative Prolo functional scale was 2.00 in the PLF group and 2.09 in the PLIF group. At the last follow-up assessment, Prolo functional scale was 3.41 in the PLF group and 4.27 in the PLIF group (Fig. 5). The PLIF group was showed statistically significant improvement in Prolo functional scale (P value=0.003) (Table 4).

Statistical analysis

Relationships between clinical outcomes and various factors (age, fusion type, obesity, follow-up duration, and segmental angle) were assessed using the multiple linear regression analysis.

In Prolo economic scale, there were statistically significant relationships between follow-up duration, change of interbody space, segmental motion, but not significant relationships between age, obesity, and fusion type.

In Prolo functional scale, there were statistically significant relationships between fusion type, follow-up duration, change of interbody space, segmental motion, but no significant relationships between age and obesity.

Discussion

This study compared the outcomes of instrumentation with PLF and PLIF for spinal stenosis, recurred disc herniation. Circumferential fusion using posterior interbody fusion also has shown satisfactory outcomes. This approach has less tissue trauma and can directly address the problem of radicular pain[18,23,26]. Therefore, PLIF seems to be an attractive option with PLF. The use of PLIF with spacers perhaps improves stability and graft sinkage that can occur with bone grafts alone[2,22].

Thomsen et al.[24] have indicated that pedicle screw fixation in postero-lateral fusion offers the advantages of correcting deformity and achieving a high rate of fusion. In this study, PLF was associated with some loss of correction despite pedicle screw instrumentation, although this was not clinically significant. Restoration of interbody space in PLIF procedures theoretically decompresses nerve roots and allows a better load-sharing structure resulting in superior pain relief and clinical outcomes compared with PLF[5,11,21,25]. Theses results suggest that PLIF increases and maintains interbody space better than PLF. Few prospective studies of PLIF are available; most of them examine the safety and outcomes of the procedure without comparing it with other fusion techniques. Ray[17] prospectively evaluated the safety and effectiveness of threaded titanium cages in 236 patients. He reported excellent or good results in 47% at 6 months and in 65% at 2 years post-operatively, based on the Prolo scale. In the series of Kuslich et al.[13], 85% of the 356 patients who underwent PLIF reported less pain at 2 years post-surgery, and 91% of the patients improved functionally. In this study, 83% demonstrated excellent or good results at 2 years after operation using the functional and economic scale described by Prolo.

Brantigan et al.[2] prospectively analyzed 221 patients who underwent PLIF reinforced with instrumented postero-lateral fusion. Clinical outcomes were reported only for the degenerative group of 92 patients where it was favorable in 86%. Interbody space increased from an average of 7.9mm before surgery to 12.3mm after surgery. Similar results were obtained by Kuslich et al.[13] in a larger prospective study. In this study, interbody space measured by Farfan method increased from 0.448 before surgery to 0.609 post-surgery in the PLIF group, although the interbody space was reduced to 0.459 at the last follow-up assessment. The PLIF group showed statistically significant improvement in the interbody space compared with the PLF group.

The number of studies comparing PLIF with PLF is limited. Suk et al.[22] retrospectively analyzed 76 patients with spondylolisthesis who underwent instrumented PLF or PLIF combined with PLF. In the PLIF group, 75% of patients showed excellent outcomes compared with 45% in the PLF group. Madan and Boeree[14] compared the outcomes of PLF vs PLIF combined with instrumented PLF in patients with grade 1 and 2 spondylolisthesis. Interbody space changes were not significant between the two group. However, clinical outcomes were better in the PLF group. In this study, the PLIF group showed statistically significant improvement in Prolo functional scale, although there was no statistical significance in Prolo economic

scale. The number of patients in each group was small, therefore caution must be exercised in drawing conclusions. More difference may appear in other variables with a large number of patients.

Conclusion

Results of this study indicate that PLIF is superior to PLF in interbody space augmentation and clinical outcomes by Prolo functional scale. Analysis of clinical outcomes showed significant relationships among various factors (fusion type, follow-up duration, interbody space, and segmental angle). The authors belive that instrumented PLIF may be appropriate to offer better clinical outcome, in cases where instrumented fusion is needed for spinal stenosis and recurred disc herniation except degenerative spondylolisthesis.

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Commentary

In this report, the authors have carefully detailed their surgical results comparing posterior lumbar interbody fusion(PLIF) group and posterolateral fusion(PLF) group in spinal stenosis and recurred disc herniations. They found that the PLIF group showed statistically better outcome as assessed by the Prolo functional scale than the PLF group and the intervertebral space height showed statistically significant increase in the PLIF group than the PLF group. This study provided valuable insight to the surgical outcome of PLIF in compare to PLF operation involving large patient number and long follow-up period. As distinct advantages of PLIF over PLF, proper anterior column load sharing, large surface areas for fusion, restoration of the normal sagittal alignment, and achievement of passive foraminal decompression have been reconfirmed with this study. PLIF without PLF has advantages of the elimination of donor site pain, shorter operating time, and less blood loss also.

Despite of all these biomechanical and technical advantages, it has been known that no significant differences in clinical results between these two techniques have been found[3,4]. This means that the biomechanical advantages of PLIF does notimpact clinical outcome in lumbar fusion, and efforts to maintain the intervertebral disc height and sagittal alignment may be unwarranted.

PLIF with stand-alone cage even showed discouraging results in some reports[1,2]. Button et al reported their experiences with 46 ALIF with stand-alone BAK cagesand they found that at least 10 patients (22%) required revision surgery, ten patients (22%) had 14 total complications not requiring revision surgery, seventy percent of patients had a fair or poor outcome as assessed by the Prolo rating system, and 58% of patients had at least "severe disability" according to the Oswestry outcome scale. They recommended that use of stand-alone BAK cages for degenerative disc disease should be reconsidered given the large number of patients with unacceptable outcomes. One possible explanation and most common radiological finding in PLIF patients with poor outcome is "subsidence." Subsidence means that bone remodeling is still going on around cage and the functional spine unit is not fused completely. Cages stabilize the functional spinal unit well in flexion, but not in extension. Supplementary posterior fixation with pedicle screws is needed to improve the stabilization in all directions[5].

There areseveral limitations I would like to comment before assuming that PLIF shows better outcome than PLF in this study. First of all, the demographic characteristics between 2 groups are definitely different. The mean age of patients in the PLF group is 54.4 years while the PLIF group is 47.6 years. The mean age of patients in the PLIF group is younger than the PLF group and the average age of spinal stenosis patients we meet in the clinic. Surgical results could be better with younger patients. There were 34 spinal stenosis and 2 recurred disc herniations in the PLF group while 20 spinal stenosis and 15 recurred disc herniations in the PLIF group. The authors did not clarifythat this study was conducted prospectively or retrospectively. They did not mention whether they randomly assigned their patient to either group.If the patients are not randomly assigned, indication of each procedure had been somewhat selective in this series. It seems that the authors preferred PLIF on younger, reherniated disc patients. The authors did not evaluate their radiographical fusion rate. As we all know, there is no conclusive and definitive criteria to judge the fusion with interboby cages[6,7] but fusion rate is one of the most important parameter to evaluate the surgical outcome in fusion surgery.

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