

# Comparison of Posterior Lumbar Interbody Fusion and Posterolateral Lumbar Fusion in Monosegmental Vacuum Phenomenon within an Intervertebral Disc

Ki-Chan An, Gyu-Min Kong, Dae-Hyun Park, Jong-Min Baik, Ji-Hong Youn, Woon-Seong Lee

*Department of Orthopaedic Surgery, Inje University Busan Paik Hospital, Inje University College of Medicine, Busan, Korea*

**Study Design:** Retrospective.

**Purpose:** To compare the clinical and radiological outcomes of posterolateral lumbar interbody fusion (PLIF) and posterolateral lumbar fusion (PLF) in monosegmental vacuum phenomenon within an intervertebral disc

**Overview of Literature:** The vacuum phenomenon within an intervertebral disc is a serious form of degenerative disease that destabilizes the intervertebral body. Outcomes of PLIF and PLF in monosegmental vacuum phenomenon are unclear.

**Methods:** Monosegmental instrumented PLIF and PLF was performed on 84 degenerative lumbar disease patients with monosegmental vacuum phenomenon (PLIF, n=38; PLF, n=46). Minimum follow-up was 24 months. Clinical outcomes of leg and back pain were assessed using visual analogue scales for leg pain (LVAS) and back pain (BVAS), and the Oswestry disability index (ODI). The radiographic outcome was the estimated bony union rate.

**Results:** LVAS, BVAS, and ODI improved in both groups. There was no significant difference in the degree of these improvements between PLIF and PLF patients ( $p>0.05$ ). Radiological union rate was 91.1% in PLIF group and 89.4% in PLF group at postoperative 24 months ( $p>0.05$ ).

**Conclusions:** No significant differences in clinical results and union rates were found between PLIF and PLF patients. Selection of the operation technique will reflect the surgeon's preferences and patient condition.

**Keywords:** Lumbar spine; Posterior lumbar interbody fusion; Posterolateral lumbar fusion; Vacuum phenomenon; Intervertebral disc

## Introduction

The vacuum phenomenon [1] is a collection of gas within the joint space. In vertebral discs, the vacuum phenomenon correlates with degenerative joint disease of the spine [2]. This phenomenon is considered to be the end stage of disc degeneration and a source of low back pain

[3]. It is not rare in elderly patients with major lower back pain and lower extremity radiating pain who are seen in clinics. Within the intervertebral disc, the vacuum phenomenon is a serious form of degenerative disease that can destabilize the intervertebral body. Very few studies have reported on surgical methodologic outcomes, such as posterior lumbar interbody fusion (PLIF) or posterolat-

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Corresponding author: Jong-Min Baik

Department of Orthopaedic surgery, Inje University Busan Paik Hospital, Inje University College of Medicine, 75 Bokji-ro, Busanjin-gu, Busan 47392, Korea

Tel: +81-51-890-6114, Fax: +82-51-892-6619, E-mail: [bbaik@hanmail.net](mailto:bbaik@hanmail.net)

eral lumbar fusion (PLF), in relation to the disc vacuum phenomenon.

The purpose of this study was to compare the clinical and radiological outcomes of PLIF and PLF to correct the lumbar monosegmental vacuum phenomenon within an intervertebral disc. The hypothesis was that there are no clinical and radiological differences between PLIF and PLF.

## Materials and Methods

### 1. Patients

With approval of our Institutional Review Board, we retrospectively reviewed the medical records of patients with a diagnosis of lumbar monosegmental vacuum phenomenon within an intervertebral disc who underwent a surgical procedure in our department between January 2006 and December 2011. The patients had to meet the following criteria: (1) level 1 vacuum phenomenon within intervertebral disc at the lumbar level; (2) gas-air within the disc space in the preoperative radiograph; (3) treated using posterior decompression, posterior instrumentation, and posterior lumbar interbody fusion or posterolateral lumbar fusion; and (4) radiographic data from at least 24 months of follow-up.

Patients who underwent multiple fusion and surgery associated with degenerated lumbar scoliosis and spondylolisthesis were excluded. The enrolled patients were divided into two groups on the basis of the surgery: the PLIF group and the PLF group. Each patient's demographic data, consisting of age, sex, operation time, estimated blood loss, fusion level, and perioperative complications, were collected from the medical records. Clinical and radiological outcomes were compared between the two groups.

### 2. Clinical evaluation

The Oswestry disability index (ODI) [4] and the visual analogue scale (VAS) for back and leg pain were used to assess the clinical results. Medical records were checked at preoperative and final follow-up, including the results from the ODI questionnaire and the VAS values for leg and back pain. These parameters were statistically compared between the PLIF and PLF groups using the paired *t*-test. The trends of the parameters were also investigated.

### 3. Radiological evaluation

L-spine standing anteroposterior and lateral view radiographs at the 24-month follow-up were used to determine the fusion state. In the PLIF group, radiographic union was defined using the Brantigan-Steffee classification [5]. In that classification system, grades A, B, and C are defined as the non-union state and grades D and E are defined as the union state. In the PLF group, the Lenke classification was used to determine the fusion state; this was based on the size of the graft bone created between the upper and lower transverse process and the discontinuity and resorption of the fusion mass [6]. In the Lenke classification system, grades C and D are defined as the non-union state, and Grades A and B are defined as the union state.

To minimize inter- and intra-observer errors, two independent radiologists evaluated the lumbar plane X-ray. If their assessment of the lumbar plane film differed, a computed tomography scan was used as a follow-up procedure. Inter- and intra-observer intraclass correlation coefficients were 0.887 (0.759–0.938) and 0.927 (0.789–0.957), respectively.

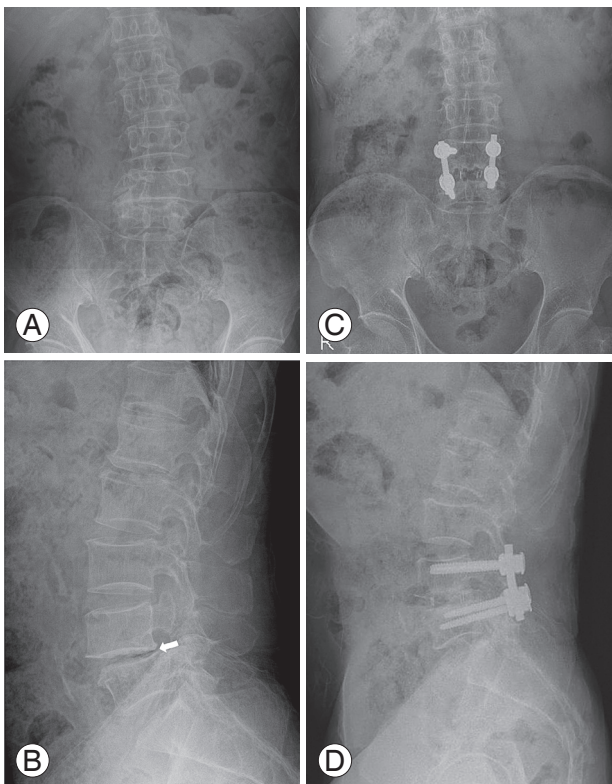
### 4. Statistical analyses

Data were analyzed using the SPSS ver. 13.0 statistical software package (SPSS Inc., Chicago, IL, USA). The continuous variables are presented as mean±standard deviation. The paired *t*-test was used to examine the statistical significance between the two groups. Intra- and inter-observer reliability in determining fusion was assessed by computing the Kappa statistic. All test results were considered significant at  $p < 0.05$ .

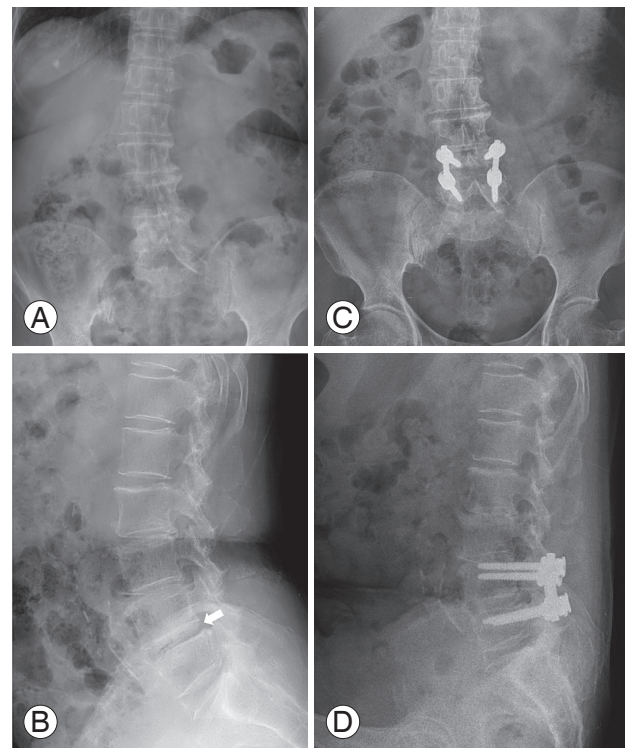
## Results

### 1. Demographics

The mean follow-up duration was 24.5 months (range, 24–26 months). Eighty four patients (17 males, 67 females; mean age, 62.5 years; age range, 41–73 years) with monosegmental intervertebral disc vacuum phenomenon were operated on by one senior author (K.C.A.) using posterior decompression and instrumentation PLIF (n=38) (Fig. 1) or PLF (n=46) (Fig. 2). The operative time was 171±51 minutes in the PLIF group and 163±42 min-



**Fig. 1.** Posterior lumbar interbody fusion. (A) Preoperative L-spine standing anteroposterior view and (B) L-spine standing lateral view radiographs, vacuum phenomenon (white arrow). (C) Postoperative L-spine standing anteroposterior view and (D) L-spine standing lateral view radiographs.



**Fig. 2.** Posterolateral lumbar fusion. (A) Preoperative L-spine standing anteroposterior view and (B) L-spine standing lateral view radiographs, vacuum phenomenon (white arrow). (C) Postoperative L-spine standing anteroposterior view and (D) L-spine standing lateral view radiographs.

utes in the PLF group. Intraoperative blood loss volume was 691±163 mL in the PLIF group and 640±172 mL in the PLF group. Although the operative time was longer and the estimated blood loss was and larger in the PLF group than the PLIF group, the difference were not statistically significant ( $p=0.159$  and  $p=0.301$ , respectively). In addition, there were no statistically significant differences

between the two groups in terms of sex and age ( $p=0.276$  and  $p=0.353$ , respectively). In the PLIF and PLF group, the fusion occurred at L4–L5 in 17 (45%) and 21 (46%) cases, respectively, and at L5–S1 in 21 (55%) and 25 (54%) cases, respectively. In terms of the level at which the fusion occurred, no statistically significant differences were found between the two groups ( $p=0.874$ ) (Table 1).

**Table 1.** Demographics and operative data

Demographic data	PLIF (n=38)	PLF (n=46)	p-value
Age (yr)	59±14	61±12	0.353
Sex (male/female)	7/31	10/36	0.276
Follow-up (mo)	24.7±0.5	24.9±0.7	0.512
Operative time (min)	171±51	163±42	0.159
Blood loss (mL)	691±163	640±172	0.301
Fusion level, no. (%)			0.874
L4–5	17 (45)	21 (46)	
L5–S1	21 (55)	25 (54)	

PLIF, Posterior lumbar interbody fusion; PLF, Posterolateral lumbar fusion.

**Table 2.** Comparison of clinical outcomes

Variable	PLIF (n=38)	PLF (n=46)	p-value
Oswestry disability index			
Pre	58.4±5.1	57.2±4.5	0.398
Post (final)	31.5±2.9	32.1±3.1	0.407
Change	-26.9±3.1	-25.1±3.4	0.411
Back visual analogue scale			
Pre	7.5±1.4	7.2±1.1	0.435
Post (final)	2.3±0.9	2.5±1.3	0.386
Change	-5.2±1.1	-4.8±1.2	0.399
Leg visual analogue scale			
Pre	6.5±1.5	6.1±1.2	0.438
Post (final)	1.3±1.2	1.2±1.5	0.455
Change	-5.2±1.3	-4.9±1.3	0.262

PLIF, posterior lumbar interbody fusion; PLF, posterolateral lumbar fusion.

**Table 3.** Fusion rate and complications

Variable	PLIF (n=38)	PLF (n=46)	p-value
Fusion rate (%)	92.1	89.1	0.298
Dural tear, case (%)	2/5.2	0	0.276
Infection	0	0	>0.99

PLIF, Posterior lumbar interbody fusion; PLF, Posterolateral lumbar fusion.

## 2. Clinical results

The mean preoperative ODI was 58.4±5.1 in the PLIF group and 57.2±4.5 in the PLF group ( $p=0.398$ ). At the final follow-up, the ODI was 31.5±2.9 in the PLIF group and 32.1±3.1 in the PLF group ( $p=0.407$ ). Improvement in the ODI was found in both groups but was not statistically significant ( $p=0.411$ ). The mean preoperative VAS for back pain was 7.5±1.4 in the PLIF group and 7.2±1.1 in the PLF group ( $p=0.435$ ). At the final follow-up, the VAS for back pain was 2.3±0.9 in the PLIF group and 2.5±1.3 in the PLF group ( $p=0.386$ ). Improvement in the VAS for back pain was observed in both groups. However, there was no statistically significant difference in the VAS for back pain between the two groups ( $p=0.399$ ). The VAS for leg pain also showed similar results. The mean preoperative VAS for leg pain was 6.5±1.5 in the PLIF group and 6.1±1.2 in the PLF group ( $p=0.438$ ). At the final follow-up, the VAS for leg pain was 1.3±1.2 in the PLIF group and 1.2±1.5 in the PLF group ( $p=0.455$ ). Improvement in the VAS for leg pain was observed in both groups. However, there was no

statistically significant difference in the VAS for leg pain between the two groups ( $p=0.262$ ) (Table 2).

## 3. Radiological results and complications

Radiologic union was observed in 35 (91.1%) of the 38 cases in the PLIF group. In the PLF group, radiologic union was observed in 41 cases (89.1%). There was no statistically significant difference ( $p=0.298$ ) between the two groups. In the PLIF group, there were two cases of intraoperative complications in which a Dural tear occurred during posterior decompression; however, there were no additional complications and the condition was well treated (Table 3).

## Discussion

The intervertebral disc vacuum phenomenon is common in the elderly [7,8], and about 50% of the patients with this condition are >40 years of age [9]. Presently, the mean age was 62.5 (range, 41–73). In addition to occurring in

the elderly, the vacuum phenomenon is often accompanied by various forms of degenerative disc changes (spondylolisthesis, degenerative lumbar scoliosis, and spinal stenosis). Thus, the appropriate surgical treatment must be selected for each of these conditions. Surgical options include PLIF, PLF, transforaminal lumbar interbody fusion (TLIF), or a combination of surgeries. PLIF or PLF used alone or in combination are most common. The optimal approach remains debatable. In the last decade, several studies have reported that the posterior lumbar interbody cage can provide anterior column stability, maintain disc height, and correct sagittal alignment [10-12]. With the help of pedicle-screw instrumentation, the PLF rate has increased to 75%, with 80% of the patients having a good to excellent clinical outcome [13,14]. PLF, PLIF, and PLIF in combination with PLF were compared in a prospective randomized study on degenerative lumbar disease; there were no significant differences in clinical results and union rates [15]. However, all of the results mentioned above were not related to cases in which the diagnosis involved the intervertebral disc vacuum phenomenon.

In this study, we tested the hypothesis that there are no clinical and radiological differences between PLIF and PLF surgical treatments. Vacuum disc that occurs at the same lumbar segment as the degenerative spondylolisthesis has been suggested as a sign of anterior instability and an indication of interbody cages for patients with degenerative spondylolisthesis with an anterior vacuum disc phenomenon [16]. Presently, both PLIF and PLF produced improvements in the VAS for back and leg pain, and ODI, with no statistical differences evident for the two surgeries. Thus, we were assuming the monosegmental vacuum phenomenon within intervertebral disc at the lumbar level and we excluded spondylolisthesis in all of the patients. Spondylolisthesis causes degenerative changes in intervertebral discs and increases ligamentous laxity and chronic instability in the facet joint. We excluded patients with spondylolisthesis and we did not consider the instability factor, so there was no statistically significant difference in improvements in the VAS back and leg pain and ODI values between the PLIF and PLF groups. Moreover, the radiologic union rate was 91.1% in the PLIF group and 89.4% in the PLF group at postoperative 24 months, with no statistically significant difference between the two study groups ( $p=0.298$ ). The PLIF procedure also increased the operative time and the estimated blood loss more than the PLF procedure; however, there were no sta-

tistically significant differences in these variables between the two groups ( $p=0.159$  and  $p=0.301$ , respectively).

The findings indicate that it is not important to choose between PLIF and PLF to treat degenerative monosegmental lumbar vacuum disc without spondylolisthesis. Instead, it is more important to consider the surgeon's preference concerning surgery and the patient's operative condition.

Our study has several limitations. It was retrospective and had a narrow spectrum of inclusion criteria for selecting patients, which led to selection bias. Second, we used medical records so many other cases were not included due to follow-up loss, inadequate records, and false records. Third, the number of cases reviewed was small, and patient characteristics like smoking, disease, and bone mineral density were not investigated.

## Conclusions

No statistically significant differences in the clinical results and union rates were found between PLIF and PLF in relation to the monosegmental intervertebral disc vacuum phenomenon. Thus, the selection of surgical technique should be based on the surgeon's preference and the patient's operative conditions.

## Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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