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Fueling the debate: Are outcomes better after posterior lumbar interbody fusion (PLIF) or after posterolateral fusion (PLF) in adult patients with low-grade adult isthmic spondylolisthesis?

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ABSTRACT

Study design: Retrospective cohort study.

Clinical question: Do more adult patients affected by low grade isthmic spondylolisthesis have significant clinical and radiological improvement following posterior lumbar interbody fusion (PLIF) than those who receive posterolateral fusion (PLF)?

Methods: One hundred and fourteen patients affected by adult low grade isthmic spondylolisthesis, treated with posterior lumbar interbody fusion or posterolateral fusion, were reviewed. Clinical outcome was assessed by means of the questionnaires ODI, RMDQ and VAS. Radiographic evaluation included CT, MRI, and x-rays. The results were analyzed using the Student t-test.

Results: The two groups were similar with respect to demographic and surgical characteristics. At an average follow-up of 62.1 months, 71 patients were completely reviewed. Mean ODI, RMDQ and VAS scores didn't show statistically significant differences. Fusion rate was similar between the two groups (97% in PLIF group, 95% in PLF group). Major complications occurred in 5 of 71 patients reviewed (7%): one in the PLIF group (3.6%), four in the PLF group (9.3%). Pseudarthrosis occurred in one case in the PLIF group (3.6%) and in two cases in PLF group (4.6%).

Conclusions: In our series, there does not appear to be a clear advantage of posterior lumbar interbody fusion (PLIF) over posterolateral fusion (PLF) in terms of clinical and radiological outcome for treatment of adult low grade isthmic spondylolisthesis.

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STUDY RATIONALE AND CONTEXT

The choice of correct surgical treatment of adult low-grade isthmic spondylolisthesis remains a topic of debate. Many studies in the literature analyze clinical and radiological outcome of different fusion techniques by various approaches, including posterolateral fusion (PLF) and lumbar interbody fusion, but considerable controversies regarding what is the “gold standard” approach still exist [1–16].

CLINICAL QUESTION

Do more adult patients affected by low grade isthmic spondylolisthesis have significant clinical and radiological improvement following posterior lumbar interbody fusion (PLIF) than those who receive posterolateral fusion (PLF)?

METHODS

Study design: Retrospective cohort study.

Inclusion criteria: All adult patients who had undergone posterior lumbar interbody fusion (PLIF) (**Figs 2, 3**) or posterolateral fusion (PLF) (**Fig 4**) for low grade isthmic spondylolisthesis (Meyerding grade 1 or 2) between February 2003 and April 2005, and who had a minimum of 4 years of follow-up.

Exclusion criteria: Previous spine surgery, age less than 40 years, etiology other than isthmic, high-grade spondylolisthesis, concomitant conditions which could compromise outcomes.

Patient population and interventions compared (Fig 1):

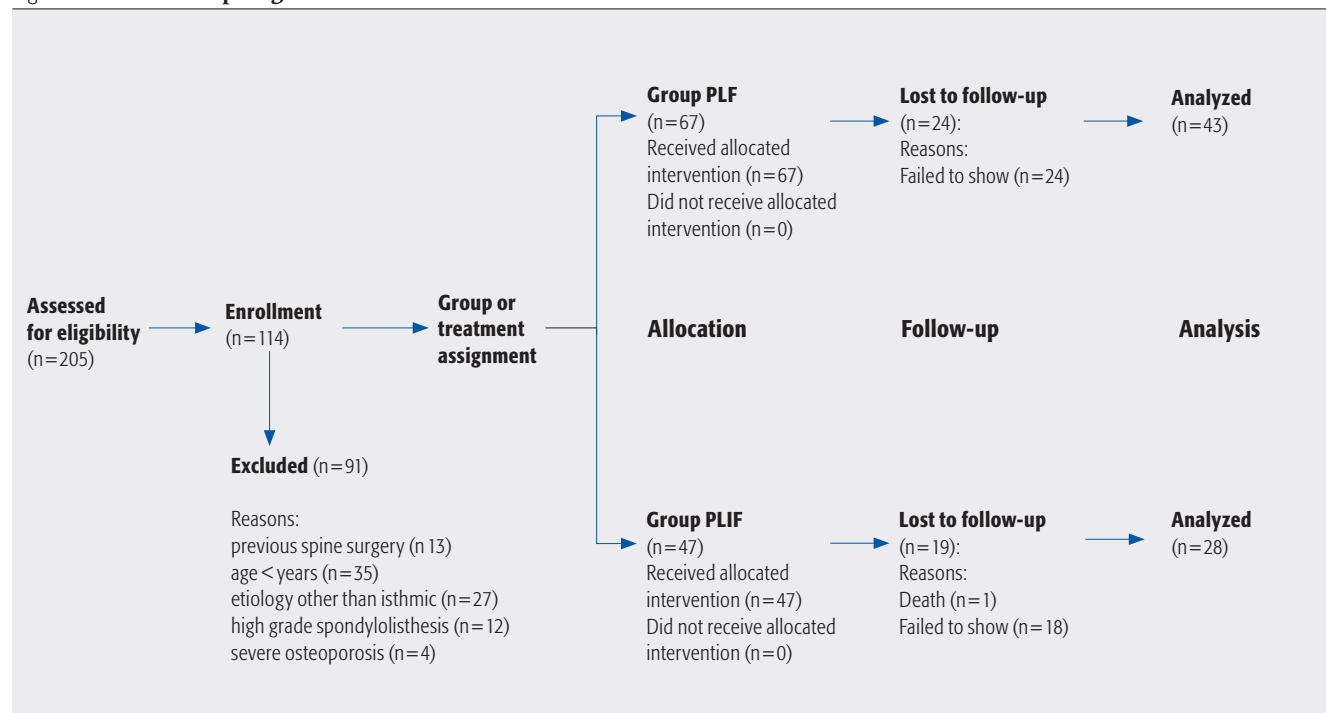
- One-hundred-and-fourteen consecutive patients met the inclusion criteria, and were divided into two groups, according to the surgical treatment they received: PLIF group (posterior lumbar interbody fusion) and PLF group (posterolateral fusion) (**Table 1**). Patients were evaluated preoperatively, postoperatively and at final follow-up.
- At the time of surgery all patients complained of low back and leg pain.
- Posterior pedicle screw instrumentation alone was used as support to fusion in the PLF group. Carbon fiber, titanium and peek cages were added in the PLIF group. A laminectomy was performed in all cases. All patients received allograft bone and autograft bone obtained from decompression.

Outcome and analysis:

- Demographic, preoperative, perioperative and postoperative data were collected.
- Clinical outcome was assessed by means of the Oswestry disability index (ODI), Roland Morris Disability Questionnaire (RMDQ) and visual analogue scale (VAS), for back and leg pain respectively, filled in by patients preoperatively and at last follow-up.
- Radiographic evaluation included preoperative CT (performed to assess the isthmic nature of the lesion) and MRI of the lumbar spine, as well as standing plain and functional films with flexion and extension views before and after surgery and during the follow-up, when requested. Fusion was defined as radiographic evidence of bone bridging, the absence of lucency around the implant, and no motion during functional films.
- Overall complications were noted. Major complications were those that needed revision surgery or resulted in permanent neurological deficit.

- The results were analyzed using the Student t-test. Results are expressed as the mean (range), with a *P*-value of < 0.5 considered as being statistically significant.

Fig 1 Patient sampling and selection



RESULTS

- The two groups were similar with respect to demographic and surgical characteristics (**Table 1**).
- At an average follow-up of 62.1 months (range 51–78), 71 patients (62.3%), 28 (59.6%) of the PLIF group and 43 (64.2%) of the PLF group, were completely reviewed.
- Clinical outcome. Both techniques ensured improvement of clinical outcome, without statistically significant differences between the two groups ($P > .05$). Unsatisfactory clinical results were achieved in four patients (14.3%) in the PLIF group and in eight patients in the PLF group (18.6%) (**Table 2**).
- Radiologic outcome. The x-rays performed at final follow-up showed a fusion rate of 97% in the PLIF group, 95% in the PLF group, without statistically significant differences ($P > .05$).

Table 1 Characteristics of intervention groups

	PLIF group		PLF group	
	All enrolled N=47	Patients at follow-up N=28	All enrolled N=67	Patients at follow-up N=43
Age, years (mean ±SD)	54.8 ±8.6	55.1 ±9.2	51.6 ±8.6	49.3 ±7.4
	n (%)	n (%)	n (%)	n (%)
Female gender	25 (53.2)	14 (50.0)	39 (58.2)	24 (55.8)
Spondylolisthesis grade I	21 (44.7)	12 (42.9)	28 (41.8)	16 (37.2)
Spondylolisthesis grade II	26 (55.3)	16 (57.1)	39 (58.2)	28 (65.1)
L3–4 spondylolisthesis	3 (6.4)	2 (7.1)	0 (0)	0 (0)
L4–5 spondylolisthesis	16 (34.0)	14 (50.0)	25 (37.3)	14 (32.6)
L5–S1 spondylolisthesis	28 (59.6)	12 (42.9)	42 (62.7)	29 (67.4)
1 level fusion	30 (63.8)	19 (67.9)	50 (74.6)	32 (74.4)
2 level fusion	13 (27.7)	7 (25.0)	16 (23.9)	11 (25.6)
3 or more level fusion	4 (8.5)	2 (7.1)	1 (1.5)	0 (0)

- Complications. Complications requiring revision surgery occurred in 5 of 71 patients reviewed (7%), one in the PLIF group (3.6%) and four in the PLF group (9.3%). Pseudarthrosis occurred in one case in the PLIF Group, in two cases in the PLF group (**Table 3**).

More information on complications is available in the web appendix at www.aospine.org/ebsj.

Table 3 Major complications requiring revision surgery

	PLIF group (n=28) n (%)	PLF group (n=43) n (%)
Major complications, n (%)		
Revision surgery	1 (3.6)*	4 (9.3)†
Pseudarthrosis	1 (3.6)	2 (4.6)

* Revision due to pseudarthrosis

† Two revisions due to pseudarthrosis

Table 2 Clinical outcome

	PLIF group				PLF group				
	Baseline	Follow-up	Percent change	Within group P-value*	Baseline	Follow-up	Percent change	Within group P-value*	Between group P-value†
ODI (mean % ±SD)	53.2 ±18.8	25.6 ±18.1	57.7 ±24.4	<.05	52.1 ± 19.0	24.5 ± 18.3	59.2 ± 24.9	<.05	>.05
RMDQ	13.9 ±6.1	7.2 ±6.2	57.3 ±26.5	<.05	13.4 ±6.2	6.9 ±6.3	58.3 ±27.4	<.05	>.05
VAS "leg score"	7.4 ±1.4	4.1 ±2.8	49.3 ±30.0	<.05	7.6 ±1.4	3.5 ±3.2	58.5 ±33.6	<.05	>.05
VAS "back score"	7.7 ±1.3	3.0 ±2.0	62.8 ±21.8	<.05	7.8 ±1.3	3.8 ±2.7	55.3 ±29.1	<.05	>.05
Persistent low-back pain (%)	100%	14.3%	n.a.	n.a.	100%	18.6%	n.a.	n.a.	n.a.
Persistent sciatica	100%	3.6%	n.a.	n.a.	100%	11.6%	n.a.	n.a.	n.a.

* P-value associated with change from baseline to follow-up in each treatment group

† P-value comparing change in baseline to follow-up between PLIF and PLF groups

DISCUSSION

- In our series, there does not appear to be a clear advantage of posterior lumbar interbody fusion over posterolateral fusion in terms of clinical and radiological outcome.
- A higher incidence of complications requiring surgical revision (9.3% versus 3.6%) was found in the PLF group. Pseudarthrosis occurred in one case in the PLIF group (3.6%) and in two cases in the PLF group (4.6%).
- Despite nerve root manipulation required to insert the cages into the intervertebral space, in our series we found only one case of sciatica at last follow-up in the PLIF group.
- Limitations. The present series should be interpreted in the context of its limitations, including the retrospective nature of the review, the fact that patients were not randomized between posterior lumbar interbody fusion and posterolateral fusion, the low follow-up rate and the small sample size.

Fig 2 Posterior lumbar interbody fusion for low grade isthmic spondylolisthesis, 3 and 15 months after surgery. Note the segmental sagittal alignment (kyphosis) that could compromise long term clinical and radiographic outcome (risk of negative effect on adjacent disc).

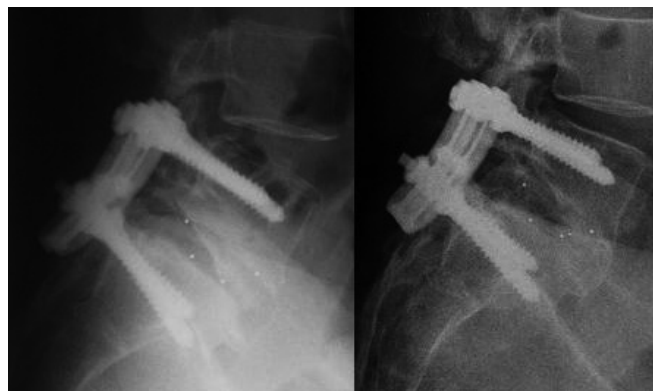


Fig 3 CT scan 15 months after surgery

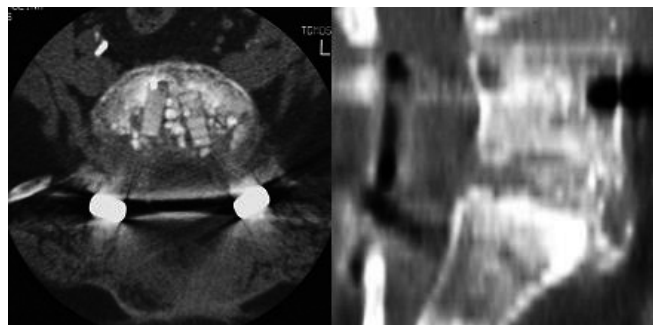


Fig 4 Posterolateral fusion for low grade isthmic spondylolisthesis. Note the postoperative disc height gain that could compromise fusion.



CONCLUSIONS

- In case of adult low grade isthmic spondylolisthesis, posterior lumbar interbody fusion doesn't seem to provide advantages in terms of mechanical stability and fusion rate (pseudarthrosis incidence: 3.6% versus 4.6%).
- In our series, both treatments ensured good clinical results, without statistically significant differences between the two techniques.

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EDITORIAL STAFF PERSPECTIVES

This is a CoE III treatment study.

Comparing outcomes from patients treated with PLIF with those treated with PLF is a commendable goal and important in the debate about the best treatment options for low-grade adult spondylolisthesis. In order to improve the quality of evidence available to settle the debate, future studies need to address a number of key factors.

Patient selection: Methodologically, selecting patients based on the completeness of follow-up at a specific time or studies where > 85% are lost to follow-up creates the possibility of selection bias. By selecting patients with a minimum of 4-years follow-up, it is possible that those with less complete

follow-up may have different clinical or other characteristics (and outcomes!) that could influence the evaluation of the study outcome and thus bias results. For example, if those who are lost to follow-up are more likely to have a good outcome for a one of the treatments, the analysis would not potentially include as many patients with a good outcome for that treatment and the results may be biased to show that it is less effective than its comparator.

Treatment allocation: How treatment was allocated was not well described in this paper, ie, what factors determined whether a patient received PLIF versus PLF aside from what appears to be institutional preference (see web appendix). Ideally, patients would be randomized to treatment groups using an appropriate method of concealed allocation. It is common for studies to describe treatment allocation based on surgeon preference or patient presentation. This has the potential to bias study results. For example if patients with more severe disease are more likely to receive one treatment over the other and also have the potential for worse outcomes, the results may not be an accurate reflection of either treatment in patients with the same disease severity. Allocation based on the institution's preference may also bias results as other factors may also differ across institutions. Factors such BMI and previous surgery may influence choice of procedure and therefore outcomes and need to be described.

Retrospective versus prospective approaches: In this study (and most retrospective studies), it isn't clear that a consistent perioperative protocol (for clinical care or outcomes measurement) was used in both study groups. With prospective study design, there is the potential to decrease study bias compared with retrospective designs. Protocols for patient selection and treatment allocation, perioperative care, collection of data and follow-up that are specified prospectively help assure less biased allocation of patients to treatment and similarity of care and measurement for both groups.

Outcomes: Definition and evaluation of fusion status is long-held area of controversy. In this study, it is unclear how fusion was determined and if its assessment was independent. Factors such as use of BMP or grafts which may influence fusion and functional outcomes need to be detailed and evaluated for their potential to influence the outcomes. In addition factors such as reduction of deformity, disc height and restoration of lordosis should be evaluated.

Final comments: This study's use of validated outcomes measures and length of follow-up are two primary strengths. The authors' acknowledgement of the significant loss to followup and limitations imposed by retrospective, nonrandomized studies is commendable.