

2018

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Recommended Citation

Shank, Timothy R., "Which Surgical Intervention for Patients Suffering from Isthmic Lumbar Spondylolisthesis, Posterolateral Fusion (PLF) or Posterior Lumbar Interbody Fusion (PLIF), Shows the Most Improvement in Lower Back Pain for Patients Younger than 65 Who Have Failed 6 Months of Conservative Therapy?" (2018). *PCOM Physician Assistant Studies Student Scholarship*. 315.
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Which Surgical Intervention for Patients Suffering from Isthmic Lumbar Spondylolisthesis, Posterolateral Fusion (PLF) or Posterior Lumbar Interbody Fusion (PLIF), Shows the Most Improvement in Lower Back Pain for Patients Younger than 65 Who Have Failed 6 Months of Conservative Therapy?

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A SELECTIVE EVIDENCE BASED MEDICINE REVIEW

In Partial Fulfillment of the Requirements For

The Degree of Master of Science

In

Health Sciences – Physician Assistant

Department of Physician Assistant Studies

Philadelphia College of Osteopathic Medicine

Philadelphia, Pennsylvania

June 14th, 2018

ABSTRACT:

Objective: The objective of this selective EBM review is to determine whether or not posterior lumbar interbody fusion (PLIF) is a superior surgical intervention compared to posterolateral fusion (PLF) for treating patients younger than 65 years old with isthmic lumbar spondylolisthesis who have failed 6 months of conservative therapy.

Study Design: Systemic review of three English language primary studies comparing the efficacy of PLF and PLIF surgical approaches for isthmic lumbar spondylolisthesis published after 2006.

Data Sources: Three randomized controlled trials published after 2006 selected from PubMed based on their relevance to the proposed question.

Outcomes Measured: The outcomes measured in the trials focused on Oswestry Disability Index (ODI) scores reported by the patients indicating the level of lower back pain they were having prior to and after the completion of the surgery.

Results: All three studies confirmed that both PLF and PLIF surgical interventions for isthmic lumbar spondylolisthesis in patients 65 years or younger who failed 6 months of conservative therapy showed improvement over the pre-operation baseline. Two of the studies indicated that there was no difference in terms of long term pain relief (1+ years post-operation) when performing PLF versus PLIF; however, one of the studies indicated that PLF showed statistically significant reduction in pain long term. One of the studies also showed that pain levels 3 months post operation were lower with PLIF compared to PLF.

Conclusions: Both PLF and PLIF are surgeries that can reduce the lower back pain felt by patients with isthmic lumbar spondylolisthesis. The results of the review indicate that there is no clear evidence as to which surgical approach is superior in terms of decreasing lower back pain in patients after surgery. Other factors such as surgeon experience and preference for performing these procedures along with patient anatomy should continue to guide surgeons in deciding the most appropriate approach to surgical repair for isthmic lumbar spondylolisthesis.

Keywords: isthmic lumbar spondylolisthesis, PLF, PLIF

INTRODUCTION:

Spondylolisthesis is a condition where a vertebra slips anteriorly relative to the inferior vertebra. There are multiple causes of spondylolisthesis ranging from congenital defects, trauma/injury, and degenerative bone changes. Isthmic spondylolisthesis is caused by a fracture in the pars interarticularis.

Spondylolisthesis affects approximately 5-6% of males and 2-3% of females¹ with prevalence markedly increased in athletes competing in sports where the spine undergoes repeated stresses. Examples of sports with high incidence of spondylolisthesis include dancers, gymnasts, figure skaters, American football linemen, wrestlers, and divers.² Spondylolisthesis can cause debilitating back pain and other symptoms that can greatly impact a patient's life. Over 146,000 hospital admissions and 39,000 emergency room visits are due to spondylolisthesis each year.³

There are multiple causes of Spondylolisthesis. Spondylolisthesis can be the result of bone malformations of the spine shortly after birth, the result of a fracture of the pars interarticularis, the result of bone degeneration or pathology, or the result of trauma to the spine. The focus of this selected EBM review is isthmic lumbar spondylolisthesis caused by fracture to the pars interarticularis.

Conservative treatment is indicated initially to help differentiate spondylolisthesis from other conditions such as muscle strain. Treatment involves rest, avoiding positions/activities that exacerbate pain, NSAIDs, warm/cold compresses, bracing, and/or physical therapy. If pain persists after six months or if the person's activities of daily living are altered by the condition, surgical intervention is considered.

Two surgical interventions have been widely used in past years to help patients who have failed conservative treatment, the posterolateral fusion (PLF) and posterior lumbar interbody fusion (PLIF). Both methods have advantages and disadvantages. The PLF surgical approach utilizes the lateral portions of the adjoining vertebrae for fusion but involves moving the paravertebral muscles for surgical access. The PLIF surgical approach stays near the midline to reduce the disruption of nearby muscles but involves deeper dissection and only attaches the vertebrae at one location. These differences in approach can cause significant differences in outcomes in patients and needs to be studied.

This paper evaluates the results from three prospective randomized studies comparing surgical outcomes from two different vertebral surgery options available for treating isthmic Spondylolisthesis. The surgical procedures being compared are posterolateral fusion (PLF) and posterior lumbar interbody fusion (PLIF).

OBJECTIVE:

The objective of this selective EBM review is to determine whether or not posterior lumbar interbody fusion (PLIF) is a superior surgical intervention compared to posterolateral fusion (PLF) for treating patients younger than 65 years old with isthmic lumbar spondylolisthesis who have failed 6 months of conservative therapy.

METHODS:

The criteria used for the selection of studies to achieve the objective of this EBM review started by restricting patient age to less than 65 years old. All of the patients used in the study must have failed conservative therapy for 6 months prior to being allowed admission into the

study. All patients used in the study must have single-level isthmic lumbar spondylolisthesis between the L4-L5 or L5-S1 vertebrae.

The surgical interventions selected for the patients must have been randomized between posterior lumbar interbody fusion (PLIF) and posterolateral fusion (PLF) surgical options. Before the surgery, and at least one year after the surgery, an Oswestry Disability Index (ODI) measurement of the patient's lower back pain must have been obtained to evaluate the impact the surgery had on the patient's pain levels. The ODI scores must be reported both pre and post operatively with a mean and standard deviation for both surgical approaches.

Searching for the studies available to meet the review criteria was accomplished by using PubMed. The search terms were "isthmic spondylolisthesis", "PLIF", and "PLF". The language for the articles must have been English and the articles must have been published. The papers must have been randomized control trials. Only papers published after 2006 were considered for the purposes of this review. Information regarding the papers chosen for this review can be found in Table 1.

Table 1: Demographics & Characteristics of Included Studies

Study	Type	# Patients	Age (years)	Inclusion Criteria	Exclusion Criteria	W / D	Interventions
Farrokh i MR, Rahmadian A, Masoudi MS. 2012 ⁽⁴⁾	RCT	80	18-65	(1) Isthmic spondylolisthesis. (2) No previous spine operation. (3) Age between 18-65 years old. (4) Failed conservative therapy including rest and pain medication, lumbosacral orthosis, and physical therapy, at least for 6 months. (5) hamstring spasm	(1) Non-isthmic spondylolisthesis. (2) Need for performing discectomy. (3) Infection. (4) Generalized bone disease. (5) Osteoporosis	0	PLF and PLIF
Lee GW, Lee SM, Ahn MW, Kim HJ, Yeom JS. 2014 ⁽⁵⁾	RCT	81	<60	(1) Failed conservative treatment after a minimum of 6 months. (2) Age less than 60 years old. (3) Undergoing lumbar fusion surgery at a single level. (4) A follow up period of 2 years or more after surgery	(1) Surgery was performed by someone other than the corresponding author. (2) Follow up of 2 years or less. (3) Greater than 60 years old. (4) Multilevel fusion surgery. (5) Abnormal muscle activity or ambulation due to neuromuscular disease. (6) Unable to accurately complete the pre- and postoperative questionnaires due to certain problems such as a stroke or dementia	0	PLF and PLIF
Musulman AM, Yilmaz A, Cansever T, et al. 2011 ⁽⁶⁾	RCT	50	18-65	(1) Presence of isthmic spondylolisthesis of Grade 1 or Grade 2 at any level, and low-back pain with or without sciatica and neurogenic claudication. (2) Lack of improvement after at least 6 months of conservative treatment measures. (3) Patient age between 18 and 65 years	(1) Previous spine surgery.	1	PLF and PLIF

OUTCOMES MEASURED:

The Oswestry Disability Index (ODI) was the method used to evaluate lower back pain levels in all patients pre and post operatively. The ODI is a series of questions asked to patients to get an understanding not only of the levels of lower back pain they are experiencing, but also the way the lower back pain is impacting their lives. There are ten categories included in the questionnaire including: pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sex life, social life, and travelling.

For each of the categories, there are different responses to indicate the severity of the impact of the patient's lower back pain. For example, the sleeping category has different responses to help the patient communicate the severity of the lower back pain in terms of sleep:⁷

- My sleep is never disturbed by pain (0 points)
- My sleep is occasionally disturbed by pain (+1 point)
- Because of pain I have less than 6 hours sleep (+2 points)
- Because of pain I have less than 4 hours sleep (+3 points)
- Because of pain I have less than 2 hours sleep (+4 points)
- Pain prevents from sleeping at all (+5 points)

Each category has six potential responses ranging from no impact (+0 points) to total impact (+5 points). The score from each of the categories is tallied to give the ODI score.

RESULTS:

The study conducted by Farrohki et al.⁴ consisted of 80 patients. The patients were randomized into groups based on the results of “random allocation software” into two groups of 40 patients, one group undergoing PLF while the other group undergoing PLIF. Table 2 shows the demographics breakdown for the patients assigned to PLF and PLIF surgeries.

Table 2: Demographics Data for Farrohki et al. Study⁴

	PLF	PLIF
Number of Patients	40	40
Males / Females	10M, 30F	9M, 31F
Age (Mean + Stan Dev)	49.66 +/- 9.01 years	50.35 +/- 11.30 years
Weight (Mean + Stan Dev)	72 +/- 12.55 kg	73.47 +/- 12 kg

For this study, ODI scores were recorded at pre operative and improvement. Table 3 shows the ODI scores for both the PLF and PLIF surgical approaches.

Table 3: ODI Scores for both PLF and PLIF Groups for Farrohki et al. Study⁴

	ODI Scores	
	PLF	PLIF
Preop	47.7 ± 1.85	43.3 ± 1.17
Improvement	25.34 ± 9.36	17.1 ± 12.98

The results show a statistically significant improvement in ODI scores for the patients in the PLF group compared to the PLIF group (Mann Whitney U test, $p = 0.001$).

The study conducted by Lee et al.⁵ consisted of 81 patients. The patients were randomized into groups using a “computer generated allocation program” that stratified patients with three variables: smoking status, bone mineral density, and level of slippage (L4-L5, L5-S1). Table 4 shows the demographics breakdown for the patients assigned to PLF and PLIF surgeries.

Table 4: Demographics Data for Lee et al. Study⁵

	PLF	PLIF
Number of Patients	39	42
Males / Females	21M, 18F	23M, 19F
Age (Mean + Stan Dev)	53.4 +/- 2.3 years	53.7 +/- 2.1 years
Weight (Mean + Stan Dev)	68.8 +/- 13.4 kg	66.3 +/- 11.4 kg

For this study, the ODI scores both pre and post operatively were listed. Table 5 shows the ODI scores for both the PLF and PLIF surgical approaches.

Table 5: ODI Scores for both PLF and PLIF Groups for Lee et al. Study⁵

	ODI Scores	
	PLF	PLIF
Preop	37.5 ± 9.4	38.9 ± 9.1
2 years	8.6 ± 1.3	9.0 ± 1.6

The results do not show a statistically significant difference in ODI scores for the patients in the PLF group compared to the PLIF group (Analysis of variance test, $p = 0.46$).

The study conducted by Musluman et al.⁵ consisted of 50 patients. The patients were randomized into groups using software that stratified patients with five variables: age, sex, medical history, clinical findings, and grade of spondylolisthesis. Table 6 shows the demographics breakdown for the patients assigned to PLF and PLIF surgeries.

Table 6: Demographics Data for Musluman et al. Study⁶

	PLF	PLIF
Number of Patients	25	25
Males / Females	9M, 16F	8M, 17F
Age (Mean)	47.3 years	50.6 years

For this study, the ODI scores both pre and post operatively were listed. Post operative scores were listed for both 3 months and 1.5-6 years post operation. Table 7 shows the ODI scores for both the PLF and PLIF surgical approaches.

Table 7: ODI Scores for both PLF and PLIF Groups for Musluman et al. Study⁶

	ODI Scores	
	PLF	PLIF
Preop	29.20 ± 6.42	30.20 ± 5.70
3 months	18.20 ± 3.65	13.60 ± 1.95
1.5-6 years	14.12 ± 2.42	13.40 ± 1.95

There was a statistically significant difference in ODI scores between the PLF and PLIF groups at three months ($p < 0.05$), but there was no statistical difference in the ODI scores between the PLF and PLIF groups at the 1.5-6 year follow up ($p > 0.05$).

DISCUSSION:

The results of the three randomized control trial studies do not give a consistent conclusion. While the Lee et al. and Musluman et al. studies indicate that there is no statistical difference in long term lower back pain reduction between PLF and PLIF, the Farrohki et al. study indicated that the PLF surgery is superior to PLIF. There are multiple factors to consider when pondering the disparity in the reported results. The first thing to review is the ODI improvement statistics from the Farrohki et al. study. The standard deviation values seem to indicate that there is a wide array of ODI improvement score results reported by the PLIF group (17.1 +/- 12.98). With such a large standard deviation, a standard distribution of results is not feasible since that would indicate some patients experienced increases in pain. The authors of the paper did not indicate complete surgical failures for patients undergoing either operation. That amount of variance could be the result of inconsistent reporting of ODI scores or perhaps that a few outlier cases have skewed the mean ODI improvement score value and significantly

increased the standard deviation value. Without seeing the individual data, it is hard to confirm whether or not the data are accurately reported.

The statistically significant reduction in lower back pain reported three months after PLIF surgeries compared to PLF surgeries in the Musluman et al. study is another interesting finding since that trend did not continue for the long term lower back pain evaluation. The disparity was discussed by the authors and “was thought to be due to the earlier maintenance of an adequate sagittal axis and lower loading to the posterior segment of the vertebra with PLIF”.⁶ Although long term pain solutions is the goal of most surgeries, the significance of the pain improvement at the three month stage with PLIF over PLF can have added benefit for patients since it means they are regaining mobility and capability faster than compared to patients undergoing the PLF procedure.

CONCLUSION:

Both posterolateral fusion and posterior lumbar interbody fusion surgical approaches have been shown to improve quality of life and reduce pain in patients with persistent isthmic lumbar spondylolisthesis. The results of the review; however, indicate that there is no clear evidence as to which approach is superior in terms of long term reduction in lower back pain and enhancement in quality of life. Other factors such as surgeon experience and preference for performing these surgeries along with patient anatomy should continue to help guide surgeons in deciding the most appropriate approach to surgical repair for isthmic lumbar spondylolisthesis.

A goal for future studies would be to conduct a multicenter study in the United States to see how local teaching of surgical technique affects the outcomes of the surgery. A multicenter study would give a perspective on how surgeon experience with different surgical approaches

affects the comparison between PLF and PLIF to see if surgeon experience can tip the scales in one way or another. Additionally, having multiple surgeons involved can show if there is a variance of care based on the selected provider and determine if different providers can greatly impact patient quality of life post operation.

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