Transforaminal lumbar interbody fusion versus instrumented posterolateral fusion in Grade I/II spondylolisthesis

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ABSTRACT

Background: Spondylolisthesis refers to slippage of one vertebra over the other, which may be caused by a variety of reasons such as degenerative, trauma, and isthmic. Surgical management forms the mainstay of treatment to prevent further slip and worsening. However, there is no consensus regarding the best surgical option to treat these patients. This study compares TLIF and instrumented PLF in patients with Grade I and II spondylolisthesis and analysis the outcome with respect to functional outcome, pain, fusion rate, adequacy of medial facetectomy for decompression, and complications.

Materials and Methods: Forty patients operated for spondylolisthesis by instrumented posterolateral or transforaminal fusion between January 1, 2010, and June 30, 2012 were included in this retrospective study. They were followed up for 3 years. Twenty one cases were of instrumented posterolateral fusion (PLF) and 19 cases were of transforaminal lumbar interbody fusion (TLIF). The patients were asked to fill up the Oswestry disability index (ODI), Dallas Pain Questionnaire (DPQ), and low back pain rating scale (LBPRS) preoperatively, at 1-month postoperatively, and at 6, 12, 24, and 36 months postoperatively. Radiological parameters were assessed using radiographs.

Results: No significant differences were found in DPQ, LBPRS, or ODI scores preoperative, 1-month postoperative, and at 6, 12, 24 and 36 months followup. No significant difference was found between the two groups in blood loss. The only significant difference between the two groups was in the operative time, in which the instrumented PLF group had a mean of 50 min lesser than the TLIF group ($P = 0.02$).

Conclusions: TLIF and instrumented PLF are equally efficacious options in the treatment of Grade I and II spondylolisthesis, except lytic type.

Key words: Instrumented posterolateral fusion, spondylolisthesis, transforaminal lumbar interbody fusion

Mesh terms: Spinal fusion, spondylolisthesis, degenerative diseases, lumbar vertebrae

INTRODUCTION

Spondylolisthesis (Greek spondulos, vertebra + olisthēsis, dislocation, slipping [from olisthanein to slip]) refers to the slipping or moving of one vertebra forward or backward compared to the vertebrae above and below it. They could be caused by a variety of reasons such as degeneration, trauma, isthmic, pathological, and dysplastic.

According to Matsunaga et al., 30% of patients with degenerative spondylolisthesis develop progressive slip. Therefore, prompt identification and treatment are necessary for preventing progression.

Surgical correction of the slipped vertebra forms the mainstay of treatment of spondylolisthesis. Different options...
include posterior fusion with or without instrumentation, transforaminal lumbar interbody fusion (TLIF), and circumferential fusion.

However, there is no consensus regarding which form of fusion surgery is the best to treat this problem. Various randomized controlled trials (RCTs) have been performed which show no significant difference in outcomes between instrumented and uninstrumented fusion especially in the short term. However, there is an increasing trend toward interbody fusion. This study has been designed to compare the outcomes between TLIF versus instrumented posterolateral fusion (PLF) in patients with Grade I/II spondylolisthesis.

This study compares TLIF and instrumented PLF in patients with Grade I and II spondylolisthesis and analyzes the outcome with respect to functional outcome, pain, fusion rate, adequacy of medial facetectomy for decompression, and complications.

Materials and Methods

Forty patients operated for spondylolisthesis by instrumented posterolateral or transforaminal fusion between January, 2010, and June, 2012 were included in this retrospective study. They were followed up for 3 years. Twenty one cases were of instrumented posterolateral fusion (PLF) and 19 cases were of transforaminal lumbar interbody fusion (TLIF). The patients fulfilling the inclusion and exclusion criteria were included in the study. Inclusion criteria were (1) People of either sex who are 18–70 years of age (2) X-ray and magnetic resonance imaging (MRI) proven spondylolisthesis Grade I and II (3) Consented for the surgical procedures (TLIF and instrumented PLF) (4) Appeared for periodic followups (5) Consented to include themselves in the study. The exclusion criteria were (1) Patients who have X-ray and MRI proven spondylolisthesis Grade III and IV (2) Lytic spondylolisthesis (3) Pregnant women (4) Unsound mind (cannot fill up the questionnaires) (5) Not consented to the study (6) Previous back surgery (7) Previous fractures of the spine.

Patients were worked up for anesthetic fitness and all comorbidities were appropriately treated.

Operative procedure

Under general anesthesia, with the patient in prone position, a standard posterior midline incision was made. Levels were confirmed using fluoroscopy. Patient is positioned prone recreating lumbar lordosis. Polyaxial pedicle screws inserted. This helped in achieving reduction. No additional reduction maneuvers were used.

In the instrumented PLF group, inferior facet of the superior vertebra was removed bilaterally. Superior articular facet of the inferior vertebral body preserved and surface curetted up to bleeding bone to make a good bed for fusion. Bone grafting was done in the triangle between superior articular facet, transverse process, and pars.

Unilateral facetectomy was performed for the TLIF group. Discectomy was done. This was followed by preparation of end plates and measurement and insertion of a TLIF cage packed with bone graft. Global fusion was not performed.

For instrumented PLF, local graft harvested from the inferior articular process of the superior vertebra bilaterally along with bone taken from lamina while doing a foraminotomy was used.

For TLIF, bones were taken from foraminotomy site with facetectomy and removal of pars were utilized. No deliberate attempt was made for reduction since the study included only low-grade listhesis. The reduction that was achieved during the procedure was accepted. Wounds were closed after securing perfect hemostasis.

Patients were mobilized as tolerated. Back strengthening exercises were started as early as second postoperative day. No brace was used. Patients were mobilized without aid as early as 4th postoperative day or as early as they tolerated.

Measurement of the functional outcomes of these patients was made by the Dallas Pain Questionnaire (DPQ), the Oswestry disability index (ODI), and the low back pain radiation scale (LBPRS). These are validated questionnaires and patients filled them up independently preoperatively and at 1, 6, 12, 24, and 36 months postoperatively.

The DPQ reflects the functional impact of chronic spinal pain. It consists of four categories: Daily activity, work-leisure activity, anxiety-depression, and social concerns with increased scores reflecting greater impact.

The LBPRS index is used to assess the leg pain and back pain, which includes measurements of pain intensity ranging from 0 to 10, in which ten represents the worst possible pain. They are 11-point (0–10) numerical rating scales assessing both back and leg pain in three ways: Worst pain within the last 14 days, average pain within the last 14 days, and actual pain level at the time of completing the questionnaire. The scores for leg pain and back pain are summed giving a pain index ranging from 0 to 60. To this is added disability index and physical impairment comprising 30 and 40 points, respectively. Higher scores reflect greater level of disability and impairment.
The ODI\textsuperscript{10} measures condition-specific outcomes of spinal disorders. Index score is calculated which ranges from 0 to 100, with a higher score reflecting greater disability. Correction loss was defined as an increased kyphosis >3° or slippage of more than 2 mm.\textsuperscript{11} All cases in this study have been performed by a single surgeon who is fellowship trained (1\textsuperscript{st} author). The postoperative evaluation is by the second author, independent of the first author. The procedure to be performed was decided by the patient after all options including pros and cons were discussed with the patient.

**Sample size**

According to the study conducted by Jacobsen et al.,\textsuperscript{12} the incidence of spondylolisthesis is approximately 6%.

Applying this to formula for calculation of sample size:\textsuperscript{13}

\[
\text{Sample size} = \frac{Z_{1-\alpha/2}^2 p (1-p)}{d^2}
\]

Where \( Z_{1-\alpha/2} \) is standard normal variate; five percentage error value is 1.96,

\( p = \) proportion in population: here \( p = 0.06, \textsuperscript{10} \)
\( d = \) absolute error/precision: \( d = 0.08. \)

Hence sample size = \( \frac{1.96^2 \times 0.06 \times 0.94}{0.08^2} = 33.85 \)

Hence, the report of this study may be considered significant.

**RESULTS**

Forty cases were evaluated [Table 1]. The groups were comparable in age range and sex. No significant differences were found in DPQ [Figure 1], LBPRS [Figure 2], or ODI scores [Figure 3] preoperative, 1-month postoperative, and at 6, 12, 24, and 36 months followup. No significant difference was found between the two groups in blood loss.

Serial X-rays were made [Figures 4-8].

The only significant difference between the two groups was in the operative time, in which the instrumented PLF group had a mean of 50 min lesser than the TLIF group (\( P = 0.02 \)).

**Complications**

Superficial infection was seen in two cases in the PLF group and one case in the TLIF group. They were treated with appropriate antibiotics and resolved completely.

**Table 1: Clinical details of patients**

| Variable       | PLF                  | Mean | Range      | TLIF                  | Mean | Range      | \( P \) |
|----------------|----------------------|------|------------|-----------------------|------|------------|--------|
| Sex            | Male/female          | 7/14 | Male/female| 6/13                  |      |            | 0.40   |
| Number         | 21/40                |      |            | 19/40                 |      |            |        |
| ODI            |                      |      |            |                       |      |            |        |
| Preoperative   | 32.28                | 13-49| 31.36      | 11-46                 |      |            | 0.81   |
| 1-month postoperative | 17.47 | 4-41 | 18.31      | 3-37                  |      |            | 0.87   |
| 6 months       | 13.80                | 2-38 | 14.21      | 3-32                  |      |            | 0.93   |
| 12 months      | 10.38                | 1-38 | 11.42      | 1-23                  |      |            | 0.97   |
| 24 months      | 10.33                | 1-41 | 9.31       | 1-26                  |      |            | 0.79   |
| 36 months      | 7.66                 | 1-48 | 8.68       | 1-23                  |      |            | 0.81   |
| DPQ            |                      |      |            |                       |      |            |        |
| Preoperative   | 48.53                | 30.6-81.2| 48.44 | 30.6-83.3 |      |            | 0.99   |
| 1-month postoperative | 29.91 | 6.3-75.8| 29.7 | 7.8-71.6 |      |            | 0.98   |
| 6 months       | 21.57                | 2.5-69.1| 21.83 | 5.5-53.6  |      |            | 0.98   |
| 12 months      | 16.45                | 2.5-70.2| 16.56 | 3.1-42.1  |      |            | 0.99   |
| 24 months      | 12.12                | 1.1-49.8| 10.93 | 2-33.9    |      |            | 0.86   |
| 36 months      | 8.95                 | 1.2-58.5| 8.87 | 1-27.1    |      |            | 0.98   |
| LBPRS          |                      |      |            |                       |      |            |        |
| Preoperative   | 68.66                | 49-87| 68.42      | 39-88                 |      |            | 0.97   |
| 1-month postoperative | 35.95 | 15-78 | 35.84 | 12-68     |      |            | 0.99   |
| 6 months       | 25.14                | 7-74 | 24.42      | 2-59                  |      |            | 0.95   |
| 12 months      | 18.23                | 5-66 | 17.47      | 2-42                  |      |            | 0.93   |
| 24 months      | 13.3                 | 3-56 | 11.94      | 1-36                  |      |            | 0.86   |
| 36 months      | 9.95                 | 1-62 | 11.05      | 1-64                  |      |            | 0.91   |
| Mean blood loss (ml) | 175 | 100-300 | 432.6 | 350-600 |      |            | 0.20   |
| Mean operating time (minutes) | 132.85 | 100-180 | 182.36 | 150-220 |      |            | 0.02   |
| Mean age (years) | 46.23 | 22-62 | 46.94 | 27-62    |      |            | 0.86   |

LBPRS=Low back pain rating scale, DPQ=Dallas Pain Questionnaire, ODI=Oswestry disability index, PLF=Posterolateral fusion, TLIF=Transforaminal lumbar interbody fusion
There were no deep infections.

There was one case of dural tear in the TLIF group, which was identified intraoperatively. There was one nerve root injury of L5 nerve root in a case of L4–L5 listhesis in the TLIF group.

There was one case of failure of fusion in the instrumented PLF group, which was due to screw breakage. This case did not opt for the second surgery.

**Discussion**

This study is a single-center, single surgical team study. This allows for standardization of patient selection and surgical technique. Many studies have established that TLIF is a better procedure than PLIF and ALIF in terms of outcomes and complications because it is currently believed that interbody fusion is the gold standard in the treatment of spondylolisthesis.

Circumferential fusion compared to instrumented PLF provides conflicting data. Fritzell et al. demonstrated no significant difference between circumferential fusion and PLF. However, Videbaek et al. demonstrated significant improvement in patients who underwent circumferential fusion as opposed to PLF.

Moreover, ALIF is not routinely used because of complications. However, there have not been many studies which have compared transforaminal interbody fusion with instrumented PLF.

Audat et al. compared PLF, PLIF, and TLIF for degenerative disc disease and found that no significant difference existed between the three groups in terms of clinical outcomes and complications. However, there was a small increase in the radiological fusion rates in the TLIF group. An RCT for comparing TLIF and instrumented PLF was performed by Høy et al. This study comprised 100 patients randomized into two groups and followed up for 2 years.

In comparison, our study was a retrospective study of forty cases followed up for a longer duration of 3 years. At the end of the study, they found that there was no significant difference in any of the scores at any point in the 2-year followup. Both groups improved compared to preoperative status. Our study findings were similar. Their study revealed an insignificant increase of leg pain in the TLIF group that was not present in the study. There was a significant increase in blood loss and operating time in their study, while in our study, the increase in blood loss was not significant when compared between the two groups. Operating time was longer by a mean of 50 min (P = 0.02).

Complications were similar in the groups in both studies, and the differences were not significant. The aim of spinal fusion...
surgery is to eliminate motion between the two vertebrae. When the vertebrae are fused at two different points, it eliminates motion in all three planes. During surgery, we have freshened the transverse process, pars, and superior facet up to bleeding bone. Subsequently, graft was placed between bleeding bones with aim to achieve union. By this method, we have ensured reliable union between the vertebrae. The absence of motion in flexion extension views, as sole criteria for assessing fusion postoperatively have been previously published by Brodsky et al., compared the findings of lumbar flexion extension radiography to surgical exploration in a series of 175 patients who underwent reoperation for various indications following instrumented and noninstrumented lumbar fusion. They found a 62% correlation between preoperative flexion extension radiography and intraoperative findings at exploration (specificity 37%, sensitivity 96%, positive predictive value 70%, and negative predictive value 86%). Their study provides Class II medical evidence that the absence of motion on flexion extension X-ray films is highly suggestive of a solid fusion.

We have omitted lytic spondylolisthesis from our study because we felt that they are unstable and always tend to do better with interbody or circumferential fusion. However, in other types of Grade I and II listhesis, instrumented PLF works as an equally good option with similar outcomes, similar patient satisfaction scores, and complications. However, the cost of adding an interbody cage is significant, especially in a low-resource country. However, we present this as a pilot study to emphasize the fact that nonlytic listhesis, unlike lytic listhesis, is not

![Figure 4](image1.png)

*Figure 4: X-ray dorsolumbar spine lateral view showing L4–L5 spondylolisthesis*

![Figure 5](image2.png)

*Figure 5: (a) Followup x-ray lumbosacral spine anteroposterior view showing pedical screw system in situ (b) X-ray lumbosacral spine lateral view in flexion and in extension (c) showing implant in situ with no excursion*
highly unstable. Therefore, addition of screws without discectomy with minimal graft in the triangular area will produce as good a result as TLIF, which is more technically demanding. We have performed a post hoc statistical analysis for identifying power of the study using operating time and blood loss as the primary parameters. The power of this study comes to 100%, which is significant.

Figure 6: Followup x-ray anteroposterior and lateral views showing screw breakage and failed posterolateral fusion

Figure 7: Another example x-ray anteroposterior (a) and lateral (b) views showing L4–L5 spondylolisthesis
Conclusions

Instrumented PLF is a simpler and safer procedure for the treatment of Grade I and II nonlytic spondylolisthesis.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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