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A prospective study on functional and radiological outcomes in degenerative spondylolisthesis treated with posterior lumbar interbody fusion with posterolateral fusion

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Abstract

Background: The degenerative spondylolisthesis is a common problem treated by an orthopaedician in day to day practice. The available data on the outcomes of posterior lumbar interbody fusion with posterolateral fusion in terms of functional and radiological parameters is scant. Hence we had evaluated the functional and radiological outcomes in degenerative spondylolisthesis patients treated with posterior lumbar interbody fusion with posterolateral fusion.

Material and Methods: A prospective interventional study was undertaken among adult patients with degenerative spondylolisthesis admitted to the tertiary care hospital were included. Seventy-five adult patients who had degenerative spondylolisthesis treated with a posterior lumbar interbody fusion with posterolateral fusion. The patients were followed up at 3rd, 6th and 12th postoperative months.

Results: The mean age was 62.9 years and more female patients are present in our study. The improvement in pain determined by visual analog scale (VAS) was statistically significant at 3rd, 6th and 12th months follow up visits when compared to baseline. In our study with respect to the patient to return to work, 63 (84%) patients show an excellent result, taking the result as satisfactory. Our study show posterolumbar interbody fusion level 5: seen in 75 levels, level 4: seen in 07 levels and posterolateral fusion grade A score is seen in 67 levels in with minimal complication rate.

Conclusion: This study was able to show that posterior lumbar interbody fusion with posterolateral fusion had a good clinical outcome.

Keywords: Degenerative spondylolisthesis, posterior lumbar interbody fusion (PLIF), posterolateral fusion, spinal fusion

Introduction

The term Spondylolisthesis was coined for the first time in 1854 by Killian' and defined as the olisthy of one vertebral body over another. Spondylolisthesis is a pathological condition¹. There are different types of spondylolisthesis. Wiltse *et al.* performed the first systematic classification according to etiology, differentiating between congenital, isthmic, degenerative, pathological and iatrogenic^[2].

The most common type of spondylolisthesis in adults is degenerative^[3]. The incidence of degenerative spondylolisthesis is around 8.7%⁴. Degenerative spondylolisthesis is more commonly found in women. The most common and most important clinical manifestation is chronic pain associated with sciatica and/or Neurogenic claudication^[5, 6].

There are different methods of fixation and fusion that can be used in different types of spondylolisthesis. Still, treatment for spondylolisthesis is very controversial. In 1985 first posterior lumbar interbody fusion was done for degenerative spondylolisthesis by Cloward^[7].

Our study presents the results of adult patients having degenerative spondylolisthesis treated with posterolateral fusion (IPLF) with posterior lumbar interbody fusion (PLIF) and compares the results between functional and radiological characteristics of patients preoperatively and postoperatively in follow up at 3 months, 6months and 12 months.

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Materials and Methods

A prospective interventional study was done in the Department of Orthopaedics in Post Graduate Institute of Swasthiyog Pratishthan Miraj, from January 2017 to December 2019. Adult patients with degenerative spondylolisthesis were admitted to the tertiary care hospital, were included in the study after obtaining informed, written and video consent. Clearance from the institutional ethics committee was obtained. Seventy five adult patients with degenerative spondylolisthesis who were undergoing surgery admitted to the hospital constituted the study sample. A detailed clinical evaluation of the patients was done. Then detailed radiological evaluation in terms of x-rays AP view, lateral view, flexion-extension view, MRI of the spine was done. Laboratory and a cardiac investigation were done for fitness purpose. All patients with degenerative spondylolisthesis are treated with posterolateral fusion with posterolateral interbody fusion.

Inclusion Criteria

The patients with type III degenerative spondylolisthesis, Meyerding classification⁸ grade I-V with chronic pain with neurological symptoms for 1-year minimum and recalcitrant to conservative treatment including pharmacological and physiotherapy protocol are included in our study.

Exclusion Criteria

Patients with any active or remote source of infection, type I: congenital, type II: isthmic, type IV: traumatic, type V: pathological and type VI: iatrogenic, psychological disorder, are those excluded from the study. Also, those patients who did not give consent for surgery or study purpose are excluded from the study sample.

Surgical Technique

In all patients, surgery was performed by the same surgeon team by using the same surgical technique under general anesthesia. The patient is placed in the prone position on the Wilson frame, checking that the abdomen remains as free as possible from external pressure in order to obtain minimum epidural bleeding during the procedure. The intraoperative level is confirmed under fluoroscopy, painting and draping done. After a sufficiently extensive skin incision, the paraspinal muscles are dissected and separated, the vertebral pedicles are identified and the pedicle screws are placed. A wide bilateral decompression is performed, with resection of the joints, the affected disc or discs are removed and disc spaces are cleared with shavers, intersomatic arthrodesis cage of appropriate size, ones on each side of the midline. These cages are filled with autogenous bone coming from the posterior bony structures previously removed and carefully prepared for that aim (spinous processes, laminae and joints). The bars are placed on both sides, which are fixed to previously placed screws, and to the interpositioning of the bony graft, also of local origin, between the superior and inferior the fusion, and finishing in this way the posterolateral fusion. Intraoperative neurophysiological monitoring is done. The patient is extubated and monitored in postoperative recovery room. Postoperative x-rays AP view and lateral views are done within 24-48 hours. If the position of screws and cages are in the correct position, the study is considered normal. Physiotherapy protocol is initiated; the patient is mobilized with the help of brace for 3 months.

Functional Evaluation

Preoperative and postoperative clinical evaluation of back pain and sciatica was carried out by visual analogical scale (vas) of pain that extends from 0-10, with "0" as the absence of pain and "10" as the exits tense of the maximum pain.⁹ Vas is a subjective unidimensional scale. The total clinical and functional result was estimated with the kirkaldy-wyllis criteria.

Radiological Evaluation

Postoperative radiological evaluation was done by the surgeon team separately with the same criteria. In a regular interval meeting, the inference was discussed by the team and the final result was noted. In case of any doubt, results were discussed with another consultant and radiologist for guidance purpose. The same followed for every case.

The posterior lumbar interbody fusion was determined according to the criteria described by brantigan *et al.* ^[11] A detailed description of the criteria (tables and figures) is presented in the original article. Those authors employed a scale of 5 levels, summarized as follows:

Level 5: radiological fusion;

Level 4: probable radiological fusion;

Level 3: uncertain radiological stage;

Level 2: probable radiographic pseudarthrosis;

Level 1: obvious radiographic pseudarthrosis.

Levels 5 and 4 usually have the excellent radiological outcome: these cases normally do not return to the operating room for cages failure.

The degree of posterolateral fusion was determined to employ the method used by lenke *et al.* ^[12] A detailed description of the criteria (tables and figures) is presented in the original work. It is specified in the following manner:

Grade A: definitive fusion with bilateral thick bony masses;

Grade B: probable fusion with a thick bony mass in one side and thin bony mass on the other;

Grade C: no probable fusion with a thin bony mass on one side and probable pseudarthrosis on the contralateral side;

Grade D: no fusion, with a thin bony mass on both sides with obvious bony pseudarthrosis or reabsorption of graft bilaterally.

Grades A and B usually have an excellent radiological outcome. These cases normally do not return to the operating room for posterolateral pseudarthrosis, instrumentation failure and pedicle screw loosening or windshield wiper-type sign.

Statistical Analysis

The data thus obtained was entered in a predesigned proforma and entered into the excel sheet. The data was analyzed using statistical package for social sciences (SPSS vs 20). Independent sample t-test for quantitative variables, paired t-test for paired observations and chi-square test for categorical observations were used as a test of significance. Value of less than 0.05 was considered a significance level and all the values below it were considered as statistically significant.

Result

Table 1: Age of the study group

Age In Years	Frequency
<50	00
50-60	31
60-70	33
70-80	10
>80	01
Total	75

The mean (\pm SD) age of the study group was 62.9 (\pm 7.6) years. Majority of the patients are in the 5th and 6th decade. The ratio of female: male is 1.34:1. In our study more females are present than males.

Table 2: Socio-demographic characteristics of the study group

Parameter	
Age	
Mean \pm Sd	62.9 years \pm
Median	7.6 65 years
Range	51-82
Sex	
Male	32 (42.6%)
Female	43 (57.3%)
Duration of Symptoms (Years)	4.1 years \pm 1.9
Symptoms	
Sciatica	04 (5.33%)
Neurogenic Claudication	40 (53.33%)
Back Pain + Sciatica	23 (30.66%)
Back Pain + Sciatica + Neurogenic Claudication	08 (10.66%)
Sign	
None	10 (13.33%)
Motor	35 (46.66%)
Sensory	18 (24%)
Motor + Sensory	12 (16%)
Surgery Level	
One Level	68 (90.66%)
Two Level	07 (9.33%)
Total Operated Level	82 (In 75 patients)
Meyerding Grading	
One	61 (81.33%)
Two	13 (17.33%)
Three	01 (1.33%)
Four	00
Five	00
Level	
L3-L4	05 (6.66%)
L4-L5	38 (50.66%)
L5-S1	25 (33.34%)
L4-L5 + L5-S1	07(9.34%)

The most common clinical symptom in our study was Neurogenic claudication seen in 53.33% (n 40) patients, followed by lumbo-sciatica pain seen in 30.66% (n 23) patients, followed by Neurogenic claudication with lumbo-sciatica pain seen in 10.66% (n 08) patients, followed by sciatica seen in 5.33% (n 04).

The isolated motor deficit was seen in 46.66% (n 35) patients, followed by sensory deficit seen in 24% (n18) patients, followed by combined motor and sensory deficit seen in 16% (n 12) patients, followed by the absence of findings seen in 13.33% (n10) patients.

The average duration of symptoms was 4.1(\pm 1.9) years before surgery was indicated.

100% of patients are having type III degenerative spondylolisthesis.

In 90.66 % (n 68) patients, surgery was performed at a single level, in 9.33% (n7) patients; surgery was performed at two continuous levels. Total number of levels operated is 82 in 75 patients.

According to Meyerding classification [8], patients are having grade I spondylolisthesis are 61(81.33%), grade II in13 (17.33), grade III in 01 (1.33%) patients.

The most affected spinal level was L4-L5 seen in 38 (50.66%) patients, followed by L5-S1 level seen in 25 (33.34%) patients, followed by L3-L4 level seen in 5 (6.66%) patients.

Table 3: Pain scores at various follow-up

	VAS (MEAN \pm SD)	Improvement (%)	t value vs pre op	p value, Sig vs pre op
Pre-operative	7.61 \pm 0.75			
3 months post-op	1.39 \pm 0.88	81.79	46.48	<0.001
6 months post-op	1.3 \pm 0.8	82.92	50.74	<0.001
12 months post-op	1.16 \pm 0.57	84.76	66.65	<0.001

All the cases those who are presented with back pain before surgery are improved at the end of follow up after surgical intervention (p <0.001) which was statically significant. All cases those who are presented with radicular pain before surgery are improved after surgical intervention (p<0.001) which was statistically significant.

Table 4: Clinical results (Kirkaldy-Willis criteria).

Clinical results	No. Patients (%)
Excellent	63 (84%)
Good	11 (14.66%)
Fair	01 (1.33%)
Poor	00

According to kirkaldy-willis criteria¹⁰, with respect to patient to return to work, 63 (84%) patients show the excellent results, 11 (14.66%) patients show good result taking the result as satisfactory.

Table 5: Radiological Results after 12 months of follow up

	Degenerative Spondylolisthesis (No. levels (%))
PLIF (Brantigan <i>et al.</i>) [11]	
Level 5	75 (91.4%)
Level 4	07 (8.53%)
Level 3	00
Level 2	00
Level 1	00
IPLF (Lenke <i>et al.</i>) [12]	
Grade A	73 (89.02%)
Grade B	09 (10.66%)
Grade C	00
Grade D	00

Table 6: Comparison between our study and relevant studies in the literature

Study	Patients (No.)	Mean Age (Years)	Gender (Women/ Men)	Type of Spondylolisthesis	Mean Follow up (Years)	Total Follow up Rate (%)	Clinical Satisfaction (No. patients (%))	Fusion Rate (No. patients (%))
Our Study	75	62.9	43/32	Degenerative	1	100%	70/75 (92.1%)	68/75 (90.67%)
Ekman <i>et al.</i> [19]	86	40	53/33	Isthmic	2	98%	74/86 (86%)	---
Abdu <i>et al.</i> [20]	63	59.7	50/13	Degenerative	4	73%	---	47/54 (87%)
Kim <i>et al.</i> [21]	48	53.4	35/13	Isthmic + Degenerative	3	---	41/48 (85.4%)	46/48 (96%)
Cunningham <i>et al.</i> [22]	31	43	17/14	Isthmic	6.33	77%	---	---
La Rosa <i>et al.</i> [23]	17	57.2	---	Isthmic	2	100%	15/17 (88.2%)	17/17 (100%)
Alunima <i>et al.</i> [16]	36	57.1	22/14	Isthmic + Degenerative	1	100%	34/36 (94.5%)	33/36 (91.6%)

According to brantigan *et al.* [11] criteria, posterolumbar interbody fusion level 5: seen in 75 (91.4%) levels, level 4: seen in 07 (8.53%) levels. No patient is seen in level 3, level 2 and level 1 group.

According to the degrees of fusion of lenke *et al.* [12] criteria,

posterolateral fusion grade A seen in 73 (89.02%) levels, grade B seen in 09 (10.97%) levels. No patient is seen in either grade C or grade D. All patients who underwent surgical intervention show 100% excellent radiological outcome. In our study, 100% follow up rate was present.

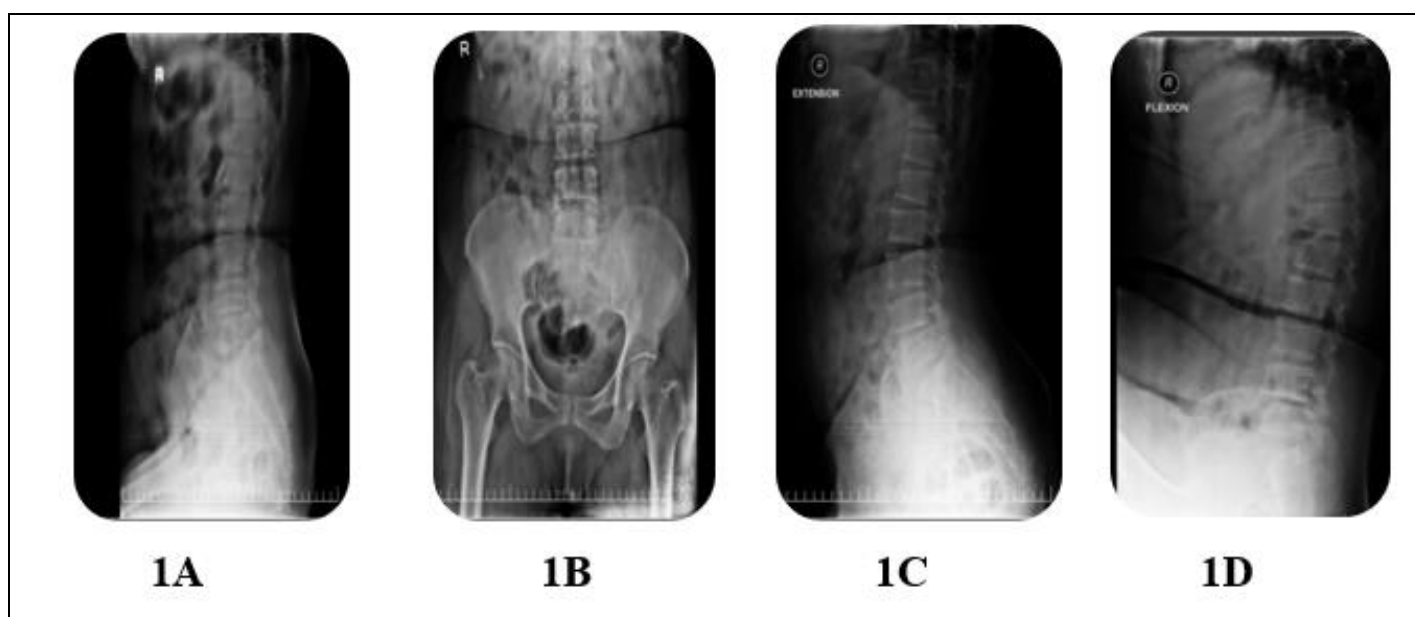


Fig 1: Preoperative X-rays 1A- lateral view, 2B- AP view, 3C- lateral extension view, 4D- lateral flexion view

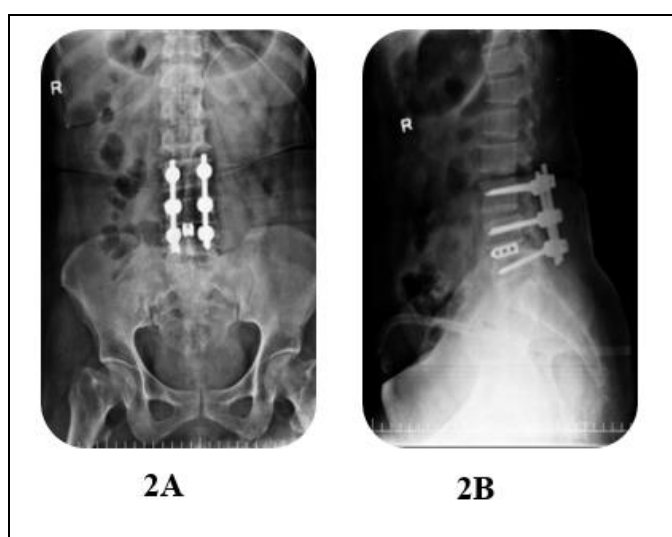


Fig 2: Postoperative X-rays 2A- AP view, 2B- lateral view

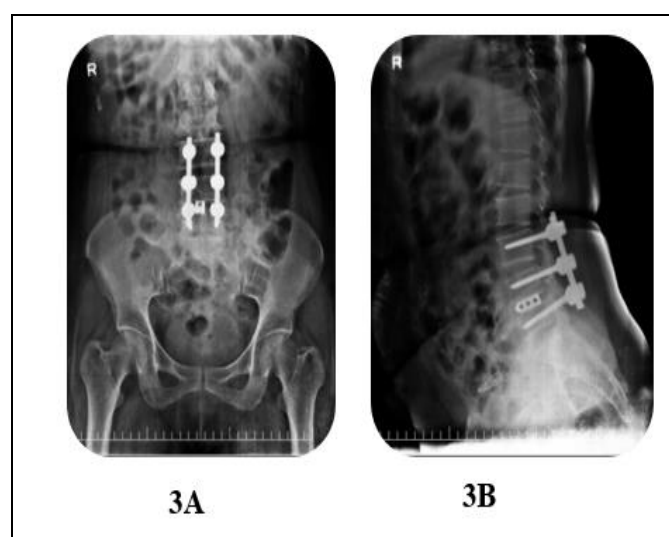


Fig 3: Postoperative X-rays at 3rd month follow-up 3A- AP view, 3B- lateral view.

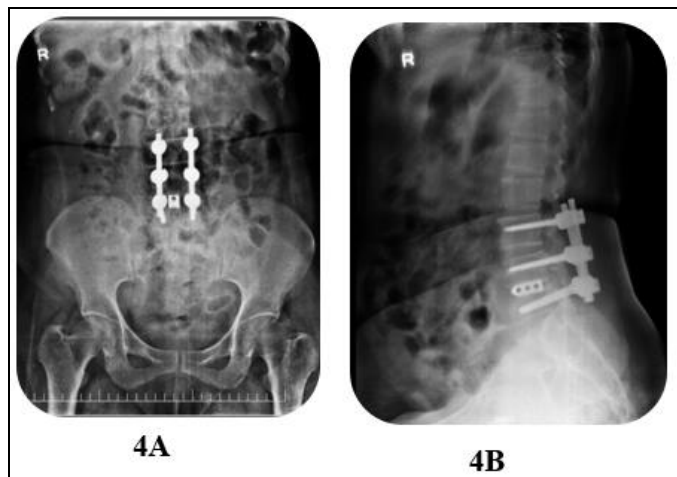


Fig 4: Postoperative X-rays at 6th month follow-up 4A- AP view, 4B- lateral view

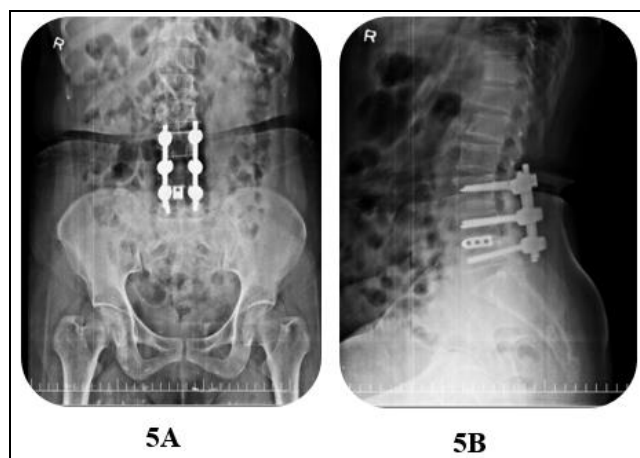


Fig 5: Postoperative X-rays at 12th month follow-up 5A- AP view, 5B- lateral view

Complication

Subcutaneous infection at the surgical site was present in 2 (2.66%) patients treated with antibiotic therapy for 15 days. A transient neurological deficit after the surgical intervention was present in 1 (1.33%) patient. All 3 patients are improved in rehabilitation therapy at the end of 12 months follow up.

Discussion

Our study was mainly undertaken to study the clinical, functional and radiological outcome of the postero-lateral fusion with posterior lumbar interbody fusion in adult degenerative spondylolisthesis. The literature available has shown a number of surgical procedures vary from an anterior approach, lateral approach to posterior approach with anterior lumbar interbody fusion, posterior lumbar interbody fusion, and total lumbar interbody fusion with decompression [13]. The complications also vary from one procedure to the other procedure [5]. The rates of complications vary from 5 to 20% with the different surgeries of the degenerative spondylolisthesis.

Our study has demonstrated the improvement in vas score for pain (7.61 ± 0.75 to 1.16 ± 0.57) at 12 months follow up and reported outcome was excellent or good by using kirkaldy-wyllis criteria. Also in our study radiological outcome, 91.4% has demonstrated and shown level 5 posterolumbar interbody fusion by using brantigan *et al* criteria; grade A score in 73 levels in posterolateral fusion by using lenke *et al* criteria. A study by Periasamy *et al.* [14] had a fusion rate of (94.6%) in

patients undergoing PLIF + PLF and 13.3% complication rates. Abdu *et al.* [15] have reported outcomes among the patients with PLIF + PLF 87% fusion rate and 14.2% complication rate. Alumina *et al.* [16] had a fusion rate of 94.5% and 13.8 complication rate.

The incidence of dural tear intraoperatively that is present in literature varies between 5.5% to 10.1% (5.8% in 7/120, 5.5% in 13/236, 10.1% in 36/356) [3, 17, 18] but in our study, there is no single patient having a dural tear.

In our study, we had a subcutaneous infection of surgical scar 2.66%, similar rate to the other study groups that varies between 1.4% to 3%. (2.5% in 3/120, 3% in 73/236, 1.4% in 5/356, 3.5% in 3/86) [3, 17, 18, 19]

The most important prognostic factors for the outcome are the age of the patient undergoing intervention, duration of symptoms and grade of spondylolisthesis. The duration of symptoms was $4.1(\pm 1.9)$ years and this is very prolonged period. Similar figures were found in the published series (table 6). So we believe that if a patient is less responding to complete conservative therapy protocol, they should be considered for early surgical intervention to obtain the best clinical outcomes. The main limitation of this study was a shorter duration of follow up.

Conclusion

This study was able to show that posterolumbar interbody fusion (PLIF) with the postero lateral fusion had an excellent clinical outcome in adult degenerative spondylolisthesis patients. The complication rates were less including the intraoperative blood loss, the need for transfusions and post-operative infections. Additional multifactorial analytical studies are needed to obtain the best outcomes of surgery.

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