Original Article

Comparison of the early results of transforaminal lumbar interbody fusion and posterior lumbar interbody fusion in symptomatic lumbar instability

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Abstract

Background: Transforaminal lumbar interbody fusion (TLIF) has been preferred to posterior lumbar interbody fusion (PLIF) for different spinal disorders but there had been no study comparing their outcome in lumbar instability. A comparative retrospective analysis of the early results of TLIF and PLIF in symptomatic lumbar instability was conducted between 2005 and 2011.

Materials and Methods: Review of the records of 102 operated cases of lumbar instability with minimum 1 year followup was done. A total of 52 cases (11 men and 41 women, mean age 46 years SD 05.88, range 40-59 years) underwent PLIF and 50 cases (14 men and 36 women, mean age 49 years SD 06.88, range 40-59 years) underwent TLIF. The surgical time, duration of hospital stay, intraoperative blood loss were compared. Self-evaluated low back pain and leg pain status (using Visual Analog Score), disability outcome (using Oswestry disability questionnaire) was analyzed. Radiological structural restoration (e.g., disc height, foraminal height, lordotic angle, and slip reduction), stability (using Posner criteria), fusion (using Hackenberg criteria), and overall functional outcome (using MacNab's criteria) were compared.

Results: Pain, disability, neurology, and overall functional status were significantly improved in both groups but PLIF required more operative time and caused more blood loss. Postoperative hospital stay, structural restoration, stability, and fusion had no significant difference but neural complications were relatively more with PLIF.

Conclusions: Both methods were effective in relieving symptoms, achieving structural restoration, stability, and fusion, but TLIF had been associated with shorter operative time, less blood loss, and lesser complication rates for which it can be preferred for symptomatic lumbar instability.

Key words: Lumbar instability, posterior lumbar interbody fusion, transforaminal lumbar interbody fusion

Introduction

Spinal stability is the vertebral ability to maintain their relationship and limit their relative displacements during physiologic postures and loads.[1] Instability develops when the spinal stabilizing system fails to maintain the physiological limit of spinal "neutral zone", which may result in progressive deterioration of the structural components of the spine leading to incapacitating symptoms [e.g., low back pain (LBP) with or without sciatica, increasing disability and progressive deterioration of quality of life]. The concept of "lumbar segmental instability (LSI)" is not new and degenerative and lytic spondylolisthesis comprises the principal aetiology. The clinical symptoms and proposed clinical tests had limited diagnostic significance,[2] hence the radiological criteria has been emphasized.[3] Although the initial treatment is conservative (e.g., patient education, exercise, bracing, physical therapy), surgery is the last resort for symptomatic instability.[4]

Spinal fusion procedures are indicated with severe disabling symptoms and radiographic evidence of increased segmental motion that fails to respond to adequate conservative trial.[5] Segmental fusion provides solid fixation, restores the spinal stability, and maintains loadbearing capacity of spine.[6] Considering all these advantages, posterior lumbar interbody fusion (PLIF) has long been the "gold standard" surgical technique for LSI,[7,8] but since transforaminal

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lumbar interbody fusion (TLIF) (a modification of PLIF by Harms[9]) has been introduced, it has been found to be better technique for different other spinal disorders.[10-12] To the best of our knowledge, there is no study comparing these two techniques in spinal instability in English language literature. Our aim was to assess and compare the early clinical and radiological outcome of PLIF and TLIF in the two most common causes of symptomatic lumbar instability.

Materials and Methods

A retrospective review of the records of 52 patients, 11 men and 41 women aged 40 to 59 years (mean 46.73, SD 05.88) who underwent PLIF (Group-I), and 50 patients, 14 men and 36 women aged 40 to 59 years (mean 49.04, SD 06.88) who underwent TLIF (Group-II) were reviewed between January 2005 and December 2011. Patients with lumbar instability (degenerative and lytic) with uni/bilateral radiculopathy who failed adequate conservative therapy (e.g., bracing, physiotherapy, and exercises) for 6-15 months (mean 9 months, SD 2.75) were included, but patients with (i) symptomatic radiological instability in > 1 segment, (ii) previous history of spondylodiscitis; and (iii) pathological condition of lumbar spine (e.g., trauma, tumor) were excluded. Higher grades (>Grade-II) of spondylolisthesis were also excluded because of unavailability of reduction pedicle screws and *in situ* reduction devices.

Preoperative X-ray lumbosacral (L/S) spine antero/posterior (A/P), lateral [Figure 1] and dynamic views were done to assess the instability by the radiographic criteria of Posner[3] and Meyerding's[13] grading was done to assess

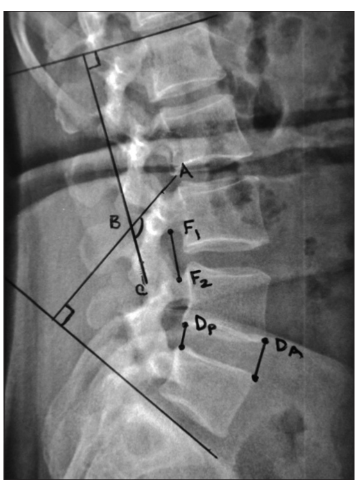

Figure 1: X-ray lumbosacral spine lateral view showing radiological assessment of structural restoration (Disc height, foraminal height and angle of total lumbar lordosis). Disc height has been measured as $(D_A+D_P) / 2$; The foraminal height has been measured as the distance between the midpoint of the superior and inferior neural arch (F_1-F_2); The angle of total lumbar lordosis has been measured by the angle formed by the perpendicular lines from the two lines drawn along the superior end plate of L_1 and superior end plate of S_1 (angle ABC)

forward slip. Magnetic resonance imaging (MRI) of the L/S spine was done routinely to delineate the intra-spinal pathoanatomy. The operative time, intraoperative blood loss, postoperative hospital stay, improvement of neurological status was recorded. Preoperative and postoperative pain status was recorded by self-evaluated Visual Analog Score (VAS)[14] and disability by Oswestry Disability Index (ODI).[15] Followup was done at 6 weeks, 3 months, 6 months, and then every yearly[16] for radiological fusion,[17] structural restoration (disc height, foraminal height, angle of total lumbar lordosis and slip reduction) in standing lateral films[18] [Figure 2], and maintenance of stability.[3] Computed tomography (CT) scan had been reserved for cases where radiological fusion was doubtful or delayed or suspected of pseudarthrosis, as recommended.[19] The overall functional outcome was assessed by Macnab's[20] criteria.

Operative procedure

After proper explanation of the management options and surgical technique, an informed written consent was taken, The patients were operated under general anaesthesia. Patients of both groups i.e. PLIF and TLIF, were placed in prone position and a routine posterior midline approach was used. The paraspinal muscles were exposed by subperiosteal dissection till the intended segmental levels. The pedicle screws were inserted using a standard "free hand targeting" technique under fluoroscopic control. In PLIF [Figure 3], decompression was commenced by laminectomy and removal of interspinous ligaments and ligamentum flavum with sufficient decompressive laminotomy superiorly and inferiorly. But in TLIF [Figure 4], unilateral laminotomy and partial facetectomy were performed on the side consistent with the patient's symptoms or anatomical abnormalities. Unlike most other literature, we used to excise the spinous process to collect adequate autografts for the prepared disc space intended to achieve good fusion. The osteophytes and bony spurs were removed. Discectomy was done bilaterally in PLIF but unilaterally in TLIF.

Disc space preparation was done by unilateral distractor instrumentation with bilateral curettage in PLIF; however, in TLIF we used unilateral curettage by using special curved curettes to remove the end plates. The morcelized bone grafts taken from the excised spinous process and/or laminar bone were introduced to the anterior part of the disc space and impacted with an L-shaped impactor. In both techniques, we used single banana cage (Titanium, size 9 mm, 10 mm, or 11 mm) which was packed with cortico-cancellous autografts and inserted in the prepared space from the surgeon's side. The final position of the cage was confirmed fluoroscopically or by check X-ray.

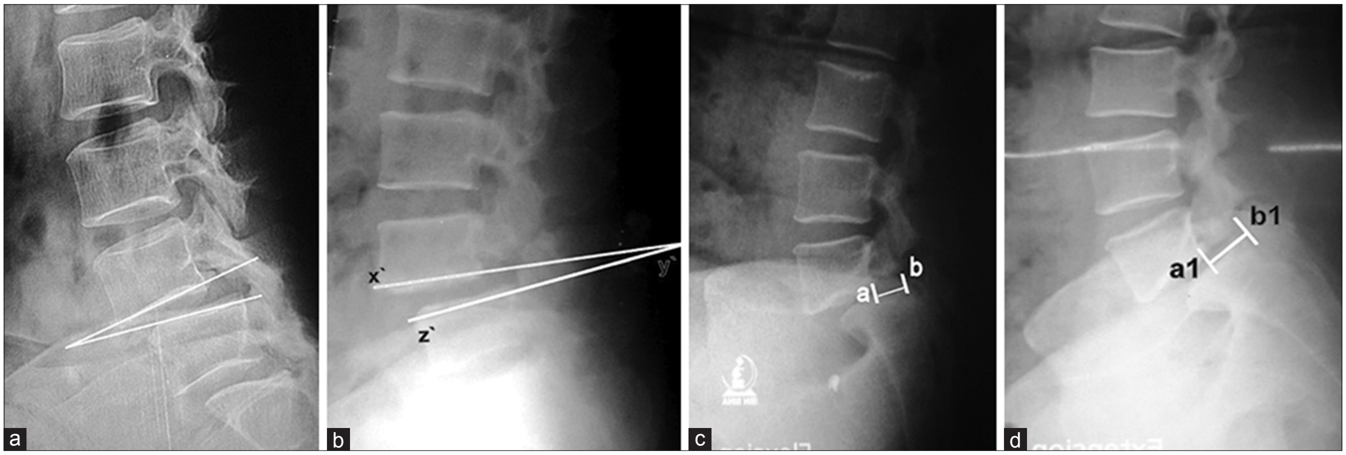

Figure 2: X-ray lumbosacral spine lateral view showing (a) Measurement of instability according to posner;[3] Dynamic lateral film (flexion) in standing posture showing >10° sagittal rotation (angular displacement); measurement is done by the angle formed between the two adjacent end-plates. (b) Dynamic film in extension. (c) The dynamic films producing anterior translation measured as the distance between a and $b = d$ (in flexion). (d) The distance of a_1 and $b_1 = d_1$ (in extension). The distance difference (D) in flexion (d) and extension (d_1) calculated as the percentage ($D = d - d_1$ above vertebral width ×100) of the width of the above vertebra

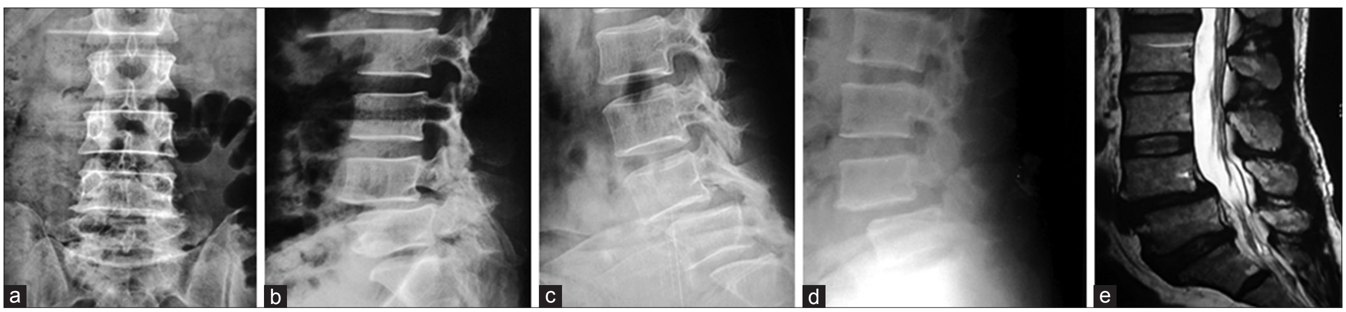

Figure 3A: Degenerative instability managed by PLIF; (a) X-Ray lumbosacral (L/S) spine Anteroposterior view. (b) X-Ray L/S spine lateral view showing degenerative spondylolisthesis at L_4 over L_5. (c) Dynamic film in flexion showing anterior translation and angular displacement. (d) Dynamic film in extension showing differences in translation and angular motion. (e) T2W MRI scan of that patient with degeneration and spondylolisthesis at $L_{4/5}$ level.

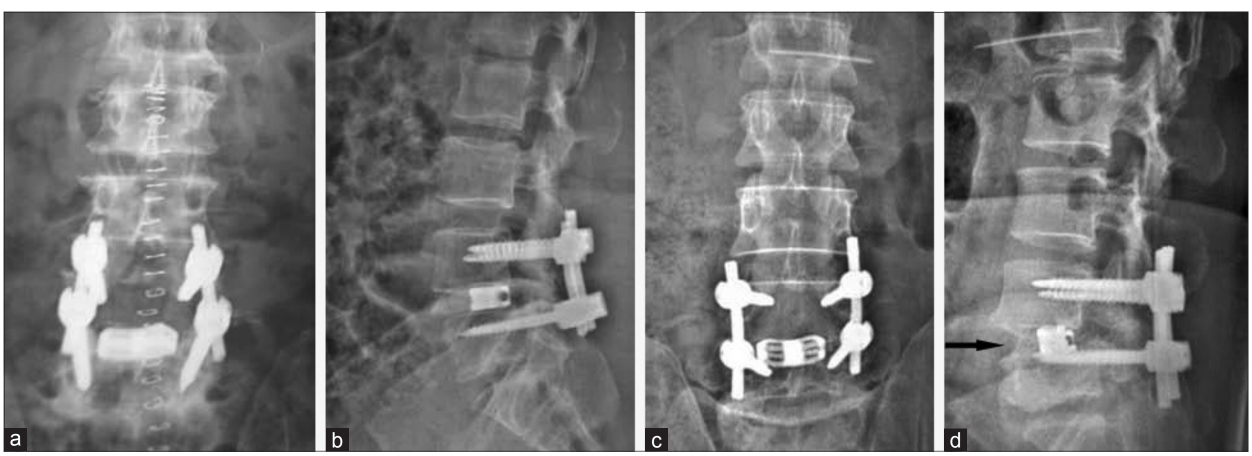

Figure 3B: (a) Postoperative X-ray lumbosacral spine anteroposterior view and (b) lateral view showing good implant position. (c) 1 year followup X-ray anteroposterior view and (d) lateral view showing listhesis reduction and radiological fusion (arrow)

Cortico cancellous bone grafts were placed to the prepared posterolateral decorticated beds. Two rods were contoured and fixed to the pedicle screw heads. Final tightening of the nuts was performed under compression. Patients were mobilized on the 2nd or 3rd postoperative day with a brace support which was continued for minimum 6 weeks postoperaively.

During the followup period, the clinical and radiological parameters were measured by the same assessor and the

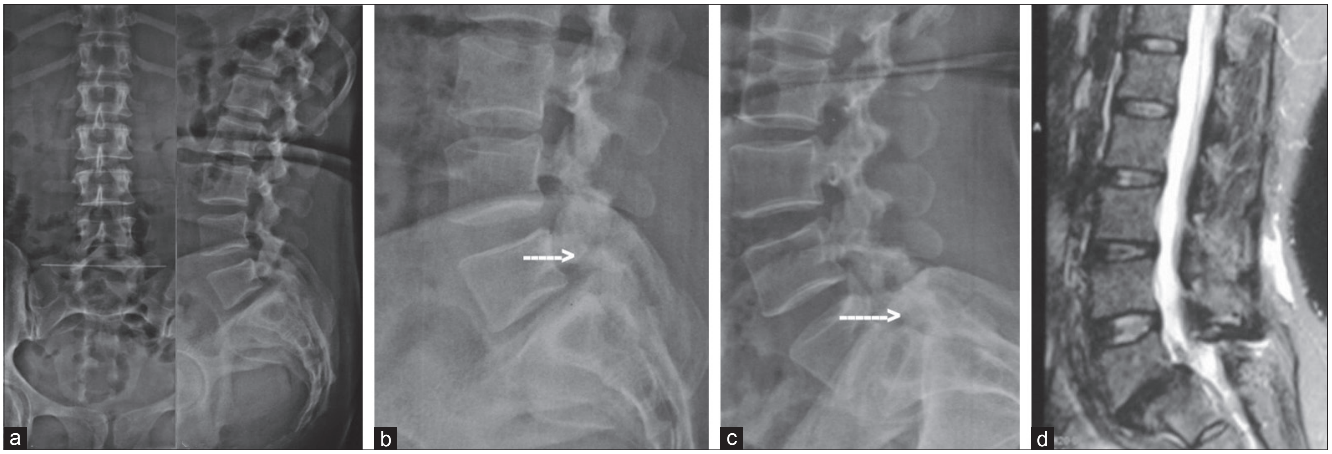

Figure 4A: Spondylolytic instability managed by TLIF: X-ray lumbosacral spine anteroposterior view (a) and lateral view (b) showing grade-I spondylolytic spondylolisthesis instability at L_5/S_1 level. (c) Dynamic lateral view (flexion) showing spondylolysis (arrow) and anterior translation. (d) Dynamic lateral view (extension) showing spondylolysis (arrow) and angular motion at L_5/S_1 level. (e) T2W MRI scan of that patient showing involvement of L_5/S_1 level

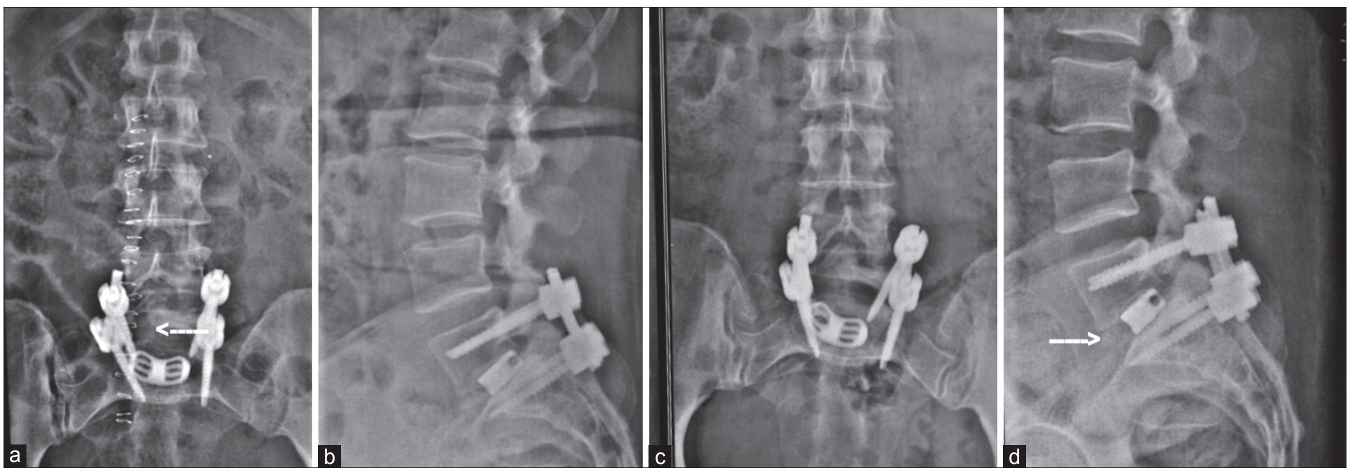

Figure 4B: (a) Postoperative X-ray lumbosacral spine anteroposterior view and (b) lateral view showing good implant position and the transforaminal approach (arrow). (c) 1 year followup X-Ray anteroposterior view and (d) lateral view showing listhesis reduction and radiological fusion (arrow)

statistical analysis was performed using the SPSS statistical software where results were achieved from the chi square test and z test where applicable.

Results

In both the groups, female patients of the 40-49 years age group were significant (Chi-square test, $P < 0.05$). Maximum cases had spondylolytic instability [PLIF = 27 (51.92%), TLIF = 24 (48.00%)] and $L_{4/5}$ level involved most commonly [PLIF = 27 (51.92%), TLIF = 28 (56.00%)] in both groups. Grade-II slip [PLIF = 41 (78.85%), TLIF = 40 (80.00%)] had been significant (Chi-square test, $P < 0.05$) in both groups [Table 1]. Preoperative LBP and radiculopathy (leg pain) was significantly present in both groups (Chi-square test, $P < 0.05$) having a highly significant improvement of their VAS scores (z test, $P < 0.001$) at 1 year. LBP score improved from 07.25 ± 01.04 to 02.25 ± 00.55 in the PLIF group and from 06.64 ± 01.24 to 01.92 ± 00.63 in the TLIF group. Similar significant improvement of the leg pain status was achieved from 05.25 ± 00.52 to 01.75 ± 00.79 in the PLIF group and from 05.24 ± 00.43 to 01.74 ± 00.63 in the TLIF group. The ODI score revealed highly significant (z test, $P < 0.001$) improvement from 60.75 ± 11.37 to 11.25 ± 02.91 in the PLIF group and 56.71 ± 11.10 to 07.46 ± 02.09 in the TLIF group. The neurological status (e.g., motor and sensory) of both groups also had highly significant recovery (z test, $P < 0.001$). None of the pain score, disability score, and neurological recovery had significant difference between the groups (z test, $P > 0.05$). Although overall satisfactory outcome [PLIF = 49 (94.23%), TLIF = 48 (96.00%)] had no significant difference, there had been more excellent results with TLIF [35 (70.00%)] than that of PLIF [29 (55.77%)] [Table 2].

Assessment of radiological restoration of structural

Table 1: Demographics of the patients (n=102)

Variables	Group-I		Group-II	
	No	Percentage	No	Percentage
Age (years)				
40-49	37	71.15	28	56.00
50-59	12	23.08	14	28.00
60-69	03	05.77	08	16.00
Sex				
Male	11	21.15	14	28.00
Female	41	78.85	36	72.00
Occupation				
Housewife	34	65.38	36	72.00
Manual worker	08	15.39	08	16.00
Sedentary worker	10	19.23	06	12.00
Instability				
Spondylolytic instability				
$L_{3/4}$	01	01.92	00	00.00
$L_{4/5}$	16	30.77	14	28.00
L_5/S_1	10	19.23	10	20.00
Degenerative instability				
$L_{3/4}$	05	09.62	04	08.00
$L_{4/5}$	11	21.15	14	28.00
L_5/S_1	09	17.31	08	16.00
Slip				
25% (Grade-I)				
$L_{3/4}$	01	01.92	00	00.00
$L_{4/5}$	03	05.77	04	08.00
L_5/S_1	07	13.46	06	12.00
50% (Grade-II)				
$L_{3/4}$	03	05.77	02	04.00
$L_{4/5}$	18	34.62	20	40.00
L_5/S_1	20	38.46	18	36.00

components revealed a significant (z test, $P < 0.05$) rise of mean disc height (MDH) from 07.50 ± 02.73 to 12.00 ± 01.97 mm in the PLIF group and from 07.76 ± 02.77 to 12.24 ± 01.89 mm in the TLIF group. The mean foraminal height (MFH) increase was recorded from 13.25 ± 01.61 to 17.50 ± 01.85 mm in PLIF and from 13.30 ± 1.55 to 17.50 ± 01.87 mm in the TLIF group, which was also significant (z test, $P < 0.05$). The preoperative value of mean total lumbar lordosis (MTLL) increased to 24.60 ± 00.85° (from 18.30 ± 03.75°) in cases the PLIF group and from 18.60 ± 03.16° to 24.00 ± 02.00° in the TLIF group. The mean anterior slip (MAS) in the PLIF group was 30.25 ± 05.75% and in the TLIF group it was 34.80 ± 03.25%. There had been a significant slip reduction in both the groups (PLIF = 90 ± 03.85% for grade-I and 81 ± 05.24% for grade-II, TLIF = 92 ± 03.63% for grade-I and 84 ± 01.50% for grade-II), which had been maintained even at their last followup. The preoperative mean anterior translation (MAT) was 09.50 ± 0.87% at $L_{3/4}$, 09.21 ± 1.03% at $L_{4/5}$, and 07.75 ± 1.93% at L_5/S_1 in the PLIF group and 09.22 ± 1.07% at $L_{3/4}$, 09.00 ± 1.12% at $L_{4/5}$, and 08.26 ± 1.07% at L_5/S_1 in the TLIF group. The preoperative mean angular displacement (MAD) was 10.75 ± 01.58° at $L_{3/4}$, 12.40 ± 00.70° at $L_{4/5}$, and 04.50 ± 01.98° at L_5/S_1 in the PLIF group and 11.12 ± 01.70° at $L_{3/4}$, 12.14 ± 00.95° at $L_{4/5}$, and 04.20 ± 01.10° at L_5/S_1 in the TLIF group [Table 3]. But all these variables of structural restoration (e.g., MDH, MFH, MTLL, MAS, MAT, MAD) had no statistical significant differences (z test, $P > 0.05$) between the groups. Postoperative dynamic films did not reveal abnormal range of movement in patients of either of the group, hence achieving radiological stability. Time required for achieving signs of radiological fusion [PLIF (17.23 ± 02.95 weeks), TLIF (16.80 ± 03.94 weeks)] also had no significant difference (z test, $P > 0.05$) [Table 4].

PLIF surgery took longer time (182 ± 10.91 minutes) and higher intraoperative bleeding (245 ± 19 ml) than TLIF (165 ± 06.63 minutes and 215 ± 12 ml). The postoperative hospital stay (07.50 ± 02.30 days for PLIF versus 05.76 ± 01.60 days for TLIF) and the intraoperative complication [PLIF (09.61%), TLIF (02.00%)] and postoperative complication [PLIF (13.47%), TLIF (04.00%)] had no significant difference between the groups. Accidental durotomy had occurred in four (07.69%) cases - all of which could be repaired primarily and none of them had any postoperative CSF leakage. Three (05.77%) cases had intraoperative root injury (during the insertion of interbody cage), among which one case developed foot drop. Five (09.62%) cases in PLIF and two (04.00%) cases in TLIF developed pseud-arthrosis (Chi-square test, $P > 0.05$). These cases were managed conservatively and had their self-assessed VAS pain score ranged within 02 to 04, ODI disability score from 19.80% to 28.20% (moderate disability) and none of them had any signs of neurological compromise, hence did not require revision surgery. There were no cases of superficial wound infection in the TLIF group but two (03.85%) cases with PLIF developed superficial wound infection, which were managed conservatively [Table 4].

Discussion

The concept of LSI has received an increased attention from the clinicians and researchers as a potential cause of chronic LBP, which has been commonly associated with spondylolisthesis and spondylolysis.[21,22] Restoration of the segmental stability by adequate neural decompression, fusion, and stabilization helps to improve clinical symptoms and achieve normal spinal anatomy.[23] Failure of restoration can result in inadequate clinical improvement potentially leading to poor long term results.[24] Significant clinical improvement was observed in both PLIF and TLIF techniques in different spinal disorders[25,26] and found to be superior due to proper neural decompression, structural restoration, and segmental stabilization that ultimately lead to improved pain, disability, and functional capability. In our study, both the techniques resulted in significant clinical

Table 2: Clinical, functional, and overall outcome of the patients (*n*=102)

Clinical assessment outcomew					
Outcome variables		**PLIF Group**		**TLIF Group**	
		Preoperative (%)	**Postoperative (at 1 year) (%)**	**Preoperative (%)**	**Postoperative (at 1 year) (%)**
Low back pain		52 (100)	01 (01.92)	50 (100)	00 (00.00)
Radiculopathy		45 (86.54)	00 (00.00)	45 (90.00)	00 (00.00)
Neurological status					
Motor involvement		35 (67.31)	01 (01.92)	24 (48.00)	00 (00.00)
Sensory involvement		36 (69.23)	01 (01.92)	22 (22.00)	00 (00.00)
Reflex involvement		15 (28.85)	00 (00.00)	10 (20.00)	00 (00.00)
Clinical and functional score					
Variables	**Assessment Criteria**	**PLIF group**		**TLIF group**	
		Preoperative	**Postoperative (At 1 year)**	**Preoperative**	**Postoperative (At 1 year)**
Low back pain	Visual Analogue	07.25±01.04	02.25±00.55	06.64±01.24	01.92±00.63
Leg pain	Score (VAS)[11]	05.25±00.52	01.75±00.79	05.24±00.43	01.74±00.63
Disability	Oswestry Disability Index (ODI)[12]	60.75±11.37	11.25±02.91	56.71±11.10	07.46±02.09
Comprehensive outcome according to Macnab's criteria					
Outcome	**PLIF Group (%)**	**TLIF Group (%)**		**PLIF Group (%)**	**TLIF Group (%)**
Excellent	29 (55.77)	35 (70.00)	Satisfactory	49 (94.23)	48 (96.00)
Good	20 (38.46)	13 (26.00)			
Fair	03 (05.77)	02 (04.00)	Unsatisfactory	03 (05.77)	02 (04.00)

PLIF= Posterior lumbar interbody fusion, TLIF= Transforaminal lumbar interbody fusion, VAS= Visual analog score

Table 3: Radiological outcome of the patients (*n*=102)

Radiological outcome				
Outcome variables	**PLIF Group**		**TLIF Group**	
	Preoperative	**Postoperative (at 1 year)**	**Preoperative**	**Postoperative (at 1 year)**
Measured disc height	07.50±02.73mm	12.00±01.97mm	07.76±02.77mm	12.24±01.89mm
Mean Foraminal height	13.25±01.61mm	17.50±01.85mm	13.30±1.55mm	17.50±01.87mm
Mean Total Lumbar lordosis	18.30±03.75°	24.60±00.85°	18.60±03.16°	24.00±02.00°
Slip reduction				
Grade-I (%)	---	90±03.85	---	92±03.63
Grade-II (%)	---	81±05.24	---	84±01.50
Stability (Posner[3])				
Ant. translation				
$L_{3/4}$ (%)	09.50±0.87	within the normal range	09.22±1.07	within the normal range
$L_{4/5}$ (%)	09.21±1.03		09.00±1.12	
$L_{5/S1}$ (%)	07.75±1.93		08.26±1.07	
Ang. displacement				
$L_{3/4}$	10.75±01.58°	within the normal range	11.12±01.70°	within the normal range
$L_{4/5}$	12.40±00.70°		12.14±00.95°	
L_5/S_1	04.50±01.98°		04.20±01.10°	
Overall (%)	---	100	---	100
Fusion				
Hackenberg[14] (%)	---	47 (90.38)	---	48 (96.00)

and functional improvement, structural restoration, fusion, and stability but PLIF had been associated with higher rates of intraoperative neural complications.

There are some limitations in this study. Firstly, the diagnosis was solely depended upon the radiological findings which may have misinterpretations.[27] Secondly, T2-weighted kinetic MRI and three-dimensional CT reconstruction had been recommended for a precise diagnosis of LSI,[27,28] but we could not perform these due to unavailability of expertise. Thirdly, foraminal widening and fusion assessment needs CT evaluation,[29] but was ignored due to patients financial constraints. The cases with multi-segmental instability were not included with an assumption of bias. Fourthly, we did not intend to assess whether there is any biomechanical relationship between pseudarthrosis and postoperative

Table 4: Operative outcome and complications in both groups (*n*=102)

Operative outcome			
PLIF group (*n*=52)	**Outcome**	**TLIF group (*n*=50)**	**Outcome**
Duration of surgery	182±10.91h	Duration of surgery	165±06.63h
Intraoperative blood loss	245±19 ml	Intraoperative blood loss	215±12 ml
Postoperative hospital stay	07.50±2.30 days	Postoperative hospital stay	05.76±1.60 days
Radiological fusion	17.23±02.95	Radiological fusion	16.90±03.94
Intraoperative and postoperative complications			
Durotomy (%)	04 (07.69)	Durotomy	00 (00.00)
Root injury (%)	03 (05.77)	Root injury	00 (00.00)
Hardware misplacement (%)	01 (01.92)	Hardware misplacement	01 (02.00)
Superficial wound infections (%)	02 (03.85)	Superficial wound infections	00 (00.00)
Pseudarthrosis (%)	05 (09.62)	Pseudoarthrosis	02 (04.00)

PLIF= Posterior lumbar interbody fusion, TLIF= Transforaminal lumbar interbody fusion

instability. Lastly, the study population was not large enough and followup period was short, as a result we could not evaluate the long term complications, pseudarthrosis requiring revision, adjacent segment degeneration, implant failure, or even the cases with failed back syndrome.

In literatures, comparison of PLIF and TLIF in spondylolisthesis and degenerative lumbar spine had been done. Both Yan[26] and Audat[30] showed highly significant improvement pain and disability status. The improvement of VAS score of the initial series [PLIF (07.08 ± 01.13 to 02.84 ± 0.89) and TLIF (07.18 ± 01.09 to 02.84 ± 0.91)] was comparable to ours. According to Audat[30] excellent outcome had been observed around 60% cases in PLIF and around 70% cases in TLIF, which was also comparable to ours. The overall satisfactory clinical outcome was not measured by the same criteria in different literatures[26,30] but even then, the overall outcome had also been similar.

Interbody cages are used to restore the disc height, foraminal height and stabilize the affected segment.[31] These parameters have significant correlation regarding structural restoration and maintenance of stability.[32] The cage was inserted from the patients left side irrespective of neurological involvement but decompression was done by changing the side with contralateral involvements. We observed a significant increase of disc and foraminal height as well as neurological improvement comparable to other studies.[33,34] The increased foraminal height effectively decompresses the nerve roots[32] and restores lumbar lordosis which ultimately maintains the lumbar sagittal profile.[33] Restoration of local and regional lordosis ultimately achieves clinical and biomechanical stability.[35] Kim[36] recommended to place the graft anterior to the cage and Hsieh[31] recommended to apply compression using the graft and cage as a fulcrum to achieve the desired lordosis.

In our study, we were able to achieve 06.50°±0.55° and 05.70°±0.75° improvement of lordotic angles in PLIF and TLIF, that were comparable to other studies.[33,34] Despite of no statistical difference of postoperative lordotic angles between the groups, we observed lesser degree of correction in TLIF which assumed to be due to intact posterior structures which had also been observed by Hsieh.[31] The correction of forward slip restores sagittal alignment and physiological transmission of weight. Inadequate restoration and abnormal lordosis is the primary predisposing factor for adjacent segment degeneration.[37] Moreover, it shifts the spinal vertical axis anteriorly to induce further degeneration and results in chronic LBP.[38] The percentage of correction of slip in our study had been significant by both techniques which was comparable to Yan[26] [PLIF (72.60 ± 05.20%), TLIF (72.40 ± 05.40%)]. But the reports of increased chance of postoperative instability with PLIF due to loss of integrity of posterior structures should not be abandoned.[32]

Interbody fusion with cage has been well accepted for its superior fusion results,[39,40] and has been reported to be significant by both these techniques.[25,26] Theoretically, TLIF is advantageous to PLIF, as it provides a full 360° fusion because of intact contralateral laminar surface that increases the surface area for new bone to grow and bridge the gap.[41] We had observed signs of radiological union at 17.23 ± 02.95 weeks in PLIF and 16.90 ± 03.94 weeks in TLIF. But these signs might not conclude regarding the achievement of fusion as because, Kim *et al.*[42] showed around 35% patients achieved solid fusion at 1 year despite of radiological union signs and it even took minimum 4 years to achieve solid fusion in 82% cases. But Brantigan[16] compared radiological fusion with exploratory fusion and stated >97% sensitivity, >94% positive predictive value and >93% accuracy of the radiological parameters. Autografts had been the gold standard for achieving fusion, but there are recent reports of graft substitutes for fusion enhancement and has become a new arena of research. We placed autografts anteriorly and impacted before the introduction of cage in all the cases of PLIF and TLIF with a theoretical background of anterior column load transmission (80%)[39] and enhancement of fusion.[43] The radiological fusion in both the groups had no statistical difference as like other studies.[11,12,30] The biomechanical concept of "fusion stability" is assessed postoperatively by dynamic films to determine the achievement of stability even after fusion. Although posterior instrumentations enhances the stability and fusion,[8] biomechanically stable spine is achieved only when solid fusion is achieved.[44] We achieved the target motion of stability in all the cases of PLIF and TLIF at 1 year according to Posner *et al.*,[3] but according to Kumar *et al.*,[45] postoperative segmental stability is achieved only when radiological motion is < 2° in dynamic films. Development of pseudarthrosis is one of the most common (range, 05-45%) complications of interbody fusion.[46] it can be managed conservatively and does not necessarily need revision surgery.[47] Pseud arthrosis was present in two (2.60%) and two (4.60%) patients with PLIF or TLIF in a series of Mehta[10] which is comparable to our results.

In different literatures, PLIF had been reported to be associated with more neural complications.[10-12,26] The excess medial retraction of the dura has been blamed to be the cause of such injuries during the placement of the cage.[11] On the contrary, TLIF approaches the disc space through far lateral portion of the vertebral foramen, which ultimately reduces the thecal manipulation and the chances of complications. In this series, we had iatrogenic durotomy in four (7.69%) cases and root injury in three (5.77%) cases. There were no such complications in the TLIF group. Intraoperative dural repair were sufficient to control the leaks but one case with root injury ultimately developed foot drop, whereas other two cases were transient and were under the process of gradual recovery. There was a case each in both groups with hardware misplacement which we identified as an instrumental default. Both the cases were reexplored within a week for reinsertion of the implant. Two (3.85%) cases in PLIF had superficial wound infection that had been managed with intravenous antibiotics following culture sensitivity (*Staphylococcus aureus)* and regular dressing, and the wound was later healed with secondary intention.

To conclude, both methods are effective in relieving symptoms, achieving stability and fusion, but TLIF can be preferred for its shorter operative time, less blood loss, and lesser complication rates in surgical management of symptomatic lumbar instability.

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