



Clinical and Radiological Outcome of Transforaminal Lumbar Interbody Fusion in Degenerative and Lytic Spondylolisthesis

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DOI: [10.31080/ASOR.2023.06.0878](https://doi.org/10.31080/ASOR.2023.06.0878)

Received: August 30, 2023

Published: November 27, 2023

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Abstract

Aim: To assess the clinical and radiological outcomes of the Transforaminal lumbar interbody fusion technique in patients with degenerative and lytic spondylolisthesis.

Methods: It is a prospective analytical study done between June 2017 and December 2018. Inclusion criteria included degenerative and lytic segmental instability, degenerative disc disease, previous laminectomy or discectomy and patients not responding to non-operative management for a minimum of 3 months. 56 patients were included, who were evaluated clinically and radiologically before surgery and after surgery till 12 months. Clinical outcomes were assessed using a visual analogue scale for low back pain and lower limb radicular pain, functional outcomes were assessed using the Oswestry Disability Index. Radiological fusion was evaluated at individual levels that were obtained postoperatively every 3 months to assess fusion till 12 months.

Results: There were 17 males and 39 females in our study with a mean age of 52.2 years. Degenerative lesions were found in 40 patients, Lytic lesions were found in 14 patients and 2 were previously operated patients. The majority of the lesions were at the level of L4-L5, followed by L5-S1 level, we also had 3 cases at the L3-L4 level, while 2 patients had lesions at two levels, L3-L4 and L4-L5. Most of the patients had lesions at one vertebral level. Only two patients had involvement of two vertebral levels. The mean duration of surgery was 164 ± 22.86 min and the mean blood loss was 450.54 ± 125.94 ml. The minimum stay was 2 days while the maximum stay was 12 days. The VAS for Back and leg pain showed a gradual improvement in the mean pain scores of 91.07% and 92.86% respectively. 89.29% had improvement in the ODI scores. We observed a radiological fusion rate of 89.29% in the follow-up examination. Our study observed complications in four patients which were managed accordingly.

Conclusion: TLIF is a safe and effective method to achieve circumferential fusion though it is technically challenging and the surgeon needs to be proficient in the technique to avoid complications, our clinical and radiological analysis confirmed that patients did benefit significantly in terms of pain, overall health and disability status.

Keywords: Clinical; Radiological; Transforaminal Lumbar Interbody; Degenerative; Lytic Spondylolisthesis

Background

Back pain is one of the most common reasons for patients to visit doctors [1]. It is estimated that up to 84 per cent of adults have low back pain at some time in their lives [2,3]. Spondylolisthesis is present in 5% of the adult population with clinical evidence of low back pain. These patients are treated initially by conservative measures, surgical fusion is indicated in patients not responding to conservative treatment.

Introduction

The structure of the lumbar spine is such that, in the erect posture it produces a downward and forward thrust to the lower lum-

bar vertebra. Vertical loading can be shown to produce stress on the neural arch, particularly in the isthmus. Repeated vertical impact loading applied to the juvenile spine will lead to typical spondylolytic defects [4]. Either nonunion or healing with elongation permits vertebral subluxation. This fundamental change in bony anatomy exposes the disc to increased shear load, even though the axial load remains unchanged. The increased shear load on the disc causes premature disc degeneration [5].

Degenerative spondylolisthesis is essentially a lesion of the facet joints. Over time the orientation of the facets becomes more sagittal, which allows the progression of the spondylolisthesis [6].

Alterations of the bone tissue of the spine result in loss of the ability of the bony hook to maintain spinal alignment, leading to the pathologic type of spondylolisthesis. Iatrogenic or post-surgical spondylolisthesis is not an uncommon situation.

The most common presenting symptom of spondylolisthesis regardless of the type is lower back pain, muscle tightness (tight hamstring muscle), numbness, or tingling in the thighs and buttocks, stiffness, tenderness in the area of the vertebra that is out of place, weakness in the legs [7].

Available Treatment options are Conservative and Surgery. Treatment for spondylolisthesis depends on several factors, including the age and overall health of the person, the extent of the slip, and the severity of the symptoms. Treatment most often is conservative and more severe spondylolisthesis might require surgery.

The Gills procedure [8] (excision of the loose laminar arch), long considered to have adequate decompression, actually fails to decompress the root in the neural foramen. A thorough decompression must include a foraminotomy, especially in patients with radicular complaints. The best use of the loose laminar arch is as a bone graft. We routinely perform the Gills procedure to obtain bone grafts, not for neural decompression.

A technique for PLIF described by Cloward in 1943 has been extended for the treatment of spondylolisthesis. It is best suited for grade I and II listhesis but is generally unsuited for the listhesis of grade III or higher unless the partial reduction is performed and maintained by segmental instrumentation posteriorly, as advocated by Vidal, *et al.* [9]. A variation of PLIF is unilateral PLIF or Transforaminal lumbar interbody fusion. Originally described by Blume, unilateral PLIF produced successful results in 80% of patients treated for lumbar disc pathology. Unique to this procedure is the preservation of the ligamentum flavum by approaching the disc in the foraminal region after unilateral facetectomy.

Our objective was to analyze the clinical and radiological outcomes in patients with spondylolisthesis who underwent Transforaminal lumbar interbody fusion.

Material and Methods

A prospective analytical study was conducted in the Department of Orthopedics at Apollo Hospitals Bilaspur (C.G.) from June 2017 to December 2018, and they were analyzed and followed for a minimum of 12 months postoperatively. All patients with degenerative and lytic spondylolisthesis who underwent TLIF during the above period were included in the study. Inclusion criteria includ-

ed patients with degenerative and lytic segmental instability on the clinical and radiological basis, degenerative disc disease, Previous laminectomy or discectomy, Pseudoarthrosis after other types of lumbar spine fusion and patients not responding to non-operative management for a minimum of 3 months. A total of 56 patients, 39 females and 17 males were included and they were evaluated clinically and radiologically before surgery, after surgery, at 3 weeks, 3, 6, 9 and 12 months after surgery. Ethical clearance was taken from the ethical committee of Apollo Hospitals, Bilaspur (C.G.), and permission was sought from the hospital management.

Surgical technique: The patient is given general endotracheal anaesthesia and positioned prone on the transversely positioned bolsters. The level of listhesis is localized under a radiographic image viewer, some degree of reduction is achieved by positioning itself. 5-10 ml of 2% lignocaine and adrenaline infiltration was done at the incision site to reduce intra-operative bleeding and proper painting and draping were done.

A standard midline skin incision is made from the mid-spinous process of the upper vertebra to the superior margin of the spinous process of the lower vertebra at the involved level, and subcutaneous tissues and subperiosteal dissection is carried down to the spine in standard fashion. The transverse process and pars interarticularis at the cephalad and caudal levels are exposed. Pedicle screw placement is undertaken via a typical standard approach. After pedicle screw placement, Decompression is initiated with a laminectomy in the midline, exposing the ligamentum. The ligamentum is removed and hemostasis is obtained. A facetectomy is then performed, Once the posterior bone elements are resected and also the decompression is complete, the dura and neural elements are mobilized. The goal is to be able to access the posterior annulus and disc space easily without any dural tension. Distraction through the TLIF level to facilitate interbody placement. A window is made on the disc, with care taken to protect the exiting and traversing roots, A window that is a minimum of 8-10 mm in size facilitates disc space preparation. Disc space preparation is performed employing a combination of curets, pituitary rongeurs, and end-plate preparation tools. Thorough disc-space preparation is done for both correcting the deformity and obtaining a solid fusion. The disc space is sized with an appropriate interbody cage. The anterior aspect of the disc space and the cage are both packed with a local autogenous bone graft. screws are converted to a longitudinal construct with a rod and bent to confirm the proper curvature of the spine, screws are secured by top loading. Screw and cage placement is verified by radiography, and lordosis is restored by compression across the screws bilaterally. Care must be taken while the graft is placed on the TLIF side as facet and pars resection expose the exiting route. The closure is undertaken in a standard fashion. A

thorough clinical and radiological examination of the patient was done. All findings such as the Visual Analogue Score (VAS) (for leg and back pain), the Oswestry Disability Index (ODI) score, numbness, weakness, associated co-morbidities and complications till the end of the follow-up were noted.

We followed up with the patients for 12 months and evaluated clinical outcomes by VAS for (Radicular pain and Back pain) and ODI score. The patient was asked to quantify their overall pain on a VAS scorecard which ranges from 0 (no pain) to 10 (worst pain). The VAS is a subjective measurement of pain that tries to measure the characteristic of pain that is believed to range across a continuum of values and cannot easily be directly measured. In the study, the patient’s functional outcome before and after surgery was measured by ODI score, which has a self-completed questionnaire containing ten topics relating to the intensity of pain, lifting, ability to take care of oneself, ability to stand, ability to walk, ability to sit down, sleep quality, social life, sexual function, and ability to travel. Each topic category is followed by six statements describing different potential scenarios in the patient’s life relating to the topic. The patient checks the statement which most closely resembles their situation. Each question is scored 0–5 on a scale with the first statement being zero and indicating the least amount of disability and the last statement is scored 5 indicating the most severe disability. The scores for all questions answered are summed and then multiplied by two to obtain the index (range 0 to 100). Zero is equated with no disability and 100 is the maximum disability possible.

0% to 20%	Minimal disability
21%-40%	Moderate disability
41%-60%	Severe disability
61%-80%	Crippled
81% - 100%	Either bed-bound or exaggerating their symptoms

Table 1: Shows the final ODI score ranges and their inference.

Age and gender distribution, common level involved, number of vertebral levels involved, average operative time, average intra-operative blood loss, average duration of hospital stays, average pre-operative and post-operative VAS score for leg and back pain, average pre-operative and post-operative ODI score, successful relief rate of VAS score for leg and back pain, successful outcome rate of ODI score were calculated. Post-operatively, patients were managed using a discharge protocol that aimed to safely discharge patients. Once the patients were relatively comfortable, they were mobilized with a lumbosacral belt.

Radiological follow-up: Radiological fusion was assessed at individual levels as observed on plain radiographs that were obtained postoperatively every 3 months to evaluate fusion till 12 months. Radiological fusion will be assessed as a continuous bone bridge between the vertebrae seen in at least one sagittal reconstruction.

Results

There were 17 males and 39 females in our study, showing the female majority. Mean Age 52.2 years, (age range 34-79 years). Degenerative type lesions were the majority in our study, found in 40 patients (71.43%), Lytic lesions were found in 14 (25.00%) patients, had 2 (3.57%) previously operated patients. The majority of the lesions were at the level of L4-L5 seen in 38 cases (67.86%), followed by at L5-S1 level seen in 13 (23.21%) cases. We also had 3 cases (5.36%) at the L3-L4 level lesion, while 2 patients (3.57%) had lesions at two levels, L3-L4 and L4-L5. The majority of the patients 54 (96.43%) had lesions at one vertebral level and only 2 patients (3.57%) had involvement of two vertebral levels.

The mean duration of surgery was 164 min ± 22.86 min (stan-

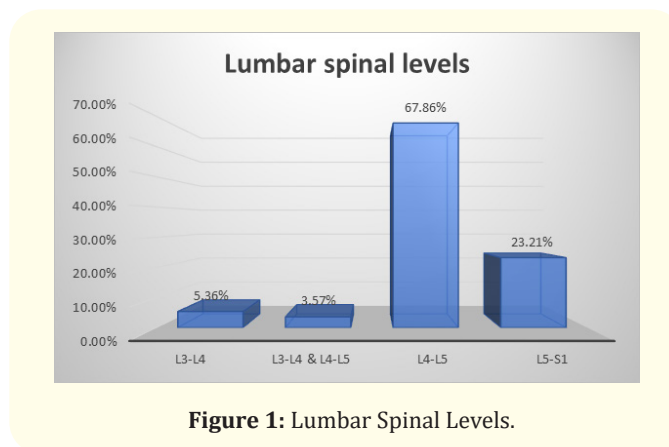


Figure 1: Lumbar Spinal Levels.

dard deviation). The minimum time was 110 min and the maximum required time was 224 min. In the study, the maximum number of patients had blood loss of 350 to 500 ml (24 cases – 42.86%), while 20 cases (35.715) had a blood loss of 500 – 750 ml and rest 12 cases (21.43%) had a blood loss of < 350ml. The Mean blood loss was 450.54 ml/125.94 ml with the minimum loss noted as 150 ml and the maximum being 710 ml. The mean length of stay was 6.5 days ± 3.13 days wherein the minimum stay was 2 days while the maximum stay was 12 days.

VAS for Back pain showed a gradual improvement in the mean pain scores, with pre-operative mean backache pain score being 7.14 ± 0.99, and at 12 months follow-up being 1.30 ± 1.28, We had the majority of the patients (91.07%) with improvement in the

Surgery Details			
Operative Time (Hr)	Operative time	Number	Percentage
	< 2.5 Hours	14	25.00%
	2.5 – 3 Hours	30	53.57%
	3 – 3.5 Hours	12	21.43%
Blood Loss (ml)	Blood Loss (ml)	Number	Percentage
	< 350	12	21.43%
	350 – 500	24	42.86%
	500 – 750	20	35.71%
Length of stay (Days)	Length of stay	Number	Percentage
	<4 Days	12	21.43%
	4 – 7 Days	21	37.50%
Complications	Complications	Number	Percentage
	Screw misplacement	1	1.79%
	Deep wound infection	1	1.79%
	Superficial wound infection	2	3.57%
	No Complication	52	92.85%

Table 2: Surgery Details.

back pain, while the rest 8.93% didn't have any significant improvement in back pain.

VAS for Leg Pain showed a gradual improvement in the mean

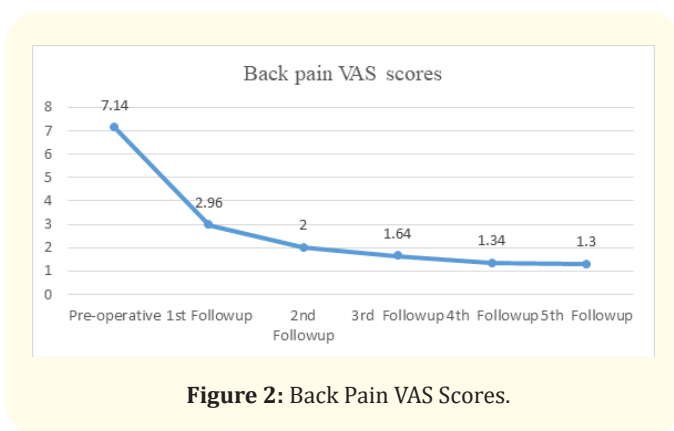


Figure 2: Back Pain VAS Scores.

pain scores, with the pre-operative mean leg pain score being 5.98 ± 1.152, and at 12 months follow-up being 0.88 ± 0.76, the majority of the patients (92.86%) had improvement in the Leg pain, while rest 7.14% didn't have any significant improvement in Leg pain.

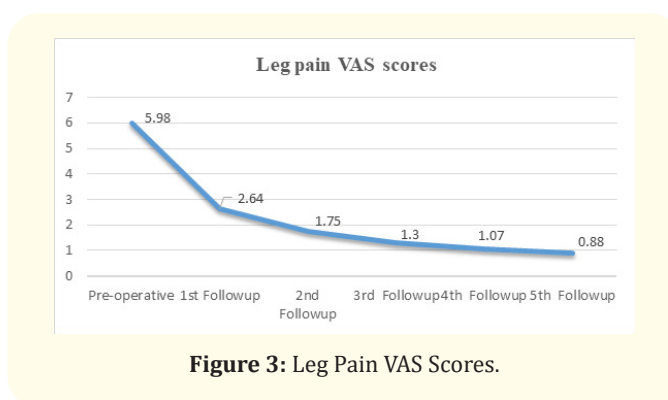


Figure 3: Leg Pain VAS Scores.

ODI Scores showed a gradual improvement in the mean pain scores, with pre-operative mean ODI score being 52.73 ± 12.71, and at 12 months follow-up being 13.79 ± 11.84, the majority of the patients (89.29%) had improvement in the ODI, while the rest 10.71% didn't have any significant improvement in ODI scores. Our study observed complications in four patients (7.15%) with the rest of the 52 cases (92.85%) without any post-op complications. The complications were one screw misplacement (1.79%), one deep wound infection (1.79%) and two Superficial wound infections (3.57%).

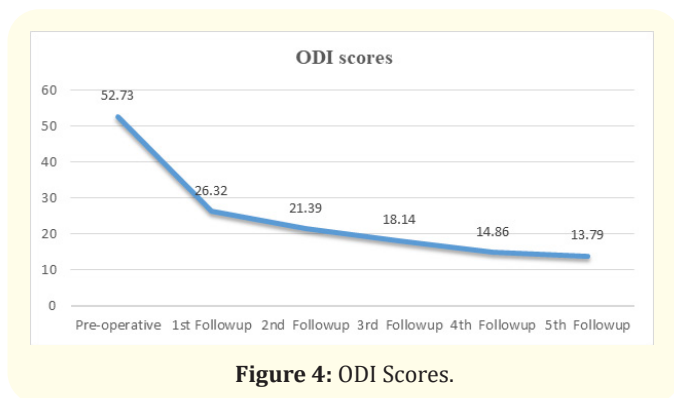


Figure 4: ODI Scores.

Discussion

Spondylolisthesis is a condition reported over two centuries ago with many different types and degrees of slip. The community prevalence rates for the condition aren't known but probably around 5-6% within the adult population. Thus, widely disparate figures for those who are symptomatic have been reported 50% in Magora's [10] study and less than 25% in Lafond s study [11]. It is clear, however, that only a small minority of affected individuals ever have symptoms but this proportion increases with the severity of slip. The surgical management in spondylolisthesis aims to relieve pain, provide stability and prevent progression by fusion. While many operative approaches are available to achieve them. There were 17 (30.4%) males and 39 (69.6%) females in our study, showing the female majority. Male: Female ratio was 0.44: 1. Potter BK., *et al.* [12]. with a male: female ratio of 0.4: 1 and MJD Jacobsohn., *et al.* [13]. observed a female majority with 33 females and 19 males in their study on 52 patients, similar to our study, with a male: female ratio of 0.58: 1. In a study conducted by Sean A. Salehi., *et al.* [14], there were total 24 patients including 9 women and 15 men, with a male: female ratio of 1.67, while Mohamed Adel EL MASRY., *et al.* [15] reported a male: female ratio of 1.31: 1 which is not in agreement with our study. We had a majority of the patients, 43 (76.79%) from the age group of 40-59 years, there were 4 (7.14%) from less than 40 years and 9 (16.07%) from the age group of 60 – 80 years. William S. Rosenberg., *et al.* [16] had the age range of 34-63 years with a mean age of 49 years, it's similar to our study. Sean A. Salehi., *et al.* [14] mentioned an average age of 42.6 ± 12.5 years, which is less than our study. MJD Jacobsohn., *et al.* [13] mentioned a mean age of 45.7 years in their study. Degenerative type of lesions was the majority in our study, found in 40 patients (71.43%), Lytic lesions were found in 14 (25.00%) patients. We had 2 patients (3.57%) who were previously operated. MJD Jacobsohn., *et al.* [13] observed in their study with 52 patients, the primary pathology was a lytic listhesis in 20 patients (38.46%), degenerative disc disease in 17 (32.69%), adjacent segment disease following a previous fusion in 8 (15.38%), degenerative listhesis in 4 (7.69%). The majority of them were at the level of L4-L5, seen in 38 cases (67.86%),

followed by at L5-S1 level seen in 13 (23.21%) cases. We also had 3 cases (5.36%) at the L3-L4 level lesion, while 2 patients (3.57%) had lesions at two levels, L3-L4 and L4-L5. Khan R *et al.*¹⁷ reported that the most common level involved is L4-L5 in 55% of cases and L5-S1 in 40% of cases, which is comparable to our study. There were a majority of the patients 54 (96.43%) with lesions at one vertebral level and only 2 patients (3.57%) had involvement of two vertebral levels. William S. Rosenberg., *et al.* [16] in their study had TLIF at one level in 86.36% of the patients, and at two levels in 13.64% of the patients. Our study had more patients with single-level involvement. Sean A. Salehi., *et al.* [14] reported 45.83% of patients with a lesion at 2 levels and 54.17% with single-level involvement. Benjamin K Potter., *et al.* [18] reported amongst 100 patients, there were 64 single-level, 33 two-level, 2 three-level, and 1 four-level TLIF (140 vertebral levels involved). Mohamed Y. El-qazaz., *et al.* [19] had 84% of cases with fusion done at a single level and 14% of patients at two levels, similar to our study. In our study, the mean duration of surgery was 164 minutes ± 22.86 minutes which is similar to the MJD Jacobsohn., *et al.* [13] study (170 minutes). El-Soufy M., *et al.* [22] observed an average operative time of 142.5 minutes, less than our study. Our study observed a mean of blood loss was 450.54 ml ± 125.94 ml. We observed a minimum blood loss of 150 ml and a maximum of 710 ml which is less than that observed in the study by MJD Jacobsohn., *et al.* [13] which reported mean blood loss was 610 ml. El-Soufy M., *et al.* [22] observed the average blood loss was 304.1 ml, less than our study. The mean length of stay in our study was 6.5 ± 3.13 days. 23 patients (41.07%) stayed for 7 days; 21 cases (37.50%) had to stay for 4-7 days while the rest 12 (21.43%) stayed for < 4 days. MJD Jacobsohn., *et al.* 20 had a mean hospital stay of 7.8 days, comparable to our study. Mohamed Y. El-qazaz., *et al.* [19] observed an average hospital stay of 4.7 ± 2.8 days, less than our study. El-Soufy M., *et al.* [22] observed the average length of stay of 3.75 days. The backache pain score in our study showed a gradual improvement in the mean pain scores, with the preoperative mean backache pain score being 7.14 ± 0.99, and at 12 months follow-up being 1.30 ± 1.28. Khan R., *et al.* [17] reported the mean preoperative VAS for Back pain was 10 which improved to 2, which shows a similar improvement to our study. Ali Y., *et al.* [21] observed a significant improvement in low back pain from 7.4 preoperative to 2.1. We had a majority of the patients (91.07%) with improvement in the backache, while the rest 8.93% didn't have any significant improvement in backache. William S. Rosenberg., *et al.* [16] mentioned that in their study, low back pain had completely resolved in 16 patients (72.73%), others got moderate relief from pain, achieved in 5 patients (22.73%), and the pain was unchanged in one patient (4.55%). Our study had better results than this study regarding back pain. Mohamed Adel EL MASRY., *et al.* [15] reported 90% clinical improvement in patients in a similar study. VAS for Leg

pain, the leg pain scores in our study showed a gradual improvement in the mean pain scores, with preoperative mean leg pain score being 5.98 ± 1.152 , and at 12 months follow-up being 0.88 ± 0.76 . Khan R., *et al.* [17] reported that the mean preoperative VAS for leg pain was 8 which improved to 1, showing a similar improvement to ours. Balasubramanian VA., *et al.* [20] reported the VAS score improvement from 8 to 2. Ali Y., *et al.* [21] observed a significant improvement in leg pain from 6.7 to 1.4. Our study observed that the majority of the patients (92.86%) had an improvement in the VAS for leg pain, while the rest 7.14% didn't have any significant improvement in leg pain. Benjamin K Potter, *et al.* [18] reported that 81% had improvement regarding symptoms of back pain and leg pains. Balasubramanian VA., *et al.* [20] reported 85% of patients with good pain outcomes, similar to our study. The majority of the other studies 21-28 observed significant improvement in the symptoms of backache and leg pains. The ODI scores in our study showed a gradual improvement in the mean pain scores, with the pre-operative mean ODI score being 52.73 ± 12.71 , and at 12 months follow-up being 13.79 ± 11.84 . Khan R., *et al.* observed that the mean preoperative ODI Score was 64% (range from 56% -74%) which improved to 20%. Showing similar improvement like ours. Balasubramanian VA., *et al.* reported mean ODI improved from 70% preop to 15% postop. Xu H., *et al.* [21] observed that the postoperative ODI showed a significant postoperative reduction of disability during the whole period of their follow-up. Ali Y., *et al.* observed a significant improvement in the mean ODI from 67.8% to 11.8%. Our study observed that the majority of the patients (89.29%) had an improvement in the ODI, while the rest 10.71% didn't have any significant improvement in ODI scores. Benjamin K Potter., *et al.* [18] also reported 93% improvement rates in their study. Balasubramanian VA., *et al.* [20] reported mean ODI improved from 70 pre-ops to 15 post-op. Xu H., *et al.* [23] observed that the post-operative ODI showed a significant post-operative reduction of disability during the whole period of their follow-up. Ali Y., *et al.* [21] observed a significant improvement in the mean ODI from 67.8% to 11.8%. Padya S., *et al.* [24] noted that global outcome was excellent in 90% of the patients in terms of clinical and surgical factors. Our study observed complications in four patients, with the rest of the 52 cases without any post-op complications. There was one screw misplacement, one deep wound infection and two superficial wound infection. Superficial wound infections and deep infections that required culture and oral antibiotics were given for one week for superficial wound infection and the infection resolved. Deep wound infection is managed by wound exploration, debridement, undermining and secondary closure and intravenous antibiotics for 5 days followed by oral antibiotics for 2 weeks, and the infection gets resolved. Screw misplacement was managed by revision surgery i.e., repositioning of the trajectory of the Pedicle screw. Sean A. Saheli., *et al.* [14] reported one patient (4.17%) having a

transient neurological complication, while the rest 25% of patients reported some minor self-limited complications. Benjamin K Potter., *et al.* [18] had described that 20% of patients sustained only minor complications, and there were no major complications, they observed that Complications resulting from the procedure are uncommon and usually minor and transient. Radiographic analysis was performed on anterior posterior and lateral radiography of the Lumbosacral spine. The radiography was evaluated by a radiologist. Criteria for bony fusion were anterior and posterior bony bridging, bony continuity between the upper and lower end plates, trabecular structure in the anterior graft and the lack of radiolucent lines around the anterior graft. He read the anterior-posterior and lateral radiography of the lumbar spine at each follow-up and the results as "fused" (three criteria positive), "probably fused" (two criteria positive), "probably not fused" (one criterion positive) and "pseudoarthrosis with loosening of the implants" (evidence of radiolucent lines). Our study observed a fusion rate of 89.29% with 50 patients showing radiological fusion in the follow-up examination. Sean A. Salehi., *et al.* [14] observed twenty-two amongst all 24 (91.67%) patients had solid fusions. Benjamin K Potter., *et al.* [18] noted that interbody fusion was radiographically solid in 88% of levels. Mohamed Adel EL MASRY., *et al.* [15] reported that fusion was either solid or probable in 91%. Aoki Y., *et al.* [25] observed that the fusion rates were 87.5% (21 of 24 patients) in the unilateral group and 95.7% (22 of 23) in the bilateral group.

Conclusion

With this study, we concluded that Spondylolisthesis is a condition that mainly affects the 40-59 years of aged population, predominantly females and L4- L5 is the most commonly involved level followed by L5-S1. TLIF can be done with success rates in properly selected patients as it provides significant pain relief, and good functional and radiological outcomes and the majority of the patients were able to return to activities of daily living and return to work. Following a good surgical technique, proper pre-operative workup, and intra-operative and post-operative precautions, can minimize the complications.

TLIF is a safe and effective method to achieve circumferential fusion though it is technically challenging and the surgeon needs to be proficient in the technique to avoid complications, our clinical and radiological analysis confirmed that patients did benefit significantly in terms of pain, overall health and disability status.

Spondylolysis and Spondylolisthesis are diagnoses that, for most patients have a benign prognosis and can be managed non-operatively. For most symptomatic patients for whom this management fails, TLIF yields satisfactory and long-lasting results and remains

the choice for the treatment of lytic and degenerative spondylolisthesis and other degenerative lumbosacral spinal diseases against which other surgical treatments must be compared.

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