*IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*
*e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 20, Issue 5 Ser.5 (May. 2021), PP 32-37*
*www.iosrjournals.org*

# Outcome Study Of Transforaminal Lumbar Interbody Fusion (TLIF) In Management Of Adult Isthmic Spondylolisthesis

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***Abstract**:*
*INTRODUCTION : Spondylolisthesis is defined as anterior or posterior slipping of one segment of the spine on the next lower segment.OBJECTIVE : To study the functional outcome of TLIF in management of isthmic spondylolisthesis using Oswestry Low Back Pain Disability Questionnaire , to assess surgical outcome on the radiological basis of interbody fusion and complications. MATERIAL & METHODS : Adult isthmic spondylolisthesis not responding to conservative treatment underwent TLIF.The process included decompression, reduction, stabilisation with pedicle screw and rods, three column spinal fusion with TLIF cage and laminectomy bone chips.RESULTS : The mean age of patients was 34.65 years with a male to female ratio of 1:2.33 in a study population of 20 patients .70% had slip at L5-S1, 30% had listhesis at L4-L5 with grade≥2.Low back pain and sciatica followed by hamstring tightness were common complaints.ODI improved from 55.90% to 14.70% by TLIF.On follow up, four patients (20%) showed post surgical fusion at six months and the fusion rate was 80% at the end of 1 year . Dural tear, local wound infection, broken implant were few complications encountered during study in 30% patients but they did not affect overall long term outcome.CONCLUSION : TLIF is a very good option for Isthmic lumbar spondylolisthesis with a favourable outcome and minimal complications.*

***Key words:** Spondylolisthesis, Spine, TLIF, Fusion.*

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Date of Submission: 29-04-2021 Date of Acceptance: 13-05-2021

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## I. Introduction :

Spondylolisthesis is defined as anterior or posterior slipping of one segment of the spine on the next lower segment.The prevalence of spondylolisthesis in the general population is approximately 5% and about equal in men and women. Increased slipping usually occurs between the ages of 9 and 15 years and seldom after the age of 20 years.[1] Recent studies shows increased prevalence of spondylolysis to 11.5% in community based population , nearly twice the prevalence by previous plain radiograph studies as compared to Computerised Tomography (CT) .[1,2]Male to female ratio for spondylolysis is 3:1.It is 2:1 for isthmic type of spondylolisthesis and 1:3 for degenerative type of spondylolisthesis .[1,2]Patients usually present with a persistent dull low-back pain with or without radiculopathy, which increases with activity and decreases with rest. Other presentation are low-back stiffness, tight hamstrings and intermittent neurogenic claudication.[2,3] With more severe slips, the trunk becomes shortened and often leads to complete absence of waistline. They walk with a peculiar spastic gait, described as a "pelvic waddle" by Newman, because of the hamstring tightness and lumbosacral kyphosis.[2,3]

The imaging analysis begins with conventional radiology; anteroposterior, lateral, and flexion–extension radiographs providing the most useful information. If an obvious pars defect is not visualized on lateral view, an oblique radiograph may be helpful in demonstrating the defect as the collar of the "*Scotty dog*." [2,3] A number of radiographic indices can be made from the standing lateral radiograph, including degree of slippage, slip angle, sacral inclination, sacro-horizontal angle, and lumbar index. The slip angle is conceptually appealing to consider as a representation of local kyphosis across the L5–S1 motion segment and its correction during surgical management is a desirable goal in an effort to restore physiologic lumbosacral lordosis.[3]

CT and MRI are useful advanced imaging methods, particularly in the preoperative planning stage, for better defining both the bony and soft tissue anatomy,respectively.[2,3] The initial treatment is conservative, with rest, hot/cold compressions, use of NSAIDs, muscle relaxants, physical therapy, core muscle strengthening exercises *avoiding extension*, and the wearing of lumbosacral extension brace. In non-

respondents, operative management is indicated. The nucleus pulposus of intervertebral disc functions as shock absorber, and the annulus fibroses maintains the stability of the motion segment along with the ligaments and articulations.The spine is unstable without the support of the muscles that power the trunk and position the spinal segments.[3,4]

Isthmic spondylolisthesis is Type II spondylolisthesis ( Wiltse classification ).[4] It includes defect in pars intercularis allowing forward slipping of L5 on S1. The surgical outcome of lumbo-sacral spondylolisthesis is better than conservative according to literature in accordance with stable reduction and early amelioration of symptoms. Determination of the patient's primary complaint (mechanical back pain or radicular pain) has a significant impact on the type of surgery that will be most appropriate if conservative treatment is not successful .The mainstay of surgical treatment for adult patients having low-grade acquired isthmic spondylolisthesis is fusion, with or without decompression. [4,5]

The fusion techniques available for this deformity can be conceptually divided into those techniques that achieve posterior column stability [ postero-lateral inter-transverse fusion (PLF)], anterior column stability [ anterior lumbar interbody fusion (ALIF)]), and combined approaches that achieve both ( ALIF + PLF ) or posterior/trans-foraminal lumbar interbody fusion (TLIF).[4,5] TLIF surgery provides unilateral access to the disc space through the intervertebral foramen. A special spacer, called a fusion cage, is inserted into the disc space from one side of the spine which was described by Hams and Rollinger in1982.[4,5]

TLIF re-establish anterior column support while allowing for posterior fixation, thus improving fusion rate.[6,7] The objective of present study was to study the functional outcome of TLIF in management of isthmic spondylolisthesis using Oswestry Low Back Pain Disability Questionnaire (OLBPDQ) , to assess surgical outcome on the radiological basis of interbody fusion and complications.

## II. Material & Methods :

The study was conducted in a tertiary care teaching institute meeting the inclusion and exclusion criteria of selecting candidates with isthmic spondylolisthesis. Patients included were of age more than 18 years and less than75 years. They were clinically symptomatic with grade $\geq 2$ isthmic spondylolisthesis and with imaging evidence . The exclusion criteria were those with extensive epidural scarring , arachnoiditis, active infection, conjoined nerve roots, osteoporosis, fracture with comorbidities prohibiting surgery and grade I spondylolisthesis. The study was carried out for a period of eighteen months on twenty patients following permission of institutional ethics committee.

The study design was institutional prospective longitudinal study.The study tools were skiagram, computerised tomography (CT) and magnetic resonance imaging(MRI) of spine. The required data was collected from patients attending outpatient department, during hospital stay and follow up. All patients included in the study were clinically assessed , physically examined and radiologically confirmed by MRI. A written and informed consent taken.

All patients underwent TLIF following proper preoperative investigations and anesthetic evaluation. TLIF comprised of decompression, reduction, pedicle stabilisation with screw and rods, three column spinal fusion with TLIF cage and laminectomy bone chips. Postoperative management was done by drain removal after 24hours, stitch removal after two weeks followed by physiotherapy.

Post surgical follow up visits done at 3months, 6 months and 1 year to assess spinal fusion. The functional results analysed by OLBPDQ inclcuded low backache, leg pain, gait, straight leg raising test, motor and sensory disturbances.The result of treatment modality was categorised according to achievement of clinical success . The clinical, functional score and imaging correlation of patients analysed by Brantigan-Steffee classification .

The criteria of assessment included more dense and mature bone in fusion area with no interspace between the cage and vertebral body and mature bony trabeculae bridging in fusion area. But, the existence of a traction spur considered an essential predictable radiologic factor of instability of fusion segment. The principle of reduction of spondylolisthesis by TLIF sequentially included decompression, instrumentation, distraction with vertical correction , posterior translation and anterior support with lordosis.

Patient was positioned prone on a padded spinalframe/Bolster with adequate padding of all bony prominences . Abdomen was allowed to hang free which decreased intravenous pressure with resultant decreased blood loss as a result of collapse of the epidural venous plexus.

A midline skin incision was centered over the involved lumbar segment with infiltration of skin and subcutaneous tissue with 1:500,000 epinephrine solution .Dissection was progressed down through the skin, subcutaneous tissue, and lumbo-dorsal fascia to the tips of the spinous processes. The posterior elements were exposed subperiosteally from distal to proximal using electro-cautery. Each segment was packed with a taped sponge immediately post exposure . The dissection was then carried down to the transverse processes to be fused.

Facet joints were denuded by removing the fascia over them and stripping them clean by subperiosteal dissection, carrying the dissection around the pars interarticularis. Loose arc was removed, if possible en bloc. Roots were identified and decompressed. A complete posterior release of the posterior annulus with disc was necessary to facilitate the reduction procedure. For grade III and IV spondylolisthesis, a partial sacral dome osteotomy needed to avoid traction injury to the nerve roots.

The pedicles were identified and localization done by intersection technique. It involved dropping a line from lateral aspect of the facet joint which intersect a line that bisect the transverse process at a spot overlying the pedicle. A small mammillary process was identified at this point and the cortex was nibbled off to open cancellous bone over the pedicle. A pilot hole was made into the pedicle using a sharp trocar with stopper. A sharp pedicle centraliser of 2.5mm diameter and 30 mm in length used to ascertain the trajectory.

A pedicle probe then used to proceed through pedicle to the body by using prono-supinatory movement within an arc of $30^{o}$ at an angle of 20-$30^{o}$ medially from midline till it reaches 80% of planned screwlength. For $L_5$, the probe was inserted in slight caudal direction and almost neutral for $L_4$and $L_3$. The holes were then tapped with appropriate tape. After probing and tapping the pedicle, a sound was inserted to check integrity of the tapped hole and ensuring absence of breakup where screws of 4.5mm and 5.5mm diameter were used.

Reduction screws were used for the affected vertebra to reduce grade of slip in some cases.Screws were checked in lateral radiograph using an image intensifier post insertion for depth of penetration which was supposed to be between 50-80% of the vertebral body.

The sacral entry point was generally at the junction of a vertical line along lateral border of $S_1$ facet and a horizontal line along inferior border of this facet. The screws were directed towards the tip of sacral promontory. The rod was then contoured and engaged fully in slots of the screw above and below the translated segment with the help of rod holder.A slight controlled distraction combined with further posterior discectomy was done. Lower part of inferior facet of superior vertebra and upper part of superior facet of inferior vertebra removed by osteotomy.

The disc space was prepared by irrigating with normal saline following removal of remaining disc material and debris. Nuts were tightened against the threaded screw shaft of reduction screws for gradual posterior reduction of the vertebra .Anterior column support and fusion done through TLIF cage impacted with bone chips. The inner screw and outer nut of pedicle screw were tightened . The left paramedian muscles were retracted laterally and the soft tissues cleared. Articular cartilage of the facets of articular processes, bases of transverse processes with adjacent lamina were denuded in order to create an osseous bed for placement of free iliac bonechips.

## III.Results :

The age group of patients ranged from 20 – 59 years. Four patients were in group of 20-29 years ( 20%) ; five in 30-39 years (25%); ten in 40-49 years ( 50%) ; one in 50-59 years (5%) .Females predominated in the study population. The study comprised of 14 females (70%) and 6 males (30%). The patients with affected L4-L5 segments were six in number (30%) and the rest 14(70%) presented with affected L5-S1 segments. All twenty patients (100%) presented with low back pain and radiculopathy. Fourteen patients (70%) presented with tight hamstrings. Grade II spondylolisthesis found in six patients (30%), Grade III in eight (40%) and Grade IV in six (30%) . Level II fixation of spinal segment found in five patients ( 25%) and level III in 15 patients (75%) .

PEEK cage was used in 16 patients (80%) and Titanium cage in 4(20%). Radiological union was absent in all (100%) during follow up visit at 3 months post surgery, four patients (20%) showed union at six months and sixteen (80%) showed union at one year. Postoperative complications were dural tear followed by infection , quadriceps weakness, implant failure and cauda equine syndrome.

## IV. Discussion

Lumbar spondylolisthesis is a disease with several aetiopathogenetic origins, as shown by Marchetti and Bartolozzi[6]. The aspect of pathological anatomy and radiological findings, the age and clinical appearance of the patients are different when they are diagnosed. Surgery is indicated in failure of conservative treatment .[6,7] The present study population of twenty patients included six males and fourteen females with a male to female ratio of 1:2.33. This is contrary to an epidemiological study by Kalichman and Hunter who showed the male to female ratio in adult isthmic spondylolisthesis of 2:1.[1.6] This discrepancy can be due to small sample size in present study.

The average age of patients in the present study was 34.65 years with a range of 25-56 years. According to Campbell's operative orthopaedics, patients requiring surgery are of younger age, which is consistent with the findings of other authors.[8] Most patients with lytic acquired spondylolisthesis present with

low grade deformities (less than 50% slip); 90% to 95% involve L5-S1 level and 5% to 8% at L4-L5. Low grade slips are much more common than those with more than 50% by a ratio of 10:1.[8] In the present study, there were 14 cases with L5-S1 slip (70%) and 6 cases (30%) with slip at L4-L5.

Low back pain and sciatica were the most common symptoms and was present in all the cases, followed by hamstring tightness in 70% of the cases. No cases had any sensory neurodeficit but one patient had EHL weakness.All patients were treated with TLIF.All but one, had significant relief from their back pain, and all were relieved of claudication and sciatica.Post surgical functional score in patients showed improvement in morbidity from 55.90% (mean) to 14.70% (mean). Bony fusion was achieved in 16 of 20 (80% ) operated TLIF patients after 1 year of surgery. The fusion rate is comparable with Fathy et al . [8]

The gold standard of surgical treatment in spondylolisthesis is fusion [9]. The different techniques for fusion discussed in literature have advantages and disadvantages with mixed and variable results and with the possibility of having several complications, which must be taken into account in the choice of treatment.[9,10] The goal of surgical treatment in spondylolisthesis includes stabilization of the motion segment, decompression of neural elements, reconstitution of disc space height, restoration of sagittal plane translational with rotational alignment. The goal of stabilizing spondylolitic level is accomplished by arthrodesis from a posterior, anterior, or combined approach[10]. Depending on the severity and clinical features of spondylolisthesis, it may also be desirable to reduce the forward translation, increase disc space height, decompress the neural elements, and increase or restore lumbar lordosis.[9,10]

Posterolateral instrumented or noninstrumented fusion (with or without decompression), anterior interbody fusion, and circumferential fusion have all been reported to provide acceptable fusion rates and clinical outcomes in adult patients with spondylolisthesis [10]. The use of an internal fixation gives a lower rate of non-fusion, but increases the risk of infection and possible iatrogenic damage. [10]

The reduction of isthmic spondylolisthesis presents considerable advantages of restoration of normal anatomy correcting local kyphosis and sagittal balance with improved decompression of neurological elements and favourable condition for fusion. Combined ALIF and PLF offers the highest mechanical stability and best chances of bony fusion of all lumbar spinal fusion techniques [10]. However, it is well recognized that the anterior approach may result in severe, life threatening intraoperative complications owing to proximity of major anatomical structures. Biomechanically, TLIF provides anterior column support and a posterior tension band [11,15]. Interbody fusion techniques are developed in an attempt to preserve load-bearing capacity of the spine restoring sagittal plane alignment and using compressive loading on the bone to enhance likelihood of fusion. This produces a biomechanically stable postoperative spine enhancing the opportunity for arthrodesis..[14,15] On reviewing available studies and present study, TLIF procedure seem to have favourable outcome.

Posterior approach avoids the morbidity factors associated with anterior approach. PLIF has gained popularity in treating spinal stenosis, instability, degenerative disc disease, spondylolisthesis, spondylolysis, and bilateral disc herniation. However, there are complications and contraindications. Retracting dural sheath to access disc can lead to nerve damage or neurogenic pain. PLIF is limited to L3–S1 because of increased risk of damage to conus medullaris and cauda equine .[13,15] TLIF technique is described as a modification of the well-established PLIF procedure .[11,13] TLIF uses a posterior approach to the spine that runs through far lateral portion of the vertebral foramen to access the disc space, providing the surgeon a fusion procedure that may reduce many of the risks and limitations associated with PLIF, yet produces similar stability to the spine. This has been shown to reduce incidence of postoperative radicular pain.[11,13]

TLIF usually is performed by unilateral approach preserving the interlaminar surface on the contralateral side, which can be used as a site for additional fusion. Like PLIF, TLIF is easily enhanced when combined with posterolateral fusion and instrumentation. Both procedures can provide circumferential spinal stabilization through a single posterior approach, but the more lateral access to the disk space in TLIF requires less retraction of the thecal sac and neural elements than with PLIF .[11.12] In August 2007, Chad D. Cole et al carried out a study of comparison of low back fusion techniques by TLIF or PLIF approaches in patients with vertebral body instabilities and spinal deformities.[11]

The chief advantages of TLIF included a decrease in potential neurological injury, improvement in lordotic alignment given graft placement within the anterior column, and preservation of posterior column integrity through minimizing lamina, facet, and pars dissection.[11] The primary indication for use of PLIF is spinal deformity or instability. Segmental fixation can provide immediate postoperative stability, correct anatomical deformities, and possibly enhance fusion rates, especially if multiple levels are to be fused.[10,11]

Patwardhan et al determined that the compressive load carrying capacity of the lumbar spine increased when the load path remained within a small range around rotation centres of the lumbar segments. Minor complications rates vary from 20 to 35.3% [12] and a revision rate of 7.6% has been reported. General complications include ileus and pseudomembranous colitis[12,13]. Specific complications include pseudoarthrosis,

pedicle screw malposition haematoma, symptomatic contralateral disc herniation, dural tears, wound infection, wound dehiscence, seroma formation, donor-site infection, as well as transient and persistent radiculopathy [14,15].

In the present study, no patient had life-threatening or permanent neurological complication or revision. Peroperative dural tear encountered in 3 patients (15%) , early postoperative mild serous discharge found in 2 patients (10%) . One patient developed early postoperative neurological weakness. All of the patients recovered and all the complications had no major adverse effects. Absence of major complication implicates TLIF to be advantageous.

## V. Conclusion :

TLIF procedure led to shortened surgical times, less neurologic injury, and improved overall outcome. ODI score improved from 55.90% (mean) to 14.70% (mean) with 80% of union rate at final follow up. It can be concluded that TLIF is a good option for Isthmic lumbar spondylolisthesis with favourable outcome and minimal complications .

LIMITATIONS OF STUDY : Small sample size , failure in eliminating confounding factors like smoking, vitamin D deficiency and longer follow up required for better evaluation.

CONFLICT OF INTEREST : None.

SOURCE OF FUND : Institutional ( Govt. Supply)

ETHICAL CLEARANCE : Permission granted by Ethical committee of institution.

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FIG. 1 : Preoperative imaging (MRI)


FIG. 2 : Postoperative imaging (skiagram ) – 1 year follow up.

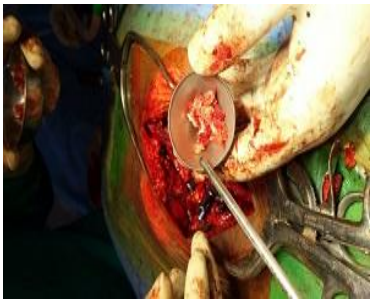

FIG.3 : Intraoperative

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