Evaluation of Transforaminal Lumbar Interbody Fusion Versus Posterior Lumbar Interbody Fusion in Patients of Lumbar Instability Submitted to Transpedicular Screws Fixation

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Abstract

Purpose: This study is conducted to compare the surgical results of Posterior Lumbar Interbody Fusion (PLIF) and Transforaminal Lumbar Interbody Fusion (TLIF), with pedicle screw fixation, in the treatment of patients with lumbar instability.

Patients and Methods: A prospective study of 21 patients to compare the clinical and radiological outcomes of the two techniques. Eleven patients had been operated with the PLIF technique with two cages (carbon fiber) and pedicle fixation (group 1), and ten patients had been operated with the TLIF technique with one cage (carbon fiber) and pedicle fixation (group 2). We included patients between 18-65 years, with lumbar instability, without previous lumbar surgery, grades 1 and 2 spondylolisthesis. Patients with previous lumbar surgery or with higher grades 3 and 4 spondylolisthesis were excluded. Visual Analogue Scale (VAS) for pain and Oswestry Disability Index (ODI) were used to assess the patients pre-operative and at post-operative intervals at 1,3 and 6 months. Pre-operative and post-operative images were done using static and dynamic X-rays, computerized tomography, and magnetic resonance imaging.

Results: Clinically, the pain index improved from 7.7 ± 1.1 to 2.6 ± 2.1 after six months of follow up in PLIF group with statistical significance. In TLIF group the pain index improved from 7.5 ± 0.7 to 1.6 ± 0.9 after six months of follow-up with statistical significance. The ODI in PLIF group improved from 60.9 ± 15.9 to 32.8 ± 11.3 after six months of follow-up, in TLIF group the ODI improved from 65.4 ± 11.1 to 30.8 ± 6.3 after six months of follow-up with statistical significance in both groups.

Radiological: 72.7% of patients in PLIF group had good fusion while 80% of patients in TLIF group had good fusion with no statistical significance, and there were no cases of cage extrusion.

Conclusion: Both PLIF and TLIF provide the same good clinical and radiological outcome in management of lumbar instability after short term follow-up of 6 months duration. Operative complication is less in TLIF technique, and risk of dural tear diminished significantly. TLIF can save time more than PLIF.

Key Words: Spondylolisthesis – Lumbar – Fusion – Transforaminal.

Introduction

SPINAL fusion, also known as spondylodesis or spondylodyndesis, is a surgical technique used to combine two or more vertebrae. Supplementary bone tissue (either autograft or allograft) is used in conjunction with the body's natural osteoblastic processes. This procedure is used primarily to eliminate the pain caused by abnormal motion of the vertebrae by immobilizing the vertebrae themselves [1]. There are two main types of lumbar spinal fusion, which may be used in conjunction with each other; posterolateral fusion and interbody fusion [2]. Interbody fusion involves radical disc removal and replacement with bone graft. It is a well-established method of spine stabilization that can be performed through a posterior approach [3]. There are three types of interbody fusion: Anterior lumbar interbody fusion (ALIF)-the disc is accessed from an anterior abdominal incision, posterior lumbar interbody fusion (PLIF)-the disc is accessed from an anterior abdominal incision, posterior lumbar interbody fusion (PLIF)-the disc is accessed from a posterior incision and transforaminal lumbar interbody fusion (TLIF)-the disc is accessed from a posterior approach through one of facet joints4. Interbody cages have become popular and are now composed of a wide range of materials, such as titanium mesh, carbon fiber, and polyetheretherketone (PEEK) [5]. Augmentation of the PLIF procedure with the addition of pedicle screws increases
Evaluation of Transforaminal Lumbar Interbody Fusion Versus the stability of the construct and has been reported to increase the fusion rate of this procedure compared with stand-alone grafts [6,7]. Posterior lumbar interbody fusion requires retraction of the thecal sac and nerve roots to gain sufficient access to the posterior disc space through the spinal canal. This increases the risks of incidental durotomy and injury to the nerve roots or conus medullaris if above L2-3 [8]. By removing the entire facet joint, it minimizes retraction on the thecal sac, decreasing the risk for a durotomy and limiting possible neurological injury. TLIF enables placement of the graft within the anterior or middle of the disc space to restore lumbar lordosis. Finally, because the contralateral laminae and spinous processes can be preserved, additional surface area is available to help achieve a posterior fusion [9]. Although the popularity of posterior lumbar fusion techniques continues to increase, there are few published studies comparing the clinical outcome or fusion rates attained between PLIF and TLIF. This study is one of the ongoing efforts to evaluate both methods.

Patients and Methods

In the period between 2009 and 2010 the first 21 patients had symptoms of spinal instability and indicated for lumbar spinal fixation and fusion were included in this prospective study. The sample was divided into two groups the first group (group 1) was treated by PLIF and posterior transpedicular screws and rod fixation, the second group (group 2) was treated by TLIF and posterior transpedicular screws and rod fixation.

Inclusion criteria: Age between 18-65 years, both sexes were accepted, patients had first time lumbar surgery, single or double level lumbar spine instability, all lumbar levels were included (L1-L2), (L2-L3), (L3-L4), (L4-L5) and (L5-S1), all types of spondylolisthesis with grade 1 or 2, lumbar spinal canal stenosis with instability and black disc disease.

Exclusion criteria: Patients had marked neurological deficits (motor affection, sphincter abnormality), patients with morbid obesity measured by BMI >40, high grade spondylolisthesis grade 3 or 4, lesions involved more than two levels and previous lumbar surgery.

Pre-operative assessment: History and examination:

Data included; sex, age, occupation, smoking and co-morbid medical conditions, past history of chronic illness as; diabetes mellitus, hypertension chronic renal or liver diseases, cardiac problems, neurological complaint, previous trauma or operations. Data concerning the presence of back pain, radicular pain and its dermatome distribution, paraesthesia, motor weakness, sphincter and sexual dysfunction was recorded.

Measurement scales of the clinical outcome:

Back pain and radicular pain were assessed using a visual analogue scale where patients select a value between pain free (VAS 0) and unbearable pain (VAS 10) [10]. Preoperative and postoperative economic (activity) and functional (pain) statuses was assessed and classified according to Oswestry disability index ODI [11,12]. After completing the questionnaire the disability was classified into: Minimal disability ODI = 0-20%, moderate disability ODI = 21%-40%, severe disability ODI = 41%-60%, crippled ODI = 61%-80% and ODI = 81%-100% means that these patients are either bed-bound or exaggerating their symptoms.

Preoperative radiological assessment:

The preoperative radiographic evaluation consisted of: Routine static and dynamic plain lumbar sacral spine X-ray lateral view to assess the spine for presence of preoperative instability, and anatomical variants. C.T. lumbar sacral spine for all patients to measure canal diameter at the stenotic level, pedicle diameter and fracture pars interarticularis. MRI lumbar sacral spine for all patients with accompanying symptoms of neural compression.

PLIF: Surgical technique:

Patients are placed prone position, after the levels of interest are exposed, the posterior spinal element (laminae and ligamentum flava) were removed to expose the traversing nerve roots and lateral extent of the disc space. After exposure of the posterior annulus, a complete discectomy was performed using rongeurs, disc shavers, and down-biting curved curettes. A carbon fiber cage (Medtronic Sofamore, Danek, Memphis, TN) packed with bone graft was tamped into the disc space on one side; and another carbon fiber cage was inserted on the other side. The bone obtained from the lamina removed and in some cases iliac bone graft 2cm posterolateral to anterior superior iliac spine was harvested. After the interbody construct is placed, pedicle screws are then inserted and attached to the rods. Once in place, the pedicle screws are compressed along a lordotic rod in an attempt to reduce any kyphosis caused by inter-discal distraction. We used side loading system or
poly-axial system for L5-S 1 fixation and mono-axial system was used at any other levels. A standard closure in layers is then performed [8].

**TLIF technique:**

Position and dissection as described in PLIF technique. Depending on the clinical presentation, a laminectomy, facetectomy, or both was performed. A unilateral laminotomy and partial facetectomy are performed on the side consistent with the patient's symptoms or anatomical abnormalities. Depending on the need for medial exposure, a medial facetectomy is usually sufficient for exposure, although in those cases not requiring a medial decompression, exposure was obtained by removing the lateral aspect of the inferior articular facet until the edge of the thecal sac comes into view. A bilateral laminectomy was reserved for clinically significant bilateral neural element compression as in bilateral fracture pars interarticularis. After adequate decompression of the neural elements had been performed, pedicle screws are placed in the standard fashion. The disc space was gradually distracted by using the pedicle screws. A complete discectomy was performed from one side using rongeurs, disc shavers, and down-biting curved curettes. Anterior third of the disc space was filled with bone graft from the lamina, facet bone or iliac bone graft. A single "banana"-shaped carbon fiber cage (Medtronic Sofamore, Daneki, Memphis, TN) packed with bone graft was tamped into the disc space. Once the graft had been placed within the interbody space, pedicle screws are then attached to lordotic rod and carefully compressed to restore lumbar lordosis while maintaining the restored disc height. The contralateral facet joint and the remaining lamina sometimes were decorticated, and the bone graft is placed over them for posterolateral fusion. A standard closure in layers is performed [13].

**Clinical follow-up:**

Full neurological examination was performed for all patients after recovery and at 1,3 and 6 months intervals. The VAS was assessed 48 hours post operative and at 1.3 and 6 months intervals. The ODI was calculated post operative at 1,3 and 6 months intervals. We reported any post operative complications including wound infection, CSF leakage, implant expulsion or implant removal.

**Radiological follow-up:**

One day post operative static lumbosacral X-ray was done to evaluate the site of screw and the cage. In case of severe post operative sciatica or progressive radiculopathy CT lumbosacral spine was requested for more evaluation of screws and graft. Six months post operative C.T. lumbosacral spine bone-window and 2D sagittal reconstructions was done for all cases to assess the fusion. The fusion was assessed by radiologist who was not aware with clinical data of the patients. Successful fusion was defined as: Presence of bilateral continuous trabecular bone bridging the interspace between the fused segments, non union is considered when there is a translucency, or absence of trabeculae in the interspace between the vertebral bodies and the graft.

**Results**

The socioeconomic data analysis showed that shows that patients in both groups of the study were matched as regard to age, sex, job and chronic medical conditions with no statistically significant difference. The mean age of (PLIF group n=11) was 40.5±13.2, while in (TLIF group n=10) it was 40.3±7.6 years.

Most of the patients in both groups were females (63.6% and 60% in PLIF and TLIF groups respectively). All of the studied patients have back pain, no motor weakness and normal reflexes. No statistically significant difference was found between both groups regarding presence, side and level of radicular pain and sensory abnormalities. In PLIF group (n=11) the preoperative radiological diagnosis was five patients with isthmic spondylolisthesis L5-S 1 level grade II, one patient with isthmic spondylolisthesis L4-L5 level grade I, four patients with degenerative spondylolisthesis L4-L5 grade 1, one patient of these 4 patients had retrolithesis in L5-S 1 level and operated for double level fixation and fusion, and one patient with black disc disease L4-L5 level. While the preoperative radiological diagnosis in TLIF group (n=10) was seven patients isthmic spondylolisthesis, four of them were L5-S 1 level, two of them were L4-L5 level and one patient with L3-L4 level. Two patients had degenerative spondylolisthesis L4-L5 and one patient with black disc disease. The patient who had diagnosed as isthmic spondylolisthesis L3-L4 level had significant lumbar disc prolapse at L4-L5 level and needed double level fusion and fixation.

The intraoperative data were collected and revealed that 3 patients only in TLIF group needed full laminectomy, while in PLIF group all patients needed full laminectomy. The iliac bone graft was harvested in 7 (63.6%) patient in PLIF group while it was harvested only in 3 (30%) in TLIF group.
In PLIF group the operative time ranged between 180-260min and the mean was 223.2 ± 24.7min while in TLIF group the operative time range was 120-220min and the mean was 150 ± 33.6min, there was statistical significance between these groups and p-value = 0.001 (Fig. 1). Regarding the blood loss there was no significant difference between the two groups the mean blood loss in PLIF group was 650 ± 208.6ml, while it was 525 ± 190.3 in TLIF group.

Regarding the visual analogue scale, there was significant reduction in VAS in both groups after 1 month postoperatively. In PLIF group VAS was pre-operative 7.7 ± 1.1 and 6 months postoperative it became 2.6 ± 2.1, while in TLIF group VAS was pre-operative 7.5 ± 0.7 and 6 months postoperative it became 1.6 ± 0.9 (Fig. 2).

Regarding Oswestry disability index, we found that it is improved in progressive manner during the period of 6 months follow-up; in PLIF group was 60.9 ± 15.9 preoperatively and declined to be 32.8 ± 11.3 after 6 months of surgery. In TLIF group the ODI was 65.4 ± 11.1 before surgical intervention and became 30.8 ± 6.3 after 6 months of follow-up (Table 1).

Regarding post operative complication in our study only four patients had wound infection (3 in PLIF group and 1 in TLIF group), the infection was superficial and managed by antibiotics and no system removal was indicated. Dural tear was repeated among 28.4% of patients in PLIF group with statistically significant difference versus TLIF group (no cases of dural tear). As regard to iliac bone graft complications, when it was done it lead to pain but in TLIF group pain persist for 2 weeks only while in PLIF group pain persist for one month and 2 months in 2 patients with no statistically significant difference. The only reported fixation system problem was signed only in one patient in PLIF group. There was mal-positioned left L5 screw resulted in severe agonizing Lt. L5 sciatica explained radiologically, redirection was done and patient improved well. Regarding fusion which was assessed by independent radiologist we found that there was no statistically significant difference between both groups regarding fusion. In PLIF group the fusion rate was (72.7%) and 3 of 11 cases showed no fusion for at least 6 months of radiological follow-up. In TLIF group the fusion rate was (80%) and 2 of 10 cases showed no fusion for at least 6 months of radiological follow-up. In our study there was no statistically significant difference between both groups regarding satisfaction. Most of the patients were satisfied with the performed operation (81.8% and 90% in PLIF and TLIF group respectively.

Table 1: ODI (%) pre and postoperatively among the studied patients in both groups of the study.

<table>
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<tr>
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<th>PLIF</th>
<th>TLIF</th>
<th>p-value</th>
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<tr>
<td>Preoperative</td>
<td>60.9±15.9</td>
<td>65.4±11.1</td>
<td>0.4 (NS)</td>
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<tr>
<td>Postoperative 1 month</td>
<td>39.3±11.9*</td>
<td>37.5±10.3*</td>
<td>0.7 (NS)</td>
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<tr>
<td>Postoperative 3 months</td>
<td>34.7±9.5*</td>
<td>35.4±8.2*</td>
<td>0.9 (NS)</td>
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<tr>
<td>Postoperative 6 months</td>
<td>32.8±11.3*</td>
<td>30.8±6.3*</td>
<td>0.07 (NS)</td>
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* Statistically significant difference versus preoperative value of same group.
NS: No statistically significant difference.

Fig. (1): Operative time among the studied patients in both groups of the study.

Fig. (2): VAS pre and postoperatively among the studied patients in both groups of the study.
Fig. (3-A): Static X-ray lumbosacral spine lateral view showing isthmic spondylolthesis grade 1 and pars interarticularis defect.

Fig. (3-B): Static X-ray lumbosacral spine lateral view 2 days after surgery showing TLIF cage (3 radio opaque dots) and good seated top loading fixation system L5-S 1.

Fig. (3-C): X-ray lumbosacral spine anterior-posterior view 2 days after surgery showing TLIF cage (4 radio opaque dots) and top loading fixation system L5-S1. L5 lamina is partially removed from the right side and spinous process of L5 is intact.

Fig. (3-D): CT lumbosacral spine axial cut on disc space L5-S 1, showing good seated lumbar banana like cage and inter body fusion.

Fig. (3-E): CT lumbosacral spine two dimension sagittal reconstruction showing good interbody fusion.

Discussion

Concepts and techniques of spinal fusion as a therapeutic modality for pathologies of the spine date back to the origins of spinal surgery. Moreover, the principles, which govern arthrodesis, are as old as orthopedics and neurosurgery. Interbody fusion techniques have been developed to provide solid fixation of spinal segments while maintaining load-bearing capacity and proper disc height. In our study we try to compare two of these techniques which were well established and accepted worldwide, these two techniques were TLIF and PLIF. In 2001, the Swedish Lumbar Spine Study Group showed for the first time in a prospective and randomized study that lumbar fusion as a treatment of disabling low-back pain was significantly more effective than a conservative treatment regime [14]. In our study we try to assess these well known techniques regarding our facilities in Suez canal university hospital. In management of low back pain due to lumbar instability we try to eliminate pain, decrease functional disability and with minimal complication [15]. So, in comparing these techniques we assessed clinical outcome regarding pain elimination, functional disability improvement and postoperative complication.

The operative time in minutes in PLIF group had the mean of (223.2±24.7) and range (180min-260min.) in comparison to TLIF group which had the mean of (150±33.6) and range (120min-220min.) there was statistically significant difference and $p$-value was 0.001.
The difference of time is due to some steps in PLIF technique is added on TLIF technique as bilateral disc opening and two cages insertion. Some complication as dural tears and their repair were more incidental in PLIF group so, cost more time. On the other side TLIF technique is simpler and didn't require bilateral disc opening so, it saves more time. Results of Lars H. and coworkers matched with our results, they found in assessment of TLIF technique in 52 patients that the operation time for one-level fusions averaged 173 min (135-220) and for multiple level fusions averaged 238 min (190-255) [16]. Inamdar and his colleges reported on operative time in their comparative study between PLIF and posterolateral fusion that the mean operating time was 4 hours for PLIF patients and 3 hours for posterolateral fusion patients [12]. The PLIF technique time were longer than posterolateral fusion as disectomy steps and their complication were cancelled.

We found that blood loss in PLIF group had mean±SD = (650±208.6ml) and range (300-1000ml). While the TLIF group blood loss mean±SD = (525±190.3ml) and range (200-800ml) these results has no statistically significant difference. Results of Humphreys and coworkers matched with our results; they compared 34 PLIF procedures with 40 TLIF procedures in respect of blood loss, operation time and complications. They found no significant differences in terms of these parameters for one-level fusions. However, significantly less blood loss occurred in the TLIF when two-level procedures were compared [17].

Lars H. and coworkers in their study in TLIF evaluation found that blood loss of the one-level fusions averaged 485ml (220-860) and that of the multiple level fusions 560ml (430-1140) [16]. Inamdar and his colleges reported on blood loss in their comparative study between PLIF and posterolateral fusion that the mean blood loss for both groups was 500ml [12]. Immediate post operative parasthesia in the form of numbness and tingling were recorded among 10 patients of PLIF group and 6 patients of TLIF group. In PLIF group, 8 patients had bilateral parasthesia while no one of TLIF group patients had bilateral parasthesia. The follow-up of parasthesia for 6 months revealed that there was no statistically significant difference between both groups regarding parasthesia pre and post operative till a period of 6 months. In PLIF group, although number of patients with parasthesia decreased from 7 preoperatively to be two cases after 6 months but there was no statistically significant difference. In TLIF group there was statistically significant reduction of number of patients with radicular pain from 7 cases preoperatively to only one patient after only one month. In PLIF group there was increase in number of patients with parasthesia immediately postoperative from 7 to 10 which didn't occur in TLIF group.

These changes of postoperative parasthesia and radiculopathy which were bilateral in PLIF group can be explained by frequent root manipulation and retraction of dura and roots which is bilateral in PLIF group. In comparison to TLIF technique where root retraction is minimal and dural retraction is absent. Our results matched with good clinical outcomes over posterolateral fusion. Interbody fusion techniques also appear to be the most effective treatment of discogenic back pain that is unresponsive to conservative measures [18]. Some of the advantages of inter body fusion include immediate anterior column load sharing, a large surface area for fusion, bone graft subjected to compressive loads that is advantageous in achieving fusion, and the ability to restore normal sagittal contour while indirectly decompressing the neural foramen [19]. Weatherly et al. reported on five patients during a 10-year period, who had “solid” posterolateral fusions but still had positive discography under the fusion and had their back pain relieved by anterior interbody fusions20. Recently, Derby et al. noted that patients with “highly sensitive discs” as determined by pressure-controlled discography achieved significantly better long-term outcomes with combined anterior/posterior fusion than with inter-transverse fusion alone [19]. Humphreys SC. and coworkers found that the post operative radiculitis in TLIF group is lower than the post operative radiculitis in PLIF group while the same stability is provided for both groups [17].

VAS was not significantly different among both groups preoperative and 48 hours postoperatively. Starting from 1 month postoperatively, VAS was significantly lower in TLIF group patients. There was significant reduction in VAS in both groups after 1 month postoperatively. In PLIF group VAS was pre operative 7.7±1.1 and 6 months postoperative it became 2.6±2.1, while in TLIF group VAS was pre operative 7.5±0.7 and 6 months postoperative it became 1.6±0.9. Deng-lu Y. and coworkers found in their study that the pain index improved from 7.08±1.13 to 2.84±0.89 in PLIF patients and improved from 7.18±1.09 to 2.84±0.91 in TLIF patients [21]. Lars H. and coworkers assessed TLIF technique only and found that the VAS improvement is related to the pre operative pathology. The VAS was in isthmic spondylolisthesis group 7.6±2.3 and became after 3.4±2.4 while in degenerative
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In this study, ODI improved in progressive manner during the period of 6 months follow-up in PLIF group was 60.9 ± 15.9 preoperatively and declined to be 32.8 ± 11.3 after 6 months of surgery. In TLIF group the ODI was 65.4 ± 11.1 before surgical intervention and became 30.8 ± 6.3 after 6 months of follow-up. Lars H. and coworker found in their study in evaluation of TLIF technique that ODI decline in group 1 (patients with isthmic spondylolisthesis n=22) from 41.6 ± 21.7 to be 17.9 ± 14.2 after 6 months. In group 2 (patients with degenerative spondylolisthesis n=30) ODI was 58.4 ± 18.4 preoperatively then improved to be 31.5 ± 20.5 after 6 months post operatively with no statistical significance [16]. Sebastian L. and his colleagues assessed TLIF technique in 39 patients and ODI improved from 20.05 ± 7.9 preoperatively to become 10.95 ± 10.6 after 2 years of surgery [22]. Inamdar and coworkers compare the ODI improvement between PLIF group and inter-transverse group. In the PLIF group, the mean preoperative and postoperative Oswestry scores were 25.1 ± 8.77 and 10.4 ± 6.29, respectively. In inter-transverse group the mean preoperative and postoperative Oswestry scores were 20.33 ± 7.0 and 7.5 ± 3.99, respectively [12].

In this study, there was no statistically significant difference between both groups regarding satisfaction. Most of the patients were satisfied with the performed operation (81.8% and 90% in PLIF and TLIF group respectively. Benjamin K. in his study for 100 patients operated for TLIF found that the rates of patient satisfaction with the surgical procedure was 76% [23]. Inamdar D, in his comparative study stated that satisfaction was 87.5% in PLIF group (n=10) and was 100% in posterolateral fusion group (n=10) [12]. Madan and Boeree found satisfaction 69.5% in 23 patient treated with PLIF, while the satisfaction was 81% in 21 patients treated with posterolateral fusion technique [24]. Mofidi and coworkers reported 85% satisfaction rate following surgery with a mean follow-up of 4.4 years after PLIF and posterior fusion [25].

In this study, only four patients out of 21 patients had wound infection (3 in PLIF group and 1 in TLIF group) the infection was superficial and managed by antibiotics the infection was not deep and no system removal was indicated. Dural tear was repeated among 28.4% of patients in PLIF group with statistically significant difference versus TLIF group (no cases of dural tear). It was believed that because the cauda equina obstructs the approach to the disc when PLIF is performed, the frequent dural sac retraction and the mandatory laminectomy increase the risk of dural tear and CSF leakage. In contrast, a TLIF technique need no retraction and laminectomy is not mandatory, so dural tear is less frequent. As regard to iliac bone graft complications, when it was done it lead to pain but in TLIF group pain persist for 2 weeks only while in PLIF group pain persist for one month and 2 months in 2 patients with no statistically significant difference. The only reported fixation system problem was reported only in one patient in PLIF group. There was mal-positioned left L5 screw resulted in sever agonizing Lt. L5 sciatica explained radiologically, redirection was done and patient improved well.

Conclusion: Both PLIF and TLIF provide the same good clinical outcome in management of lumbar instability after short term follow-up of 6 months duration. Operative complication is less in TLIF technique, and risk of dural tear diminished significantly. TLIF can save time more than PLIF. TLIF costs is less than PLIF, as we use only one banana shaped cage.

References


