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Comparison of Minimally Invasive Transforaminal Lumbar Interbody Fusion (MIS-TLIF) and PLIF for Lumber Degenerative Disc Disease and Results of Final Clinical Outcomes

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Abstract**—***A retrospective study was performed involving a total of 96 patients with degenerative lumber spine disease to analyze the MIS-TLIF and PLIF for degenerative disc disease. Method-I: MIS-TLIF (N=37) and method-II: PLIF (N=59) were used. Pre and post-operative visual analog scores for back and leg pain, Oswestry disability index, and short form-36 scale were compared. Excellent clinical outcomes were obtained in 91 out of 96 patients at 15 months of follow-up in each group. Relatively more incision site, blood loss, and hospital stay period was seen in the PLIF group (P>0.05) and the latter was greater in the MIS-TLIF group, there were fewer incision site, less blood loss and hospital stay (P<0.05). The few surgical outcomes that were found to be statistically significant between MIS-TLIF and PLIF, did not affect the overall outcomes. However, MIS-TLIF may have better outcomes. The final clinical and neurological results were similar and satisfactory in both MIS-TLIF and PLIF groups.*

Keywords**—** *Degenerative disc disease, Minimal invasive surgery, Posterior lumber interbody fusion, Transforaminal lumber interbody fusion.*

I. INTRODUCTION

Degenerative disc disease is the most common cause of acute and chronic low back pain or neck pain as well as nerve pain depending on the location of the affected disc and the amount of pressure it places on the surrounding nerve routes. More than half of the affected patients respond to conservative treatment for some short period. In fact, several years ago, degenerative disc disease became the leading diagnosis associated with spine fusion in North America[1]. Surgical procedures either through open or minimal invasive approaches are indicated for those patients with continuous low back pain, paresthesia, weakness, intermittent claudication, sphencteric disturbance, and sciatica at least six months of conservative treatment or in those with early or progressive neurological impairment. Neurovascular structures compressed by due to disc space narrowing, vacuum disc end plate sclerosis, osteophyte formation, and degenerative disc disease remains the most common indication for disc disease. Several surgical approaches with or without instrumental fixation have been suggested to deal with this entity, and each operative technique has its own merits and limitations. But MIS-TLIF and PLIF are two commonly used surgical techniques recommended for degenerative disc disease patients who fail to conservative care to achieve spinal fusion[2-4].

In this article, the authors compare the clinical and surgical outcomes of MIS-TLIF and PLIF, the common surgical techniques used to treat degenerative disc disease, and recommend the technique of choice. The minimally invasive technique of degenerative disc disease has been popularized in recent years. In 1997, Foley and Smith et al.[5]recommends a minimally invasive technique to deal with degenerative disc and other spinal diseases with less rate of complications. The standard surgical treatment for lumber disc disease has been open discectomy[6] but there has been a trend toward minimally invasive surgery. The minimally invasive discectomy is traditionally done by mobilizing the muscles laterally off the spinous process and lamina using a unilateral retractor. The MIS-TLIF reduced muscle injury, less blood loss, short hospital stay, and expected less back pain while achieving good clinical outcomes compared to PLIF.[7] The benefit of minimally invasive discectomy is thought to decrease surgical morbidity[8]. Also augments segmental lordosis when compared to PLIF and makes revision surgery easy because the contralateral foramen is not disturbed.

PLIF was first described by Cloward[9] in 1940 and how it widely used all over the world. This technique provides column fixation stability with anterior support and 360 fusion and is approached only from posterior [10-12]. It also prevents the posterior instruments from strain and failure and may result in a significant spondylolisthesis reduction.[13-15] The posterior

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approach has less co-morbidity and cost when compared to the anterior approach[16]. The pitfall of PLIF is the limitation of fusion to L3-S1 to evade the risk of damage to the conus medularis and cauda equina from traction. These complications make it very difficult to choose an appropriate surgical procedure for multilevel degenerative disease.

Current indications for PLIF and TLIF include disc herniation, degenerative disc disease, spondylolisthesis, severe instability, and pseudoarthrosis. Long-term clinical results have conformed the efficacy of TLIF and PLIF to high rates of fusion and they all have merits of adding anterior column support through a posterior approach. PLIF and TLIF were observed with better clinical outcomes in spinal fusion alone in selecting patient populations. In addition, many studies have confirmed that MIS-TLIF is associated with both cost-saving, time-saving, and outcomes compared to open procedure[17-19]. Both MIS-TLIF and PLIF have been reported to be associated with excellent outcomes in treating degenerative disc disease.

II. Materials and Methods

2.1. Research Methodology

2.1.1. Study Design:

Retrospective study

2.1.2. Target population

Patients of degenerative disc disease of the lumber spine, Fujian Medical University Union Hospital

2.1.3. Surgical techniques:

In group-I (MIS-TLIF): After the induction of anesthesia, the image intensifier machine, METRx Quadrant system, and pedicle screw were prepared before the operation. Patients were positioned prone over a radiolucent table. The arms were held at 90 degrees and fixed on padded boards. The bilateral iliac crests were palpated and marked by the surgeon and the target level conformed to the image intensifier. A single 1.5g dose of antibiotics was administered before the skin incision. A three to four-cm posterior midline incision was made centered over the marked disc space. The paravertebral muscles were split and retracted laterally to the outer edge of the facet joints, a guidewire was advanced to the zygapophyseal joint overlying the target disc space, with biplanar fluoroscopic control. METRx tissue dilators of increasing diameter were introduced sequentially onto the facet joint capsule to ensure the docking of the 18-mm METRx tubular retractor directly on the bone surface without intervening soft tissue. A limited laminotomy was performed as described by De Lamarter and Mc Culloch. Using a small annulotomy, the fragment of the disc was removed as described by Spengler.[20] The surgeon conducted the decompression by cutting the inferior portion of the lamina, hypertrophied upper and lower articular process, and ligamentum flavum. Then enlarge the intervertebral space with a distractor followed by the cage and conducted to fix the pedicle screw.

In group II (PLIF): The patients were placed in the same position as previously on the operating table after general anesthesia and tracheal intubation. Then panting and draping, an image intensifier is used to conform the target segments. Then a longitudinal incision was made in the middle of the spine (approx. 14-15cm), and the fasciae muscles were cut apart. Sacrospinalis muscles were dissected until the lumber transverse process was exposed. Pedicle screws were located into the superior and subjacent vertebral pedicle of the segmental lesions. Spinous process, lamina, hyperplasia of ligament, and internal zygapophysis were removed and lateral cavity as well as nerve root canal was enlarged with the protection of the Dural sac and nerve root. Then, the fibrous portion was decompressed and nucleus pulposus was removed, and the intervertebral space was opened. The removed laminar and zygapophysis were crushed into small pieces for an autograft, and then the cage was filled with a bone graft inserted. The titanium rods were used to connect the screw and fixed. Then the screw fixed position by the image intensifier machine and the suture was made layer after hemostasis. Drainage was placed and incision was completed layer by layer in both procedures. Pre and post-operative evaluation consisted of a neurological examination, the Visual analog score (VAS), Oswestry Disability Index (ODI), and short film-36(SF-36). The surgical wound pain was assessed after 12 hours of surgery by using VAS. The VAS scores intensity of pain from 0 to 100-no pain to worse pain ever experienced). Functional outcome were assessed using the Oswestry Disability Index. After discharge from the hospital, the patients were followed up regularly by the surgeon (3 months, 7 months, 15 months, and monitored closely for complications. After 15 months researcher closed their research on this topic.

2.1.4 Inclusion Criteria

Patients with persistent low back pain, lumber stenosis, and neurologic leg pain who failed six months of conservative treatment including oral medicine, physical therapy, exercise, and rest

2.1.5 Exclusion Criteria

Patient with a history of previous spine surgery, spine fracture, spondylolisthesis, spondylosteomylitis, spinal tumor, or degenerative scoliosis.

2.1.6 Data Collection

Preoperative demographic data collected- age, sex, fusion level, and indication were used for treatment. Pre-operative and post-operative outcomes data included patients who had co-relate pre-operative and postoperative Oswestry disability index(ODI), visual analog score(VAS), short film 36 scores, and also compared pre and postoperative complications of both groups.

A diagnosis was made after a physical exam, acquisition of plain lumber x-ray films, and magnetic resonance imaging (MRI). As this was a retrospective analysis of prospectively collected data, no power analysis was completed, but all consecutive eligible patients met, only inclusion criteria were included.

2.1.7 Statistical Analysis

Data were analyzed using the IBM SPSS Statistics 22.0 version software package. All data were written as mean ± standard deviation. We used an independent student t-test to compare the differences between the two groups. The Chi-square test was applied to compare the categorical variable

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difference between the two groups. In all the data analyzed, P<0.05 was considered as statistical significance.

III. RESULTS

i. Demographic and clinical characteristics of patients

A total of 96 patients were enrolled, 37 patients in group-I and 59 in group II. Data with patient demographics and lumber level fused are presented in Table 1. In group-I, there were 24 male patients (64.9%) and 13 female patients (35.1%), with a mean age of 53.08 ± 11.58 years. The vertebral level affected was L4-L5 in 24 patients (64.9%), L5-S1 in 8 patients (21.6%), L3-L5 in 2 patients (5.4%), and L4-S1 in 3 patients (8.1%). In group-II, there were 36 male patients (61.0%) and 23 female patients (39.0%), with a mean age of 59.12 ± 12.82 years. The vertebral level affected was L4-L5 in 31 patients (52.5%),L5-S1 in 8 patients(13.6%),L3-L5 in 9 patients(15.3%) and L4-S1 in 11 patients(18.6%) respectively.

TABLE 1: Demographic and clinical characteristics of patients

S.No.	Variables	MIS-TLIF (N=37)	PLIF (P=59)	P-value
1	**Age (years)**	53.08 ± 11.58	59.12 ± 12.82	0.136
2	**Gender**			
	Male	24(64.9%)	36(61.0%)	
	Female	13(35.0%)	23(39.0%)	
3	**Disk Level**			
	L4-L5	24	55	
	L5-S1	8	16	
	L3-L5	2	11	
	L4-S1	3	14	

ii. Perioperative parameters

Perioperative parameters are demonstrated in Table 2. When comparing group I (MIS-TLIF) with group II (PLIF), there was no statistical significance found in age, gender, or lesion segments. Radiographic follow-up observation revealed good fusion 7 months after the operation in all the patients. Other clinical outcomes are demonstrated in the next table. The operation time was 185.85 ± 57.43 in the PLIF group and 232.16 ± 54.63 min in the MIS-TLIF group (P=0.672). The estimated blood loss was 498.57 ± 465.44ml in the PLIF group and 224.86 ± 190.36 in the MIS-TLIF group (P=0.00). The hospital stay was 15.10 ± 3.81 days in MIS-TLIF and 18.53 ± 10.63 days in PLIF (P=0.163). The operation time was greater in the MIS-TLIF (P=0.672) and the later blood loss and hospital stay were greater in the PLIF group (P=0.00, P=0.163), but the difference was not statistically significant. The MIS-TLIF patients used about 15% of intravenous morphine used comparison to PLIF patients. PLIF patients generally took more time to start walking, and they stayed long in the hospital. All these differences were significant.

TABLE 2: Perioperative parameters

S.No.	Parameters	MIS-TLIF (N=37)	PLIF (N=59)	P-value
1	**Operation time (min)**	232.16 ± 54.63	185.85 ± 57.43	0.672
2	**Blood loss (ml)**	224.86 ± 190.35	498.47 ± 465.44	0.000
3	**Hospital stay (day)**	15.10 ± 3.81	18.52 ± 10.63	0.163

iii. Comparison between group-I (MIS-TLIF) and group-II (PLIF) preoperative and postoperative parameters.

In this study, we recorded follow-ups at preoperative and postoperative 7 months, and 15 months. There were no significant differences in VAS for back and leg pain between the two groups, either preoperative and postoperative 7 months or 15 months after operation (P>0.05). However, significant differences were observed when comparing preoperative VAS of back pain at 7 months and 15 months (P<0.05). Moreover, patients who underwent MIS-TLIF had less low back VAS than those in the PLIF group in 7 months and 15 months follow-up (P=0.00). Similarly, there were no significant differences in VAS of leg pain between the two groups, either preoperative or postoperative at 7 months or 15 months (P>0.05) However, significant differences were observed when comparing preoperative VAS of leg pain at 7 months and 15 months after operation (P<0.05). Additionally, there were no significant differences in SF-36 scores between the MIS-TLIF and PLIF groups, either preoperative or within 7 and 15 months after operation (P>0.05). However, significant differences were observed when comparing preoperative SF-36 scores with 7 months or 15 months after operation (P<0.05). moreover, there were no significant differences in ODI between MIS-TLIF and PLIF groups, either preoperative or 7 months or 15 months after operation (P>0.05). However, significant differences were observed when comparing preoperative ODI with 7 months or 15 months after the operation (P<0.05).

TABLE 3: Comparison between group-I (MIS-TLIF) and group-II (PLIF) preoperative and postoperative parameters

S,No.	Parameters	MIS-TLIF	PLIF	P-value
1	**VAS back pain**			
	Preoperative	6.05 ± 0.74	6.14± 0.15	0.39
	7 months	2.59 ± 0.92	3.03 ± 0.61	0.00
	15 months	1.37 ± 0.49	1.55 ± 0.50	0.22
2	**VAS leg pain**			
	Preoperative	5.94 ± 0.32	6.11 ± 0.37	0.26
	7 months	2.48 ± 0.86	2.94 ± 0.71	0.69
	15 months	1.27 ± 0.45	1.68 ± 0.39	0.30
3	**ODI score**			
	Preoperative	38.59 ± 1.18	38.44 ± 1.67	0.61
	7 months	19.54 ± 1.50	18.93 ± 1.33	0.13
	15 months	17.37 ± 1.42	16.05 ± 2.02	0.34
4	**SF-36**			
	Preoperative	43.10 ± 0.73	40.60 ± 0.53	0.48
	7 months	58.08 ± 0.79	57.18 ± 0.79	0.11
	15 months	62.56 ± 1.06	61.93 ± 1.14	0.58

iv. Complications of both groups

For complications, two patients were found cerebral leakage, one was muscle weakness, one was wound infection in PLIF group, and two patients had wound infection in MIS-TLIF group (P>0.05).

TABLE 4: Complications of both groups

S.No.	Complication	(Group-I) MIS-TLIF	(Group-I)PLIF
1	**Cerebral fluid leakage**	1/37	1/59
2	**Surgical infection**	1/37	2/59
3	**Muscle weakness**	0/37	1/37

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IV. Discussion

The clinical outcomes of MIS-TLIF and PLIF in degenerative disc disease give excellent resolution of back and leg pain Therefore, techniques of MIS-TLIF are better than PLIF but still need some clinical research. The protruding disc fragments, which irritate the cauda or the root are decompressed during MIS-TLIF. Therefore, the removal of this fragment gives immediate relief to the pain. To the final efficacy of both treatment methods, we analyzed the collected data in as much detail as possible. The author's findings indicated that MIS-TLIF had a better performance in some fields i.e. shorter hospital stay, quick recovery, as well as less blood loss compared to PLIF groups. MIS-TLIF resulted in quicker rehabilitation, less incision site, fusion rate, and less postoperative neurological complications as well as lower medical costs. For clinical functional outcomes, the preoperative variables were similar between the two groups.

Data analysis suggested that the MIS-TLIF group significantly improved postoperative VAS and ODI scores compared to the PLIF group. Thus, some parts of the MIS-TLIF group resulted in better outcomes. Various surgical techniques are widely suggested to deal with degenerative disc disease. Many authors recommended anterior, lateral, transforaminal, and posterior but posterior approaches for a variety of conditions requiring spine stabilization[21]. Among them, PLIF is commonly used and may provide a higher immediate stability compared with that of MIS-TLIF especially in lateral bending[22].

In 1997, Foley and Smith et. al recommended a minimally invasive technique to deal with degenerative disc disease and other spinal disease i.e. spondylolisthesis, lumber canal stenosis, and so on with less rate of postoperative complications and PLIF was first described by Cloward9 in 1940 and how it is widely used all over the world. PLIF provides a column fixation stability with anterior support and 360 fusion and is approached only from the posterior) [10-12]. We analyzed the collected data and finally clinical outcomes showed that there were no significant differences of VAS of back and leg pain, ODI, and SF-36 scores at 15 months of follow-up in both groups. Additionally, the VAS of back and leg pain were also significantly reduced and SF-36 was significantly improved after surgery, so patients undergoing MIS-TLIF had significantly lower back VAS than the PLIF group in the first follow-up, and MIS-TLIF indicated quicker improvement of back pain due to less muscle injury but MIS-TLIF had significantly longer operation time due to instrumental surgical procedure.

The L4-L5 lumber disc level prolapse was more than half of the studied patients. The finding is close enough to the results of Musharbash A, et al. study in Jordan (2009). Which recorded that common-level lumber disc prolapse was at L4-L5. The L4-L5 and L5-S1 are the two lowest levels in the lumber spine together with the attached disc, joints, nerves, and soft tissues. It provides a variety of functions including supporting the upper body and allowing motion in multiple directions. However, with their heavy load and range of flexibility, these segments are also prone to developing pain from injury or degenerative changes.

There was so much literature supporting to use of MIS-TLIF with less intraoperative blood loss, postoperative less pain with less complications rate.)[17, 18]. In contrast, patients who underwent MIS TLIF may have a quicker recovery and less blood loss due to minimal tissue injury. Clinically, we observed less intraoperative blood loss and hospital stay in MIS-TLIF when compared with the PLIF group.

The most common complications in both groups are neurological injury, dural tear, surgical infection, cerebral fluid leakage, and muscle weakness. In the comparison of both, the PLIF had more complications than the MIS-TLIF. The intraoperative and postoperative for our studied patients were in MIS-TLIF one was cerebral fluid leakage, one was surgical infection and in PLIF 1 was cerebral fluid leakage, two were surgical infection and one was muscle weakness. Mehta et al. found that neurological injury was higher with PLIF than with TLIF 7.8% and 2% resp.)[23]. Dural tear or cerebral fluid leakage is a common complication whether during PLIF, open TLIF, or minimally invasive TLIF, which varies from 2% to 14%) [24]. As for surgical infection, it is reported in 0% to 9% of patients[25]. Lastly, we found that more subjects and longer follow-ups would be better for dealing with degenerative disc diseases.

V. Conclusion

The few parameters that were found to be statistically different between the two groups but MIS-TLIF has better clinical outcomes i.e. less blood loss, less tissue injury, quick rehabilitation, fast improvement of back pain, and shorter hospital stay. However, less complication in the MIS-TLIF group. Besides that, the preoperative and post-operative ODI, VAS, and SF-36 had no statistical differences at all. We suggest any surgical technique to the other, better outcomes can be achieved with certain patient selection and the experience of the surgeon.

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