Comparison of outcomes between Oblique Lumbar Interbody Fusion and MED-Assisted Minimally Invasive Transforaminal Lumbar Interbody Fusion in single-level lumbar spondylosis

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Abstract

Background: For Lumbar degenerative spondylolisthesis, lumbar fusion surgery is usually one of the treatment options after conservative treatment has failed. This retrospective study compared the recent clinical efficacy of Oblique Lumbar interbody Fusion (OLIF) and Microendoscopic Discectomy combine Minimally Invasive Transforaminal Lumbar Interbody Fusion (MED-assisted MIS-TLIF) in the treatment of lumbar single-level spondylolisthesis.

Methods: A total of 55 patients with degenerative lumbar spondylolisthesis who underwent OLIF or MED-assisted MIS-TLIF between February 2019 and February 2021 were enrolled. Operating time, intra-operative bleeding and post-operative drainage were recorded to evaluate the intraoperative performance. The oswestry disability index (ODI) and visual analog scale (VAS) for back and leg pain were used to evaluate the clinical outcomes. Lumbar lordosis (LL), fused segmental lordosis (FSL) and disc height (DH) were measured preoperatively, three days postoperatively, 3 months and 12 months postoperatively. Fusion status (FS) and cage subsidence (CS) were assessed at final follow-up postoperatively. Results were analyzed statistically.

Results: In this study, patients were divided into the OLIF group (35 cases) and the MIS-TLIF group (20 cases). No statistically significant difference in preoperative indicators between groups. Intraoperative performance of the OLIF group was better than that of the MIS-TLIF group. At the immediate postoperative, the VAS was 3.54±1.12 in the OLIF group and 4.25±1.02 in the MIS-TLIF group(P=0.024). There was no significant difference in the VAS and ODI score at subsequent follow-up. Comparison of radiographic indicators showed that there was a significant difference in the DH between groups at post-operative and final follow-up(12.11±1.83 mm vs 11.04±1.26 mm, P = 0.024; 11.98±1.81 mm vs 10.88±1.27 mm, P =0.011). At the last follow-up, the fusion rate and CS in the OLIF group and the MIS-TLIF group was not statistically significant (91.43% vs 75%, P=0.206; 8.57% vs 15%, P=0.775).

Conclusion: OLIF has advantages in terms of intraoperative performance and postoperative recovery. In terms of clinical presentation, both two groups have excellent short-term outcomes for patients with lumbar spondylolisthesis. Further follow up is required for long term outcome.

Introduction

Lumbar degenerative spondylolisthesis (LDS) is a common spinal disease in which the lumbar vertebra slides forward relative to the inferior vertebrae. The main clinical symptoms include lower back pain, radiating pain in the lower limbs, neurogenic intermittent claudication and bladder and bowel incontinence.[1] Operative indications for lumbar spondylolisthesis are severe neurological deficit or intractable radiating pain not responding to conservative treatment. The primary surgical objective are decompression and long-term stability in the main segments. Lumbar fusion is typically the most effective treatment in this type of surgery.[2] The good efficacy of open surgery has been proven, but intra- and post-operative complications have led doctors to prefer a more minimally invasive procedure, which can allow patients to exercise earlier and achieve similar outcomes in clinical and imaging aspects compared to traditional open procedures.[3]

Since the first report of OLIF surgery for degenerative lumbar spine disease, this procedure has become increasingly popular because of its excellent clinical outcomes and imaging results.[4–9] The MIS-TLIF can reduce tissue damage, decrease blood loss, reduce postoperative pain, shorten hospital stays, speed up recovery and have similar clinical outcomes to TLIF [10–13]. The microendoscopic discectomy (MED) allows for minimally invasive endoscopic decompression of the lumbar nerve roots, but may not be used alone to treat patients with spondylolisthesis.[14, 15] Wu, H. et al.[16] reported the use of MED-assisted MIS-TLIF for the treatment of multilevel degenerative lumbar spinal stenosis with spondylolisthesis and both have achieved satisfactory clinical results postoperatively.

Although all of the above treatment modalities have achieved excellent clinical results. However, there are no reports comparing clinical outcomes and radiographic indicators between OLIF and MED-assisted MIS-TLIF. The purpose of this study was to compare the recent clinical efficacy of OLIF and MED-assisted MIS-TLIF in the treatment of single-level spondylolisthesis.

Materials And Methods

Inclusion and exclusion criteria

The inclusion criteria were: patients with: (1) Lower back pain and/or radiation pain of lower limbs with neurogenic intermittent claudication and/or severe neurological deficit; (2) Single-level grade 1 or 2 lumbar spondylolisthesis; (3) Patients with ineffective conservative treatment for 6 months. The exclusion criteria were: patients with (1) Scoliosis; (2) cauda equina syndrome; (3) Severe osteoporosis; (4) Trauma, Infection, tumor or revision surgery.

Patient Information

Between February 2019 and February 2021, a total of 55 patients with single-level lumbar spondylolisthesis underwent surgery in the Department of orthopedics of Shanxi Provincial People's hospital were enrolled. 35 patients were received OLIF with Lateral screws and 20 patients were treated with MIS-TLIF with MED assistance. Patients’ characteristics and personal data, including age, sex and body mass index (BMI) are shown in Table 1. All procedures in both groups were performed by a single surgeon. Our hospital ethics committee approved the retrospective study.

Operative Technique

single-level OLIF with Lateral screws

After general anesthesia, the patient was placed on their right side and the operating bed was adjusted to make the lumbar like bridge which can fully expose the target segment. The target intervertebral disc was located and marked on the skin via a C-arm. A 4 to 6 cm skin incision was made on the marked disc level at the left abdomen. Then carry out blunt dissection of the abdominal oblique muscles according to the directions of the fibers, which includes the external oblique, internal oblique, and transversalis abdominis muscles. The retroperitoneal space between the abdominal aorta and the psoas major muscle was performed by blunt dissection. Abdominal organs,

vascular sheath, ureter, peritoneal membrane, and other tissues are mobilized anteriorly. Psoas major muscle reclined posteriorly. It provided an oblique surgical pathway to expose the lateral circumference of the intervertebral disc and anterior longitudinal ligament. Then, inserted a Kirschner wire into the middle of the disc space confirm the surgical level by C-arm X-rays and placed Sequential dilators over the Kirschner wire

step by step to establish working tunnel. After the disc was removed and endplates were prepared, the suitable cage is clearly and safely inserted in the optimal position. The cage size that was larger than pre-operative disc height was chosen to assure increasing the height of the disc space and the foramen. Lateral screws were placed on the lateral side of the vertebral body to make the screws pass through the contralateral cortex as far as possible. Then, the abdominal wall muscles and the incision were closed layer by layer after a drainage tube was placed (Fig. 1).

single-level MED-assisted MIS-TLIF

After general anesthesia, the patient was positioned prone on the operating table. With the help of the C-arm, located the spinous process, marked it on the skin, and drew two paramedian lines about 1–2 cm outside the lateral edge of the pedicle. The paramedian skin marks are incised with a scalpel through the dermis, subcutaneous tissue, and fascia. Using blunt dissection with fingers, the planes are split further until touches the transverse process facet junction. Under the guidance of C-arm, inserted Kirschner wire through the incision to the superior vertebral level. The left side is about 9 o’clock position of the pedicle and the right side is about 3 o’clock position of the pedicle. Then push each needle advanced about 2cm and be careful not to exceed the medial boundary of the pedicle projection. On the lateral fluoroscopy, the needles usually lie in the posterior third of the vertebral body. Then, taken out the trocar from the Kirschner wire and insert the guide wire. After fixing the guide wire, take out the Kirschner wire and place the sequential expander step by step until the working tube is placed in the intervertebral facet joint complex. After fluoroscopy, pedicle screws were placed. Removed the lower articular process and part of the upper articular process. The proximal incision of the affected side or the side with severe symptoms was selected as the decompression channel, and MED cold light source and camera were placed. The nerve root and dural sac were stripped to expose the intervertebral disc. After cutting the fibrous ring, the intervertebral disc was removed with intervertebral brace and scraper. The cartilage end plate was scraped with end plate scraper and placed into intervertebral fusion cage. Place the pre bending rod and fix it under pressure. Wash the incision, stop bleeding and place the drainage tube (Fig. 2).

Clinical dates

All clinical outcomes such as operation time, intraoperative bleeding loss and postoperative drainage were evaluated by experienced clinicians. The VAS and ODI were assessed preoperatively, at 3 months and 12 months postoperatively. The ODI index was not assessed three days after surgery because the patient remained bedridden for most of the time.

Visual Analog Scale

The VAS is commonly used in the assessment of patient lower back pain and leg pain, which is widely used in clinical practice. The VAS is easy, objective and sensitive for patient assessment. On a scale 10 cm long, with a score of 0 indicates no pain and 10 represents the most severe pain, which is unbearable. 0–2 is excellent, 3–5 is good, 6–8 is acceptable and > 8 is poor.

Oswestry Disability Index

ODI[17] is a specific index used to evaluate the impact of lower back and leg pain on patients' daily activities. The system was evaluated from 10 aspects: pain intensity, self-care ability of daily life, lifting, walking, sitting, standing, sleeping, sexual life, social activities and traveling. Each evaluation score is 0–5 and calculated as (total score/50 *100%), with higher scores indicating poorer function.

Radiographic Evaluation

All radiograph parameters were measured independently by two spine surgeons, and the average value was taken after two consecutive measurements. Radiographs of the patients were taken preoperatively, 3 days after surgery, at 3 months and 12 months postoperatively. LL refers to the angle between the upper endplate of L1 and S1 vertebral body on the lateral of lumbar spine X-ray (Fig. 3). FSL was defined as the angle between the upper endplate of the upper vertebral body and the lower endplate of the lower vertebral body at the fusion segment on the lateral lumbar radiograph (Fig. 3). DH refers to the average of the height of the anterior and posterior margins of the upper to lower endplate (Fig. 3). FS was defined as the vertebral endplates and cage have continuous trabecular formation without gaps in the sagittal or coronal plane on radiographs[18]. CS was identified by damage to the bony endplates visualized on x-ray or CT. We assessed CS and FS at the final follow-up.

Statistical analysis.

All statistical parameters analyses were carried out using the Statistical Package for SPSS 25.0 statistical software. For continuous variables, Student’s t test was used for normal distribution. For categorical variables, the fisher exact probability test and Mann-Whitney test was applied as appropriate. All quantitative variables were expressed as mean standard deviation, and qualitative variables were expressed as quantities and ratios. $P < 0.05$, the difference was statistically significant.

Results

From February 2019 and February 2021, a total of 35 patients that underwent OLIF and 20 patients that received MIS-TLIF were selected to enroll in this study. All patients received adequate preoperative preparation and post-operative management. The mean follow-up time was 14±1.85 and 13.3±1.49 months for the OLIF and MIS-TLIF groups, respectively. No statistically significant differences in the basic characteristics of the two groups. (Tab 1)

Clinical Standardized Outcomes

As shown in Table 1, the operative duration was shorter, intraoperative hemorrhage and postoperative drainage were less in the OLIF group compared with the MIS-TLIF group(130.57±29.52 min vs 188.25±19.55 min; 102.86±27.07 ml vs 152.25±17.74 ml; 38.86±25.67 ml vs 79.5±13.28 ml; respectively, both P < 0.05). In addition, the OLIF group had a shorter hospital stay compared to the TLIF group(17.6±2.84 vs 20.15±4.44, P < 0.05).

Table 1

Basic information and clinical data

	OLIF	MIS-TLIF	P
Number of patients	35	20	
Age (Mean ± SD, years)	66.57±8.47	63.45±6.83	0.166
Sex (Female: Male)	23:12	13:7	0.957
BMI(Kg/m^2)	25.88±3.03	25.67±2.87	0.801
Operation time (mins)	130.57±29.52	188.25±19.55	<0.001
Blood loss (mL)	102.86±27.07	152.25±17.74	<0.001
postoperative drainage	38.86±25.67	79.5±13.28	<0.001
Day of hospital (d)	17.6±2.84	20.15±4.44	0.012

OLIF: oblique lateral interbody fusion; MIS-TLIF: minimally invasive transforaminal lumbar interbody fusion; BMI: body mass index; SD: standard deviation; P < 0.05, statistical significance.

No statistically significant difference in preoperative VAS and ODI scores between the two groups. (8.37±0.91, 30.77±3.07 vs 8.3±0.92, 29.9±3.09, respectively, both P<0.05). Immediate postoperative VAS was superior to MI-TLIF in the OLIF group and was statistically significant. (3.54±1.12 vs 4.25±1.02, P=0.024). There was no statistically significant difference in VAS and ODI between the two groups at each subsequent follow-up. There was no statistically significant difference in the degree of improvement in DOI between the two groups at the last follow-up.(Tab 2 ,5)(Fig 4)

Table 2

clinical outcome

	Pre	Post	Post-3m	F-F/U	Z	P
VAS						
OLIF	8.37±0.91	3.54±1.12	2.66±0.94	1.91±0.70	100.353	<0.001
MIS-TLIF	8.30±0.92	4.25±1.02	2.70±0.85	1.95±0.60	64.757	<0.001
t	0.279	-0.324	-0.365	-0.191		
p	0.782	0.024	0.716	0.850		
ODI						
OLIF	61.54±6.14		25.48±3.34	21.83±3.54	76.848	<0.001
MIS-TLIF	61.10±6.79		26.80±4.32	22.80±4.56	42.941	<0.001
t	0.248		-1.260	-0.880		
p	0.805		0.213	0.383		

VAS: visual analog scale; ODI: oswestry disability index; OLIF: oblique lateral interbody fusion; MIS-TLIF: minimally invasive transforaminal lumbar interbody fusion; Pre: Pre-operative; Post: post-operative (3 days after surgery); Post-3m: 3 months after surgery; F-F/U: Final follow-up; t: Student's t test; Z: Z Test; P<0.05,statistical significance.

Radiographic and Fusion Outcomes

There were no statistically significant differences in LL, FSL, and DH between the two groups preoperatively. The LL in the OLIF group and MIS-TLIF group increased from 45.71°±9.01° and 44.85°±9.67° preoperatively to 50.91°±8.52° and 46.25°±8.80° postoperatively, respectively(P=0.740, 0.059). There was a statistically significant difference in the immediate postoperative changes in LL between the OLIF group and MIS-TLIF group(5.2°±2.41° VS 1.4°±6.06°, P=0.013). LL decreased in both the OLIF and MIS-TLIF groups at the last follow-up (50.03°±8.10° VS 45.95°±8.57°, P=0.084). Statistically significant difference in the degree of improvement at the final follow-up compared to the preoperative period (4.31°±3.41° vs 1.1°±6.07°, P=0.038). The FSL in the OLIF group and MIS-TLIF group increased from 18.77°±4.99° and 19.50°±3.71° preoperatively to 22.11°±5.02° and 22.20°±3.90° postoperatively(P=0.572, 0.948). The difference in the immediate postoperative change in FSL between the two groups was statistically significant(3.34°±1.06° vs 2.70°±1.03°, P=0.033). FSL also decreased in

both the OLIF and MIS-TLIF groups at the last follow-up (22.03°±4.97° vs 21.30°±3.06°, P=0.555). Statistically significant difference in the degree of improvement at the final follow-up compared to the preoperative period(3.26±°±2.66° vs 1.80°±2.29°, P=0.045).There was a significant increase in DH in both groups postoperatively. The OLIF group increased by 3.7±1.67mm from 8.41±1.44mm to 12.11±1.83mm postoperatively and the TLIF group increased by 2.51±1.14mm from 8.53±0.98 to 11.04±1.26 postoperatively. The difference between the increased values in the two groups was statistically significant. DH at final follow-up was 11.98±1.81mm and 10.88±1.27mm in the OLIF and MIS-TLIF groups respectively(P=0.011) Statistically significant difference in the degree of improvement at the final follow-up compared to the preoperative period(3.57±1.71mm vs 2.35±1.11, P=0.002)(Tab 3,5)(Fig 5).

Table 3

Radiographic indicators

	Pre	Post	F-F/U	F	P
DH					
OLIF	8.41±1.44	12.11±1.83	11.98±1.81	53.288	<0.001
MIS-TLIF	8.53±0.98	11.04±1.26	10.88±1.27	28.495	<0.001
t	-0.331	2.318	2.630		
p	0.742	0.024	0.011		
LL					
OLIF	45.71±9.01	50.91±8.52	50.03±8.10	3.704	0.028
MIS-TLIF	44.85±9.67	46.25±8.80	45.95±8.57	0.133	0.875
t	0.333	1.930	1.759		
p	0.740	0.059	0.084		
FSL					
OLIF	18.77±4.99	22.11±5.02	22.03±4.97	5.099	0.008
MIS-TLIF	19.50±3.71	22.20±3.90	21.30±3.06	2.958	0.060
t	-0.569	-0.066	0.593		
p	0.572	0.948	0.555		

DH: disc height; LL: lumbar lordosis; FSL: fused segmental lordosis; OLIF: oblique lateral interbody fusion; MIS-TLIF: minimally invasive transforaminal lumbar interbody fusion; Pre: Pre-operative; Post: post-operative(3 days after surgery); F-F/U: Final follow-up; t: Student's t test; F: F-test; P<0.05,statistical significance.

Both groups had excellent fusion rates, 32 out of 35 OLIF patients and 13 out of 20 MIS-TLIF patients had solid fusion at final follow-up(P=0.037). At the last follow-up, there were 4 cases of CS in the OLIF group and 2 cases in the TLIF group(P=1.000) (Tab 5).

Table 4

Other indicators

	OLIF	MIS-TLIF	P
cage subsidence(F-F/U)			
yes	3	3	0.775
no	32	17	
Fusion status(F-F/U)			
Solid	32	15	0.206
Incomplete	3	5	
Complication			
	4	2	1.000

OLIF: oblique lateral interbody fusion; MIS-TLIF: minimally invasive transforaminal lumbar interbody fusion; F-F/U: Final follow-up; P<0.05,statistical significance.

Table 5

Degree of improvement

	OLIF	MIS-TLIF	P
F-F/U DOI change	39.71±7.11	38.30±9.52	0.534
Post LL change	5.2±2.41	1.4±6.06	0.013
F-F/U LL change	4.31±3.41	1.1±6.07	0.038
Post FSL change	3.34±1.06	2.70±1.03	0.033
F-F/U FSL change	3.26±2.66	1.80±2.29	0.045
Post DH change	3.7±1.67	2.51±1.14	0.003
F-F/U DH change	3.57±1.71	2.35±1.11	0.002

OLIF: oblique lateral interbody fusion; MIS-TLIF: minimally invasive transforaminal lumbar interbody fusion; DOI: oswestry disability index; DH: disc height; LL: lumbar lordosis; FSL: fused segmental lordosis; Post: post-operative(3 days after surgery); F-F/U: Final follow-up; P<0.05,statistical significance.

Discussion

Lumbar spondylolisthesis is a degenerative change of the lumbar spine with typical clinical manifestations. For patients who have not succeeded in conservative treatment, lumbar fusion surgery is one of the treatment options available. Lumbar fusion procedures, including anterior lumbar interbody fusion (ALIF), posterior lumbar interbody fusion (PLIF) and direct lateral interbody fusion (DLIF), all have their own unique advantages and inevitable risks.[19] It is important that each patient's anatomy, age, expectations, concerns and the experience of the surgeon are factored into the decision-making process to determine the best strategy for the individual patient to maximize recovery while minimizing the risk of complications.[20] In the OLIF procedure, the posterior column structure is preserved, the imbalance between the coronal and sagittal planes is corrected and excellent clinical results have also been demonstrated.[21, 22] Furthermore, the efficacy of MIS-TLIF has been proven and is a better choice for patients.[23–26]

In our present retrospective study, we first compared some intraoperative and postoperative data between the two groups. The OLIF group outperformed the MIS-TLIF group in terms of operative time, intraoperative bleeding and postoperative drainage(Table 1). The OLIF procedure reduces operative time and intraoperative injury by bluntly separating the natural corridor from the artery to the psoas major muscle to access the intervertebral space, rather than successive dilatation of the paravertebral muscle and subtotal joint resection as in MIS-TLIF.[24] Furthermore, the indirect decompression of OLIF reduces the time spent using intraoperative neuromonitoring.[27] Although these indicators may related to operator technique and individual anatomical differences, we prefer to believe that OLIF has better perioperative results. Surely, the steep learning curve of MIS-TLIF is also a relevant factor.[28] Only single-segment fusion was studied in the current study, we theoretically believe that OLIF has an advantage when performing multi-stage fusion, which can be done via a single channel.[29] Additionally, there was a significant difference in VAS between the two groups at three days postoperatively, which may be due to the fact that OLIF has no effect on the paravertebral muscles. Neither ODI nor VAS were significantly different at subsequent follow-up. The availability of MED for nerve root decompression under direct vision and the higher intervertebral space recovery in the OLIF group both contributed to the improvement of the patient's symptoms. The MED-assisted MIS-TLIF maximizes anatomical preservation, allows for the re-treatment of the nucleus pulposus under direct vision, preserves the ligamentum flavum, and allows for the placement of screws under MED access with minimal trauma and rapid recovery and guaranteed clinical efficacy.

Changes in the physiological curvature of the spine and loss of DH have both been found to contribute to lower back pain in patients and it is clinically important to study their changes. In our current retrospective study, there was a statistically significant increase in imaging parameters in both groups compared to the preoperative period and the degree of improvement was statistically significant at each subsequent follow-up. (Table 4,6). The OLIF procedure improves the patient's symptoms by increasing the disc height through the placement of a larger cage, lengthening the hypertrophic ligamentum flavum and achieving indirect nerve decompression.[30] The larger DH improvement in the OLIF group was attributed to the lateral surgical access allowing for the placement of a larger cage, which was not possible in the MIS-TLIF group due to tissue obstruction and channel limitations. This is consistent with previous reports[31]. The Ko, M. J. [32] study showed that placement in the strongest position at the front of the endplate helped restore lumbar lordosis. The MIS-TLIF group in the study did not have a significant effect on the recovery of sagittal angulation and the relevant factors, in addition to the size and position of the cage, the fusion of a single segment may have prevented it from performing excellently.[33]

The incidence of CS and fusion are related to factors such as damage to the endplate, material of the cage, and bone quality. Higher magnitudes of CS were associated with worse surgical improvements. [34] Hence, CS should be considered an early postoperative complication, so delicate and gentle intraoperative manipulation, long-term postoperative intervention is necessary. In our study, neither postoperative CS nor fusion rates were statistically significant at the final follow-up between the two groups($P = 0.775$, 0.206), but were both better than in previous studies.[35] Such a result may be associated with our better intraoperative protection of the bony endplate, the addition of additional screw fixation and shorter duration of follow-up. Biomechanics shows that the stress load on the fixator in OLIF is less than that of the MIS-TLIF group, which is more advantageous in terms of postoperative CS and fusion rates.[36, 37] One study divided the vertebral body into five zones from anterior to posterior. When the larger Cage is placed in the more rigid Zone II, the cage spanning the entire width of the vertebral body reduces the stress distribution in the vertebral endplate and cancellous bone, and also increases the maximum stress load. This facilitates improved fusion rates and resistance to subsidence.[38] This has contributed to the better performance of OLIF, whereas MIS-TLIF cage are mostly placed near the center of the vertebral endplate.[39, 40] Therefore, we have reason to believe that the advantages of OLIF will become increasingly apparent after a long follow-up period.

Different surgical approaches can lead to different complications. The OLIF creating access through the natural gap between the psoas major muscle and the abdominal vessels, avoiding the need to expose dura and thereby reduce the chances of dural injury[28]. The MIS-TLIF in our study is based on the MED by creating a working channel through the Wiltse approach to reach the surgical area, requiring only partial removal of the articular processes and the vertebral plates, avoiding unnecessary damage to the multifidus muscle, major vessels like aorta and better maintaining spinal stability[41].

In our present retrospective study, three patients in the OLIF group suffered from numbness of the thighs and weakness of the psoas major muscle after surgery all of which resolved at follow-up, another patient presented with ureteral injury. These are related to the anatomy of the body. The psoas major muscle mainly originates from the diaphragmatic fascia and the front of the transverse processes, vertebrae and discs of the L1-L5 lumbar vertebrae, ends at the lesser trochanter of the femur and the fascia of the pelvic floor. We consider that excessive contraction of the psoas major may lead to postoperative numbness in the groin, anterior thighs or weakness of the psoas major. When we choose an inappropriate surgical incision, the surgical access is too vertical and the duration of the operation is too long it may cause symptoms of weakness of the psoas major.[42] The ureter is located retroperitoneally and passes anteriorly down into the pelvis through the medial aspect of the psoas major muscle. Complete retrieval of the retroperitoneal adipose tissue before initiating disc removal can avoid urinary tract injury. The ureter should be repaired immediately after the diagnosis is clear.[43] A life-threatening complication of OLIF is the intraoperative rupture of a large vessel, the incidence of which has been reported to be 0.3%-2.4%.[21] However, this did not occur intraoperatively, which was related to precise preoperative planning, and we performed a preoperative CTA of the abdomen in each patient to exclude individual anatomical variation. In the MIS-TLIF group, A patient with a postoperative cerebrospinal fluid leak due to a ruptured dural sac was lying flat and resting for three days before no more cerebrospinal fluid was seen in the drainage bag and the dizziness subsided. Another patient presented with a hematoma. Postoperative nerve root symptoms and rupture of the dural sac are difficult to avoid. MIS-TLIF is a direct decompression of the nerve roots, and our posterior access to the disc necessarily affects the paravertebral tissues and requires partial resection of the intervertebral joints.

This study is also limited in that it is a non-randomized, retrospective single-center study. This study only included single-level lumbar fusion. Clinical outcomes, radiological results and complications may differ when multi-segment procedures are performed. In addition, this study also had limitations, with only a short follow-up period. Longer-term follow-up and more high-quality randomized controlled trials are needed to confirm the results of the current study.

Conclusion

OLIF and MED-assisted MIS-TLIF are excellent treatment modalities for single-segment lumbar spondylolisthesis. There was no significant difference between the two groups in terms of pain relief and improved postoperative function. However, the OLIF group was superior to the MIS-TLIF group in terms of intraoperative performance, postoperative recovery and imaging changes.

Abbreviations

OLIF: Oblique Lumbar interbody Fusion; MED: Microendoscopic Discectomy; MIS-TLIF: Minimally Invasive Transforaminal Lumbar Interbody Fusion; BMI: body mass index; SD: standard deviation; VAS: visual analog scale; ODI: oswestry disability index; DH: disc height; LL: lumbar lordosis; FSL: fused segmental lordosis; Pre: Pre-operative; Post: post-operative (3 days after surgery); Post-3m: 3 months after surgery; F-F/U: Final follow-up; t: Student's t test; Z: Z Test.

Declarations

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Not applicable.

Authors’ contributions

JPW analyzed the data and wrote the initial draft. FC, GG, PZ, TZ performed the surgery, designed the study protocol, revised the draft. YZG, ZGZ, CY measured the radiographic parameters. YH and YLX carried out the statistical analysis of the data. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study protocol was approved by the institutional review board at Shanxi Provincial People's Hospital, Taiyuan, Shanxi, People’s Republic of China (2022ky107).

Consent for publication

Written informed consent for publication was obtained from each participant.

Competing interests

The authors declare that they have no competing interests.

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Figures

Figure 1

A patient was diagnosed with degenerative spondylolisthesis and lumbar spinal stenosis, as shown on lumbar spine antero-posterior lateral view(A), lumbar lateral view(B), and T2-weighted MR image(C). He underwent oblique lumbar interbody fusion (OLIF) with lumbar antero-posterior view(D) and lumbar spine lateral view images(E) taken immediately after the surgery. Follow-up images (F,G,H) were taken at the last follow-up.

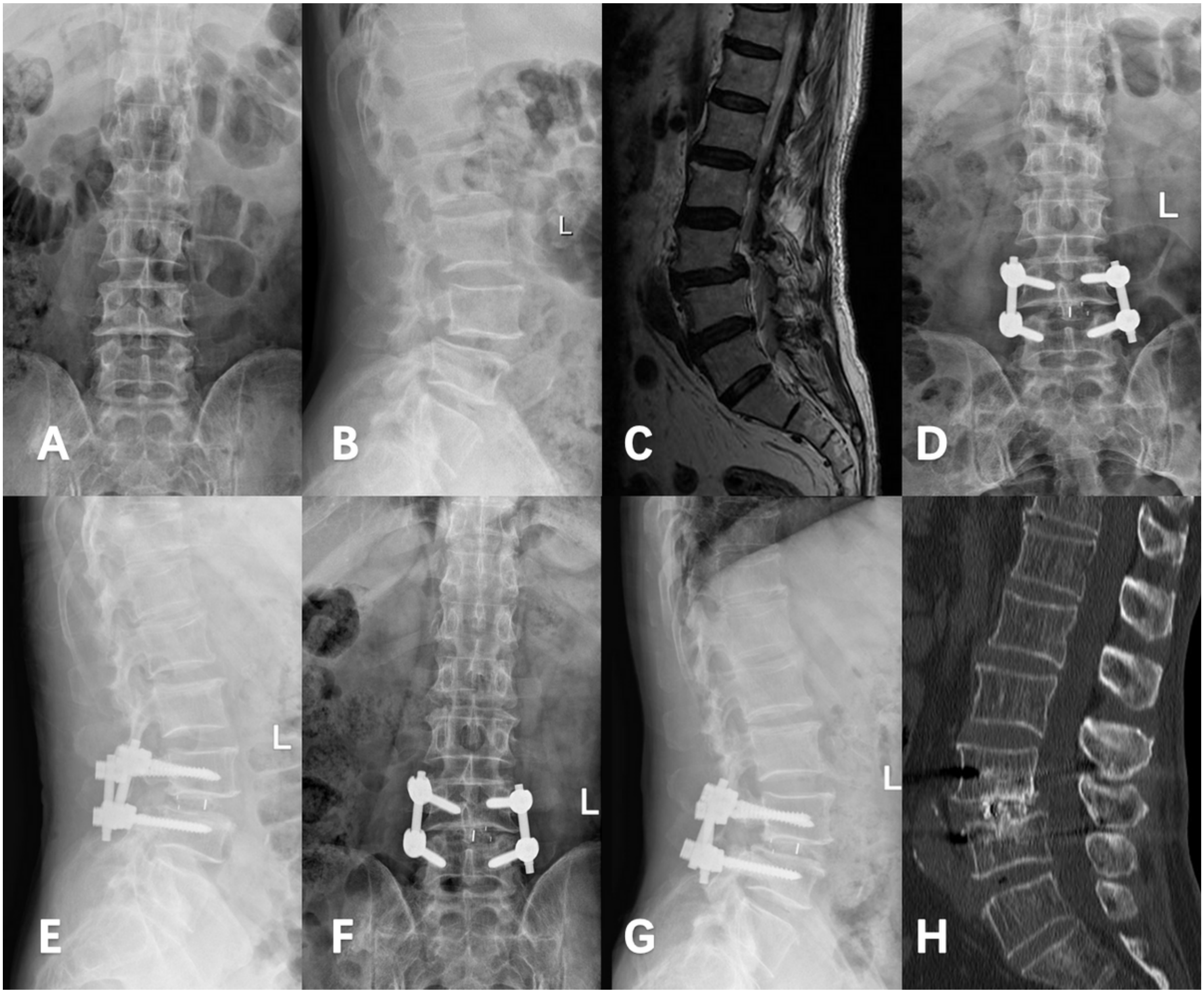

Figure 2

A patient was diagnosed preoperatively with degenerative spondylolisthesis and lumbar spinal stenosis at L3-4 level, and underwent MED-assisted minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF). Radiographic images (A,B) and MRI (C) were taken preoperatively. The immediate post-operative lumbar spine antero-posterior view (D) and lumbar lateral view (E) are shown. Follow-up images (F,G,H) were taken at the last follow-up.

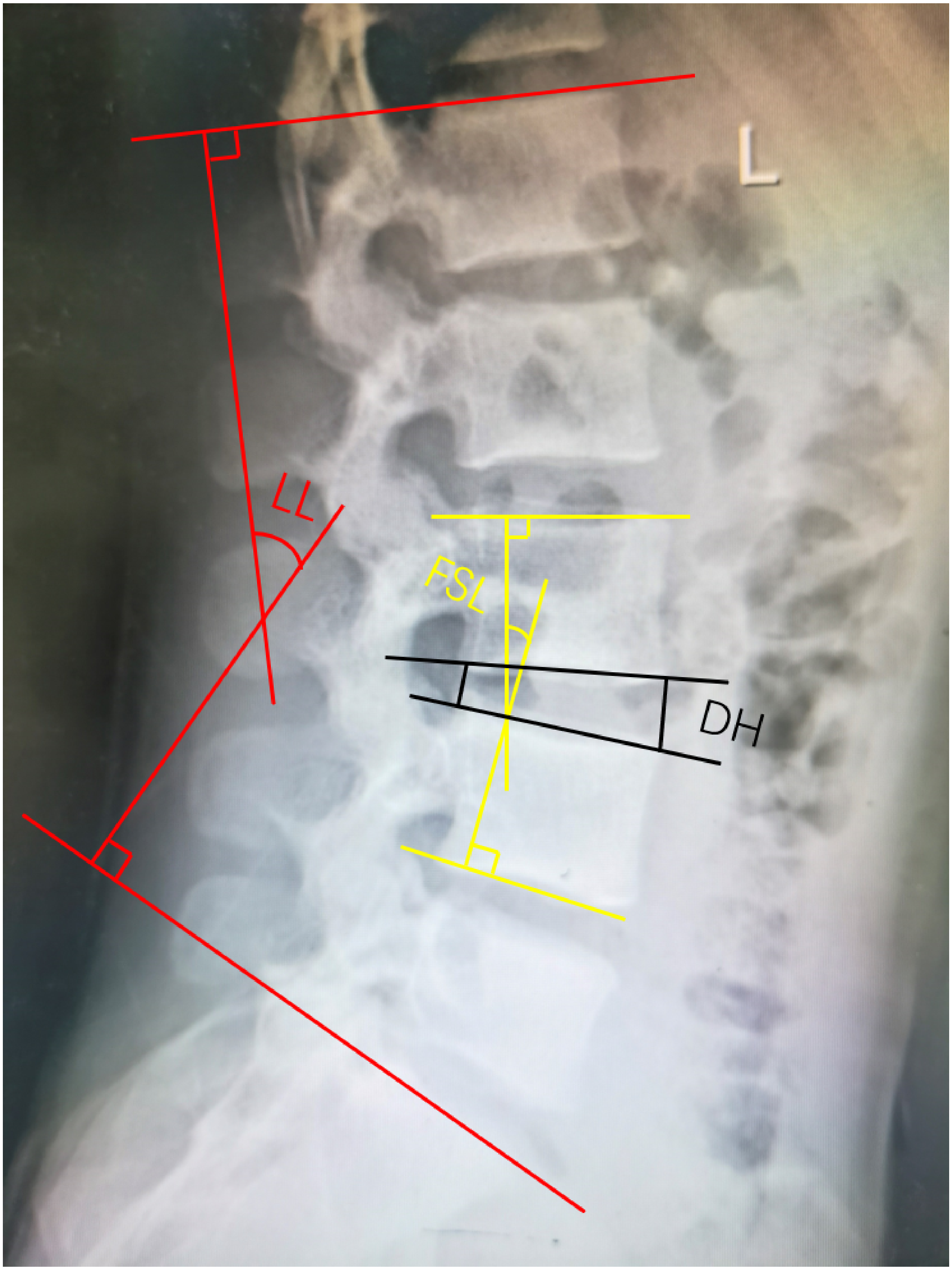

Figure 3

The lumbar spine lateral view image of a patient without any underlying disease was used to demonstrate how lumbar lordosis, fused segmental lordosis and disc height were measured. Lumbar lordosis(LL) refers to the angle between the upper endplate of L1 and S1 vertebral body. Fused segmental lordosis(FSL) is defined as the angle between the upper endplate of the upper vertebral body and the lower endplate of the lower vertebral body at the fusion segment. Disc height(DH) refers to the average of the height of the anterior and posterior margins of the upper to lower endplate.

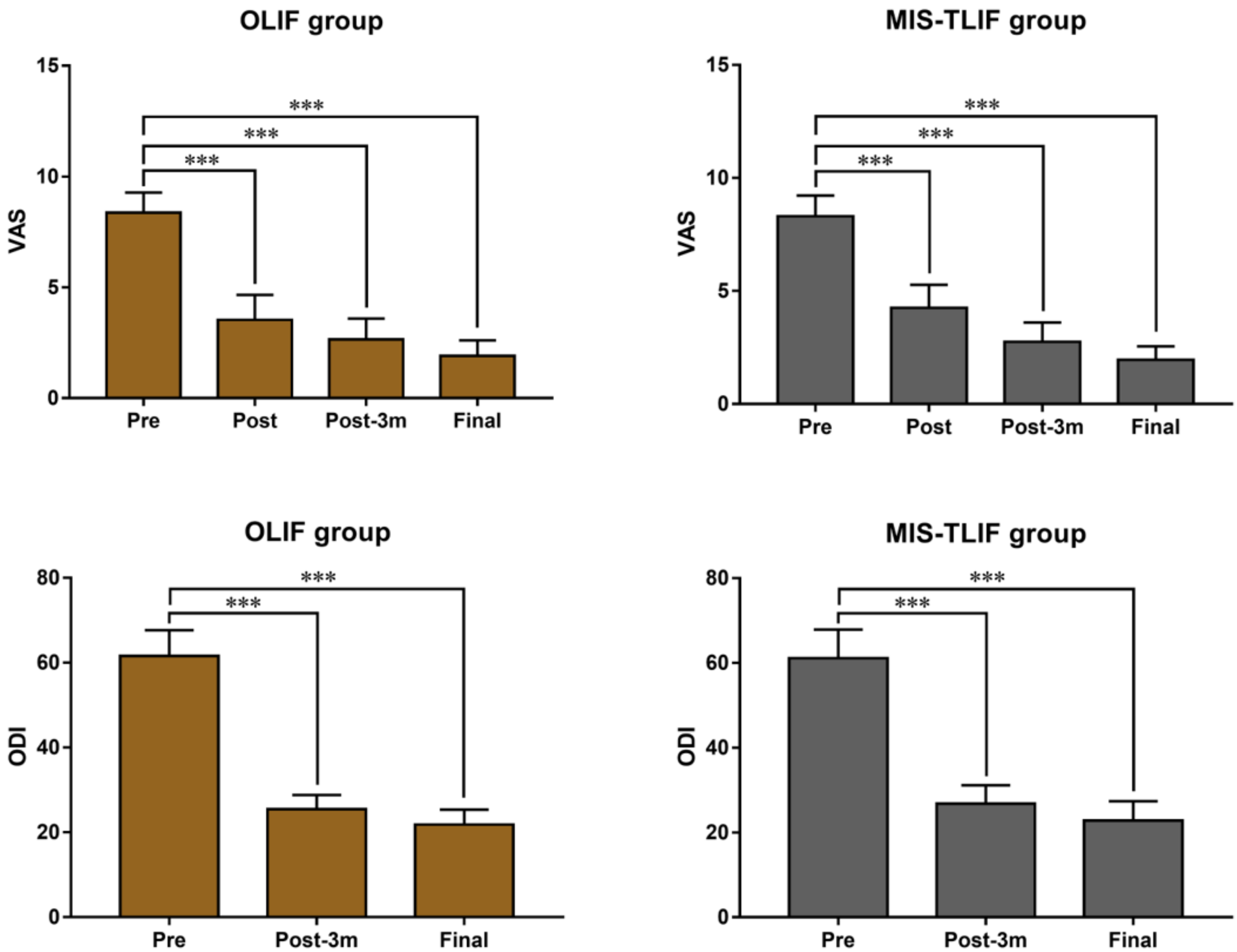

Figure 4

OLIF: Oblique Lumbar Interbody Fusion; MIS-TLIF: Minimally Invasive Transforaminal Lumbar Interbody Fusion; VAS: visual analog scale; ODI: oswestry disability index; Pre: Pre-operative; Post: post-operative (3 days after surgery); Post-3m: 3 months after surgery; Final: Final follow-up; ***: P<0.001

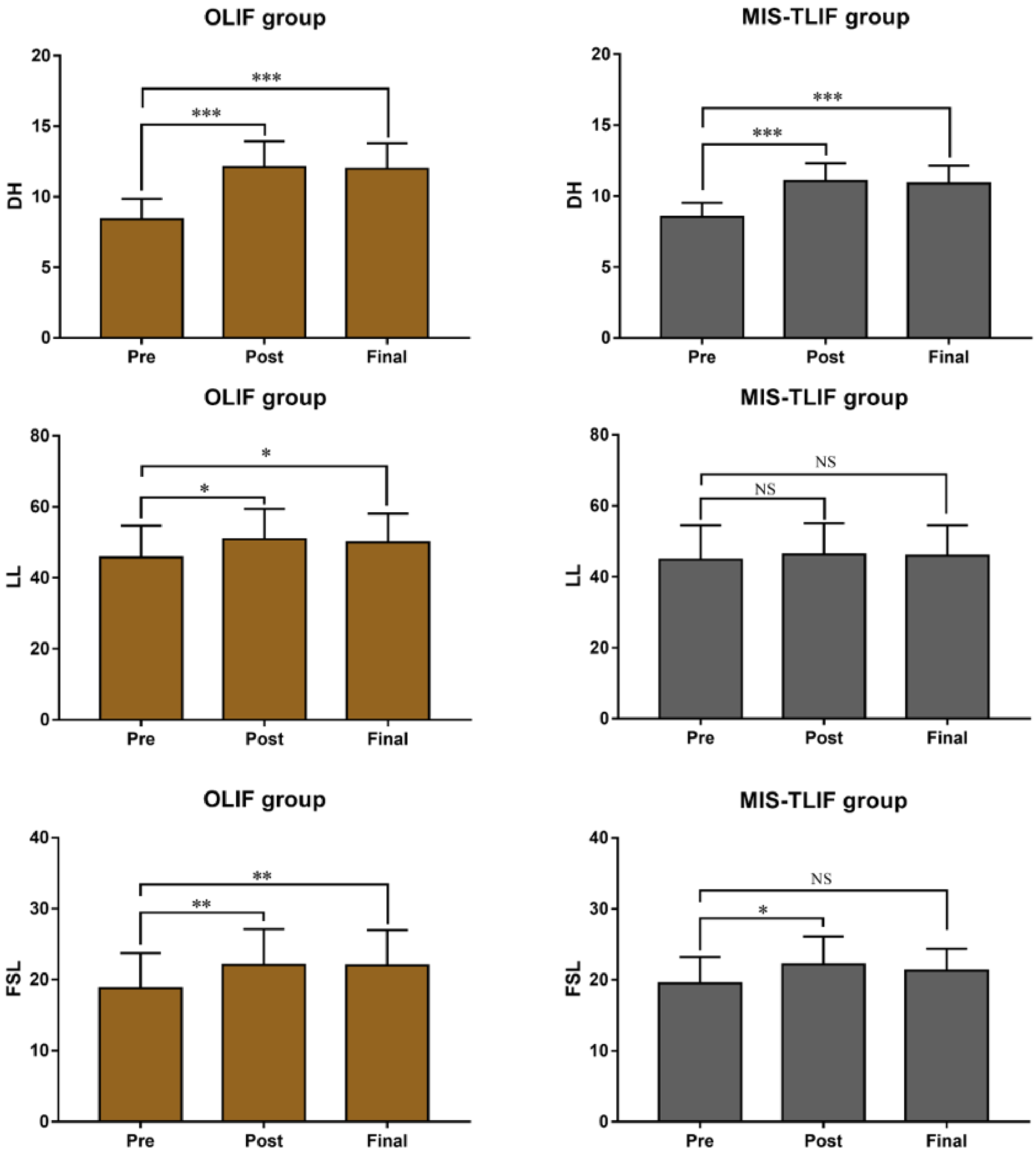

Figure 5

OLIF: Oblique Lumbar Interbody Fusion; MIS-TLIF: Minimally Invasive Transforaminal Lumbar Interbody Fusion; LL: lumbar lordosis; FSL: fused segmental lordosis; DH: disc height; Pre: Pre-operative; Post: post-operative (3 days after surgery); Final: Final follow-up; ***: P<0.001; **: P<0.01; *: P<0.05; NS: not significant.