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ORIGINAL RESEARCH

Comparison of Percutaneous Transforaminal Endoscopic Surgery (PTES) With MIS-TLIF for Treating Lumbar Degenerative Disease in Obese Patients

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Purpose: The purpose of this study is to compare clinical outcomes of obese patients with lumbar degenerative disease (LDD) receiving either percutaneous transforaminal endoscopic surgery (PTES) or minimally invasive surgery-transforaminal lumbar interbody fusion (MIS-TLIF).

Methods: There were 26 patients underwent PTES, and 29 patients were treated with MIS-TLIF between June 2014 and June 2019. Various factors were compared between the two groups, including operation time, blood loss, incision length, fluoroscopy frequency, and hospital stay. Visual analog scale (VAS) pain scores, Oswestry disability index (ODI), and complications were also recorded.

Results: Patients in PTES group showed significantly shorter operation time (54±10min vs 103±18min, P<0.001), lower blood loss (5/2-15mL vs 60/40-100mL, P<0.001), shorter incision length (9±2mm vs 41±3mm, P<0.001), reduced fluoroscopy frequency (5/5-10 times vs 7/6-11 times, P<0.001) and shorter hospital stay (3/2-4 days vs 6/4-8 days, P<0.001) than MIS-TLIF group. No differences in leg VAS scores were found between the two groups. However, PTES group showed significantly lower back VAS scores during follow-ups (P<0.001). At 2-year follow-up, PTES group also had significantly lower ODI scores compared to MIS-TLIF group (12.0 ±3.6% vs 15.8±4.9%, *P*<0.01).

Conclusion: PTES and MIS-TLIF showed favorable clinical outcomes for LDD in obese patients. Compared with MIS-TLIF, PTES has advantages of less trauma and faster recovery, and can be conducted under local anesthesia.

Keywords: lumbar degenerative disease, PTES, MIS-TLIF, obesity, minimally invasive surgery

Introduction

Lumbar degenerative disease (LDD) is the most common cause of lower back and leg pain, significantly impacting patients' quality of life. Transforaminal endoscopic discectomy has emerged as a viable surgical treatment option for LDD.[1] This minimally invasive technique allows surgeons to access the epidural space through the intervertebral foramen, offering several advantages such as local anesthesia, minimal soft tissue trauma, dorsal musculature preservation, reduced perioperative morbidity, accelerated rehabilitation, and earlier return to work.[2] Our specific technique, percutaneous transforaminal endoscopic surgery (PTES), simplifies the orientation and puncture process, reducing procedural steps and minimizing fluoroscopic X-ray exposure. It has been shown to be safe and efficient in the treatment of various types of LDD.[3–8]

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Obesity has emerged as a major public health concern, with its prevalence nearly tripling worldwide in recent decades. Approximately 13% of the adult population is now considered obese.[9] Obesity is an independent risk factor for LDD, as the increased pressure can compromise the integrity of intervertebral discs.[10] Furthermore, obesity poses additional challenges during surgical procedures and increases the risk of complications.[11,12] However, there is a lack of follow-up studies investigating the outcomes of transforaminal endoscopic discectomy in obese patients. Additionally, there is limited research comparing the effects of transforaminal endoscopic discectomy with minimally invasive surgery-transforaminal lumbar interbody fusion (MIS-TLIF) for obese patients undergoing surgical treatment for LDD. Hence, this study aimed to compare the clinical outcomes of obese patients who underwent either PTES or MIS-TLIF.

Methods

Patient Selection

A retrospective analysis was conducted by reviewing the medical records of obese patients diagnosed with lumbar degenerative disease (LDD) who underwent either PTES or MIS-TLIF procedures between June 2014 and June 2019.

The inclusion criteria for this study were as follows: (1) patients experiencing unilateral or bilateral leg pain, or intermittent claudication as neurologic symptoms; (2) MRI and CT scans indicating single-level lumbar degeneration, including lumbar disc herniation, lateral recess stenosis, intervertebral foramen stenosis, or central spinal stenosis from L1 to S1, consistent with the corresponding neurologic compression observed clinically (Figures 1a, b, 2a and b); (3) BMI≥28; (4) a minimum follow-up period of 2 years. Patients with lumbar instability, spinal deformity, or prior lumbar surgery were excluded.

Surgical Procedures

Group: PTES

Anesthesia involved the infiltration of 1% lidocaine locally, supplemented with conscious sedation. Patients were in a prone position (Figure 1c). The puncture aiming target was determined by the intersection of the midline and the horizontal line of the operation segment. The puncture entrance at "Gu's point"[3–8] was located at the corner of the flat

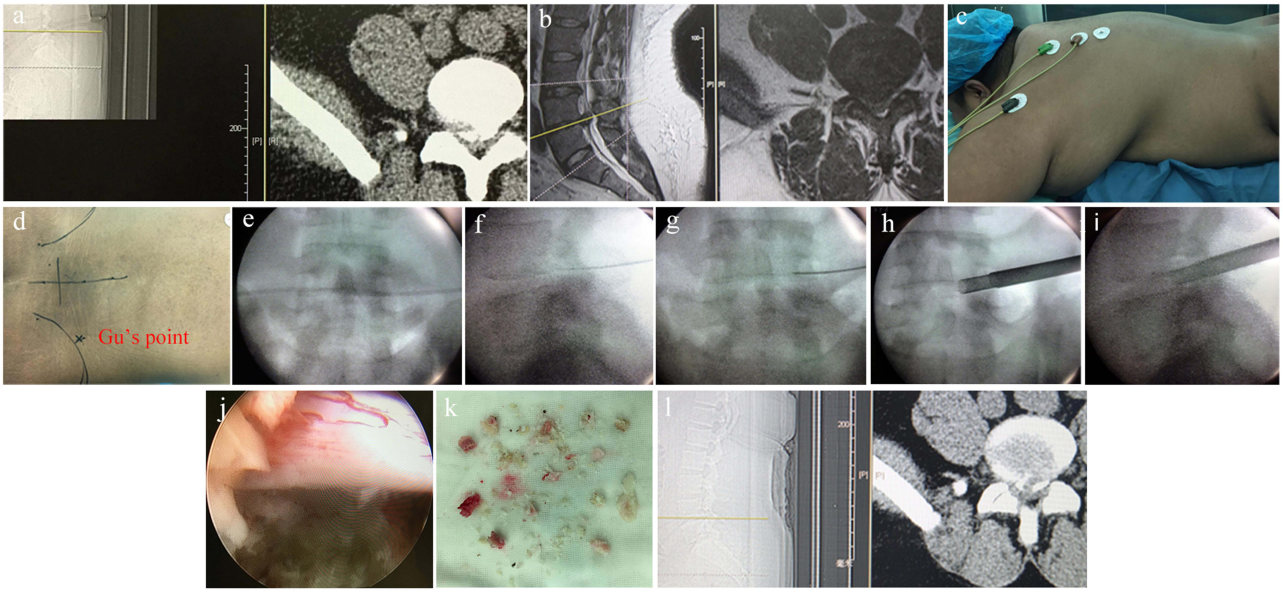

Figure 1 Preoperative CT (**a**) and MRI (**b**) showed L4/5 LDD of a 37-year male patient with BMI=41. He had a right leg pain. The patient was placed in prone position for PTES (**c**), and the puncture entrance was located at the corner of the flat back turning to the lateral side, named "Gu's point" (**d**) after the intervertebral space of L4/5 was confirmed in the posteroanterior fluoroscopic view (**e**). The perpendicular line passing through the intersection of the midline and the horizontal line of operation segment is the puncture aiming target. After successful puncture, the tip of needle was near the posterior wall of intervertebral space on the lateral view (**f**), and near the lateral border of pedicle on the posteroanterior view (**g**). In press-down enlargement of foramen until resistance disappeared, the tip of trephine was beyond the medial border of pedicle on the posteroanterior view (**h**) and close to the posterior wall of disc in the spinal canal on the lateral view (**i**). The nerve root was decompressed under the endoscopy (**j**) after the ligamentum flavum and calcified protruding nucleus pulposus were removed (**k**). L4/5 was observed by the postoperative CT (**l**).

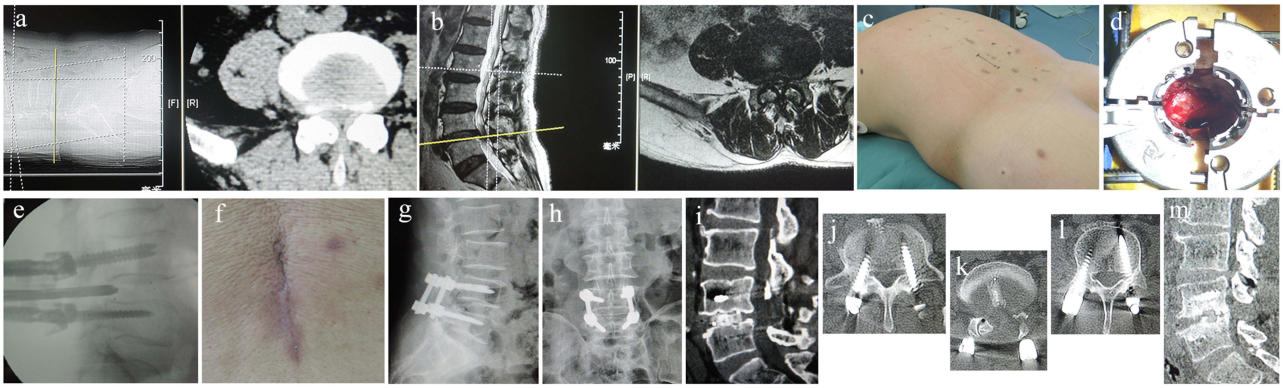

Figure 2 Preoperative CT (**a**) and MRI (**b**) showed L4/5 LDD of a 35-year male patient with BMI=38. He had a left leg pain. The patient was in prone position for MIS-TLIF, and the location of involved lumbar segment was marked in the skin (**c**). An expandable retractor was placed to perform the hemilaminectomy and facetectomy for neurologic decompression and insert the cage into disc space after the pedicle screws were introduced (**d**). Fluoroscopic image was taken to confirm the position of cage (**e**). The picture showed the incision after MIS-TLIF (**f**). Postoperative X-ray (**g** and **h**) and CT (**i–l**) showed good position of implants. Grade I fusion was confirmed by sagittal CT at 2-year follow-up (**m**).

back turning to the lateral side (Figure 1d and e). Successful puncture was confirmed by positioning the needle tip within the disc or near the posterior wall of the intervertebral space in the lateral view, and near the lateral border of the pedicle in the posteroanterior view (Figure 1f and g). Soft tissue was dilated gradually along the guidewire, and an 8.8-mm protective cannula was inserted following the guiding rod. When the cannula positioned against the articular process, it was pressed down to reduce its angle to the horizontal plane. Subsequently, a 7.5-mm trephine was used to remove the ventral bone of the articular process, enlarging the foramen. This technique is known as "press-down enlargement of foramen".[3–8] Finally, the tip of trephine was beyond the medial border of pedicle on the posteroanterior view, and close to the posterior wall of disc in the spinal canal on the lateral view (Figure 1h and i). In cases with calcification, the trephine was further pressed down to directly remove the calcification until the tip extended beyond the midpoint between the medial border of the pedicle and the spinous process and crossed the posterior wall of the disc. Bilateral neurologic decompression was achieved by exposing both the ipsilateral and contralateral traversing nerve roots, along with the enlargement of the central spinal canal (Figure 1j and k).[7,8]

Patients were advised to rest in bed for 3 days. Functional exercise was initiated on the third day. They were able to resume work after 1 week. It was recommended to wear a flexible brace for a duration of 2 weeks.

Group: MIS-TLIF

Patient was positioned prone under general anesthesia (Figure 2c). After localization, facet joints and transverse processes of the upper and lower vertebrae were exposed through paraspinal muscle-splitting approaches. Pedicle screws were placed at the junction between the lateral facet wall and the middle transverse process. An expandable tubular retractor was inserted after sequential dilation (Figure 2d). Subsequently, the dura and involved nerve root were exposed by unilateral complete facetectomy and hemilaminectomy, and the disc and cartilaginous endplate were cleared. Autologous bone was sufficiently packed in the intervertebral space and a cage filled with autograft bone was inserted obliquely (Figure 2e). Finally, fixed two rods onto the pedicle screws and closed the incision (Figure 2f).

The drainage tube could be removed once the volume <20mL per day. Patients were encouraged to mobilized after the tube removed. An external brace was recommended to ware for 3 months.

Outcome Assessment

Clinical outcomes: 1) Operation time, blood loss, intraoperative fluoroscopy frequency, incision length, and hospital stay; 2) VAS was used to assess low back and leg pain before and immediately, 1, 2, 3, 6, 12, 24-month post-surgery; 3) Oswestry disability index (ODI) was recorded before and 24-month post-surgery; 4) Related complications were recorded during the follow-up, including nerve injury, infection, thrombosis and recurrence.

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Imaging examination: All patients underwent evaluations using X-ray, CT and MRI. X-ray images were obtained to detect lumbar instability, scoliosis, or a high iliac crest. CT and MRI images were used to determine the specific segment involved and assess lumbar degeneration associated with conditions such as disc herniation, stenosis, and the presence of calcification.

Statistical Analysis

The statistical analysis was conducted using SPSS 25 software (SPSS Inc., Chicago, IL, USA). Age, BMI, operation time, blood loss, incision length, fluoroscopy frequency, hospital stay, follow-up period, VAS, and ODI were compared by *t*-test. Gender, herniation segment, and rates of calcification or high iliac crest were compared by *Chi-square test. P<0.05* was considered a significant difference.

Results

PTES group consisted of 26 patients, while MIS-TLIF group included 29 patients. The two groups did not show any significant differences in age, gender, BMI, and lumbar level. There were seven patients with herniation calcified, two with high iliac crest (L5/S1) in PTES group and eight with herniation calcified, one with high iliac crest (L5/S1) in MIS-TLIF group. In comparison to MIS-TLIF group, PTES group exhibited significantly shorter operation time, lower blood loss, shorter incision length, reduced fluoroscopy frequency, and shorter hospital stay (detailed data summarized in Table 1). The suction tube was removed 4(3–6) days after surgery in MIS-TLIF group.

The back pain VAS scores experienced a significant decrease from 6 (4–10) to 0 (0–1) immediately after surgery in PTES group, while the scores in MIS-TLIF group only decreased to 3 (2–5) after surgery, and decreased to 1 (0–2) at 1-month. Regarding leg pain VAS scores, both groups exhibited a significant decrease from 8 (7–10) to 1 (0–3) immediately after surgery, which was maintained at 1 (0–2) during the follow-up period. No differences in leg VAS scores were found between the two groups. However, in terms of back VAS scores, PTES group showed significantly lower scores compared to MIS-TILF group after surgery (Tables 2 and 3). Furthermore, the ODI significantly decreased after surgery in both groups, from 67.2±9.2% to 12.0±3.6% in PTES group and from 68.1±9.3% to 15.8±4.9% in MIS-TLIF group. The ODI was significantly lower in PTES group compared to MIS-TLIF group (Table 4).

One patient in PTES group encountered herniation recurrence at the same level 5 years after surgery, and clinical symptoms were related to the recurrence of disc herniation, not the adjacent disc. This patient underwent PTES again and

Table 1 Comparison of Clinical Data Between Group PTES and MIS-TLIF

		Group 1	Group 2	P value
Age (years)		46±11	44±10	0.384
Gender	Female	11	12	0.994
	Male	15	17	
BMI		33±2	32±2	0.122
Level	L3-L4	5	5	0.953
	L4-L5	13	14	
	L5-S1	8	10	
Herniation calcified		7/19	8/21	0.956
High iliac crest		2/24	1/28	0.489
Operation time (min)		54±10	103±18	0.000
Blood loss (mL)		5/2-15	60/40-100	0.000
Incision length (mm)		9±2	41±3	0.000
Fluoroscopy (times)		5/5-10	7/6-11	0.000
Hospital stay (days)		3/2-4	6/4-8	0.000
Follow-up (months)		32±3	32±5	0.611

Table 2 VAS Pain Assessments of Back Between Two Groups

Group	Preoperative	Postoperative	1-Month	2-Month	3-Month	6-Month	1-Year	2-Year
1	6(4–10)	0(0–1)	0(0–1)	0(0–1)	0(0–1)	0(0–1)	0(0–1)	0(0–1)
2	6(4–10)	3(2–5)	1(0–2)	1(0–2)	1(0–2)	1(0–2)	1(0–2)	1(0–2)
P value	0.869	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3 VAS Pain Assessments of Legs Between Two Groups

Group	Preoperative	Postoperative	1-Month	2-Month	3-Month	6-Month	1-Year	2-Year
1	8(7–10)	1(0–3)	0(0–2)	0(0–2)	0(0–2)	0(0–2)	0(0–2)	0(0–2)
2	8(7–10)	1(0–3)	0(0–2)	0(0–2)	0(0–2)	0(0–2)	0(0–2)	0(0–2)
P value	0.983	0.865	0.404	0.260	0.368	0.368	0.368	0.368

Table 4 ODI of Two Groups (%)

Group	Preoperative	2-Year
1	67.2±9.2	12.0±3.6
2	68.1±9.3	15.8±4.9
P value	0.710	0.002

showed favorable prognosis. Two patients developed adjacent segment disease (ASD) 4 years in MIS-TLIF group and received PTES with good outcomes.

Discussion

In view of the growing pertinence of obesity and its related medical complications, it is important to ensure proper surgical management of obese patients. Two meta-analysis reported that MIS-TLIF and TLIF had equivalent efficacy in obese patients as evident by the improvement in VAS and ODI scores, while the blood loss, hospital stay and complication rate were lower in MIS-TLIF than in TLIF.[13,14] One recent study compared biportal endoscopic discectomy to tubular microscopic discectomy for treating single-level lumbar disc herniation in obese patients. Although outcomes of VAS, ODI and EuroQol-5D were comparable between the two surgical procedures, reoperation and complications were less prevalent in endoscopic group.[15] Endoscopic spine surgery is emerging as a less invasive way of performing lumbar decompressions than tubular MIS-TLIF.[16]

Transforaminal endoscopic discectomy is a prevalent minimally invasive technique, but longer operating path in obese patients and accompanied calcification make the surgery challenging.[17] Based on traditional transforaminal endoscopic surgery, we made improvements in this technique and firstly introduced PTES in 2017.[3] At present, there is a lack of assessment regarding the efficacy of PTES in treating LDD of obese patients. The results in this study showed that PTES had the comparable effects to MIS-TILF on neurologic decompression of leg pain relief in obese patients and there were no complications of wound infection, nerve injury, and instability, which confirmed that PTES was a safe, feasible and effective technique for treating LDD of obese patients.

There are two primary optimizations in our technique. The first one is the specific location of our entrance point, called "Gu's Point".[3–8] It is located at the corner where the flat back turns to the lateral side. This point is more medial compared to those used in other transforaminal endoscopic techniques.[18] It not only shortens the manipulation path, especially for obese patients; but also avoids blockage by the high iliac crest at L5/S1 level.[19,20] The second one is referred to as "press-down enlargement of foramen".[3–8] When the cannula is docked at the articular process, pressing it down to decrease the horizontal angle of the trephine allows for more effective removal of bone in the ventral part. This optimization enables the working channel to be inserted into the spinal canal, even when the puncture angle is as steep as 85° relative to the horizontal plane. These methods ensure the efficacy of PTES for obese patients.

In our study, no patients had lumbar instability and scoliosis, the back pain of patients might result from soft tissue and discogenic factor.[21] The results showed that PTES was more effective for low back pain improvement than MIS-TLIF. Notably, the soft tissue damage associated with PTES was smaller than that seen in MIS-TLIF.[22] There was no new intervertebral instability after PTES although the facet joint was involved in some cases. The paraspinal muscle-splitting approach in MIS-TLIF could protect the attachment of the muscle to bone, avoiding disruption of supraspinous and interspinous ligaments, and decreasing bleeding.[23] However, PTES had much less blood loss, shorter operation time and a smaller incision. And compared with MIS-TLIF under general anesthesia, the use of local anesthesia during PTES had no obvious effects on the body.[24] There was shorter hospital stay and faster recovery in PTES than those in MIS-TLIF. The patients could walk to toilet 1 day, begin functional exercise 3 days, and returned to work 1 week after PTES.

Our previous studies have highlighted the importance of postoperative care in achieving a low recurrence rate after PTES.[3,4,8] Patients should pay attention to the following: 1. Avoid frequent bending of the waist; 2. Refrain from heavy loading or lifting; 3. Do not maintaining the same posture for extended periods.[25] In this study, there was only one patient with herniation recurrence 5 years after PTES and two patients with occurrence of ASD 4 years after MIS-TLIF. Upon reviewing their postoperative history, it was found that they shared the same bad habits of long time sitting or standing with a stooped posture, such as playing card or fishing. This posture exerted high pressure on the lumbar disc, particularly the adjacent segment after MIS-TLIF. Due to stress concentration, it could lead to the rupture of the remaining nucleus pulposus or healthy disc.

There were still some limitations. This retrospective study was conducted in a single medical center. And included patients in each group was relatively small. A multicenter prospective cohort with more samples will be conducted in the future.

Conclusion

PTES and MIS-TLIF showed favorable clinical outcomes for LDD in obese patients. Compared with MIS-TLIF, PTES has advantages of less trauma and faster recovery, and can be conducted under local anesthesia.

Ethics Statement

This study was approved by the ethics committee of Zhongshan Hospital, Fudan University. Written informed consents to participate were obtained from all the patients. The study was performed in accordance with the guidelines of the Declaration of Helsinki.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no competing interest exists in this work.

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