Transfacet full-endoscopic posterior lumbar interbody fusion for lumbar degenerative diseases: Consecutive case series

Xu Shen
Zhongda Hospital Southeast University
Yu-cheng Gao
Zhongda Hospital Southeast University
Pei Zhang
Zhongda Hospital Southeast University
Wen-bin Xuan
Zhongda Hospital Southeast University
Peng Song
Zhongda Hospital Southeast University
Zeng-xin Gao (1447335764@qq.com)
Zhongda Hospital Southeast University

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Abstract

Objective

To introduce the operative technique for a transfacet full-endoscopic posterior lumbar interbody fusion (Endo-PLIF) and evaluate the clinical effect.

Methods

41 patients were treated with single-segment Endo-PLIF from July 2020 to July 2021. General demographic and perioperative data were recorded. VAS and ODI scores were evaluated at 1, 6,12 months postoperatively and the last follow-up. The radiological outcomes were based on the disk height (DH) at 3 months after operation.

Results

All cases were successfully completed surgery and followed for at least one year. The mean estimated blood loss was 81.53 ± 25.96 ml, operative time was 210.24 ± 37.06 minutes and postoperative hospitalization days were 4.71 ± 1.42 days, the VAS and ODI scores at each time point after surgery were significantly decreased in comparison with the preoperative scores($p < 0.05$). The DH was significantly heightened postoperatively compared to the preoperative images($p < 0.05$).

Conclusion

Transfacet Endo-PLIF is a minimally invasive, safe, and satisfactory surgery for lumbar degenerative diseases (LDD).

Introduction

Lumbar degenerative diseases (LDD) are common diseases, especially in the elderly population, which always cause low back or leg pain and intermittent claudication[1]. For patients in which conservative treatment is not effective, lumbar decompression or fusion procedure is commonly used to decompress the compression of the nerve roots or spinal canal and improve clinical symptoms[2; 3]. However, the traditional surgery always results in many complications, such as postoperative pain, infections, nerve injury, dural sac tears and destruction of the lumbodorsal muscular stabilizers[4–6].

With the evolution of endoscopic technology, the traditional surgery has been developing towards minimally invasive surgery[7]. Subsequently, according to different approach, some studies reported direct lateral interbody fusion (DLIF)[8; 9], anterior lumbar interbody fusion (ALIF)[10; 11], lateral lumbar interbody fusion (LLIF)[12] and oblique lateral lumbar interbody fusion (OLIF)[13; 14]. Full-endoscopic posterior lumbar interbody fusion (Endo-LIF) had become a wide procedure since endoscopic transforaminal decompression and interbody fusion was reported by Osman in 2012[15]. It was performed in cases of symptomatic LDD as an option for open surgery. The advantages of Endo-LIF were less paravertebral muscle injury, less perioperative blood loss, shorter hospitalization days and lower complications, while acquiring comparable long-term clinical outcomes and fusion rates compared to the traditional surgery[15–17].

To date, the transforaminal approach and the interlaminar approach are the two most common approaches used for access to the intervertebral space in Endo-LIF[18; 19]. In the present study, we performed transfacet Endo-PLIF as a modification to the standard Endo-PLIF for treating LDD and evaluated the radiographic and clinical outcomes.

Materials and methods

2.1. Demographic data

41 patients with an average age of 55.14 years who were performed transfacet Endo-PLIF surgery were involved in this study. The inclusion criteria: (1) a history of low back pain, leg pain or numbness; (2) single-segment lumbar disc herniation or lumbar spinal stenosis, with segmental instability, or lumbar spondylolisthesis (Meyerding grade I,); (3) failed at least 6 months conservative treatment. The criteria for exclusion: (1) more than one-level lumbar interbody fusions; (2) lumbar fractures, tumors or infections; (3) less than 12 months of the follow-up. The study was performed in compliance with ethical standards and was approved by the institutional review board of our hospital.

2.2. Surgical equipment and materials

ILessys Delta endoscopic system (Joimax, Germany), pedicle screw locking system (Beijing Fule, Beijing, China), PEEK cage (CAPSTONE Spinal, System, Sofamor Danek, USA), allogeneic bone (BIO-GENE, Beijing, China).

2.3. Surgical method (L4/L5 segment as an example)

2.3.1. Anesthesia and position

All operations were performed under general anesthesia and adopted Endo-PLIF through a transfacet approach. The patients were placed in the prone position and knees were slightly bent to expand the laminar space. The skin entry points were located at the pedicle of vertebral arch through fluoroscopic view (approximately 2–3 cm off midline). The 18G puncture needles were firmly inserted into the medial vertebral body. Then, four puncture needles were removed after guide wires were inserted through the cannula. (Fig. 1a, Fig. 2a).

2.3.2. Endoscopic decompression

Then extended the decompressive incision of approximately 2 cm, a guide rod was inserted and reached the medial aspect of articular process (AP). Sequential dilating catheters were inserted progressively with the help of guide pin and the primary cannula (diameter of 12 mm) was inserted towards the intervertebral space (Fig. 1b, Fig. 2b). The endoscope (Joimax TESSYS endoscopic system, Germany) was connected through the cannula and a continuous irrigation with saline was used to guarantee clear surgical field. The superior articular process (SAP) was exposed after the inferior articular process (IAP) was resected with a series of trephines or pliers under endoscopic visual guidance. Adequate space for the working cannula was created when the medial SAP and the lower edge of L4 lamina were resected. Then, the ligamentum flavum (LF) was exposed. After the LF were stripped, we could see the L5 nerve root and dural sac under endoscopic visualization (Fig. 2c). If necessary, we could perform contralateral decompression by the over-the-top technique[20].

2.3.3. Discectomy and endplate preparation

The surgeon could see the nerve root via the endoscopic visual field when the secondary protection cannula turned towards the vertebral canal. Sufficient decompression was performed with forceps until free pulsation of the L5 nerve root. Then, turned over the cannula so that the bevel was facing toward the opposite direction, which pulled the L5 nerve root out of the endoscopic visual field. We can see the intervertebral disc in the endoscopic visual field. Pituitary forceps and different models of reamers were used to perform the discectomy until anterior longitudinal ligament and scraped away the cartilaginous endplate (Fig. 1c, Fig. 2d).

2.3.4. Cage insertion and fusion

After preparing the fusion site, the local bone from the AP, lamina and allogeneic cancellous bone (BIO-GENE, Beijing, China) were inserted into the disc space through a funnel-shaped device. Then a suitable PEEK cage (CAPSTONE Spinal, System, Sofamor Danek, USA) filled with additional local bones and allogeneic bones was hammered into the disc space (Fig. 1d, e, Fig. 2e).

2.3.5. percutaneous pedicle screw fixation

Percutaneous pedicle screw fixation was conducted after removing the endoscopy and working tubes (Fig. 2f). Then tightened the screw-rod attachment. Last, the fascia and skin were sutured without drainage (Fig. 1f).

2.4. Clinical and radiological evaluated

The intraoperative blood loss, operative time and postoperative hospitalization days were recorded. The body temperature and C-reactive protein (CRP) were measured on postoperative day 3. The VAS for back or leg pain and ODI were recorded at 1, 6,12 months postoperatively and the last follow-up. Disc height (DH) was measured though X-ray at 3 months after surgery.

2.5. Statistical analysis

The data was statistically analyzed with the SPSS 18.0 (SPSS, Chicago, USA). All the quantitative data were reported as mean ± standard. Continuous variables were compared with the paired t test. A p value < 0.05 was considered statistical difference.

Results

3.1. Perioperative data

A total of 41 patients who underwent transfacet Endo-PLIF were analyzed. All patients were followed for average 18.31 ± 6.3 months (range 12–28 months). The average operation time was 210.24 ± 37.06 min, the estimated intraoperative blood loss was 81.53 ± 25.96 ml, the values of temperature were 37.5 ± 0.2℃, 37.3 ± 0.6℃, 36.9 ± 0.5℃ at 1, 2 and 3days postoperatively, the CRP was 15.9 ± 8.3 mg/L on postoperative day 3 and the postoperative hospitalization days were 4.71 ± 1.42 days. All patients were no transfusions and successfully got out of bed with the help of strong waist protector on 1 day after surgery. Demographic and perioperative data were presented in Table 1. The rear hip pain was observed in two patients and diminished within 5 days of surgery. A representative patient is shown in Fig. 3.

Table 1
The demographic and perioperative data.

PE-PLIF(n = 41)	
Age (years)	55.14 ± 10.51
Gender (Male/Female)	15/26
BMI (kg/m2)	23.91 ± 5.13
Diabetes(yes/no)	8/33
Segment(L4-5/L5-S1)	23/18
Operative times (min)	210.24 ± 37.06
intraoperative blood loss (ml)	81.53 ± 25.96
postoperative temperature	
1 day postoperatively (°C)	37.5 ± 0.2
2 days postoperatively (°C)	37.3 ± 0.6
3 days postoperatively (°C)	36.9 ± 0.5
Postoperative CRP (mg/L)	15.9 ± 8.3
Postoperative hospitalization (days)	4.71 ± 1.42

3.2. Clinical efficacy

The VAS score for back pain or leg pain and ODI score significantly descended in comparison with the preoperative scores at 1, 6,12 months after operation and at the last follow-up ($p < 0.05$, Fig. 4).

3.3. Radiographic outcomes

The DH significantly heighten in comparison with the preoperatively ($P < 0.05$, Fig. 5).

Discussion

With the development of enhanced recovery after surgery (ERAS), the surgical methods for LDD have evolved from open surgery to endoscopic surgery, which has become a trend. In 2012, the firstly Endoscopic transforaminal decompression and interbody fusion reported by Osman and acquired favorable clinical efficacy[15]. Subsequently, full-endoscopic lumbar interbody fusion (Endo-LIF) had been widely performed in spinal surgery.

The Endo-LIF could be commonly performed through a transforaminal, and a translaminar approach in most cases. The transforaminal approach was called percutaneous full-endoscopic transforaminal lumbar interbody fusion (Endo-TLIF), which was described as facet-sacrificing endoscopic fusion through Kambin's Triangle[21; 22]. The translaminar approach was called full-endoscopic posterior lumbar interbody fusion (Endo-PLIF), which was described as facet-preserving endoscopic fusion through interlaminar corridor[23]. He et al[18] described percutaneous endoscopic posterior lumbar

interbody fusion (PE-PLIF) though interlaminar approach and acquired the satisfactory clinical results. Yang et al[22] reported Endo-TLIF could acquire comparable treatment effects and less complication rates compared with traditional procedures. However, the learning curve of these procedures required optimal knowledge of endoscopic anatomy. It was well known that spinal surgeons were always confronted with the inability to identify anatomy under the endoscopic visual field.

In present study, we performed Endo-PLIF through transfacet approach, which took the articular process as a reference and resected the medial articular process to provide a working corridor that protected the nerve roots. Our approach was a modification to the standard Endo-PLIF, it had several core concepts. First, the approach of our technique was similar to PLIF but more outward and the learning curve was short. The working channel was inserted through the skin incision which implanted the pedicle screw and not required another incision. Second, the protection of nerve roots though bevel protection sleeve rotation under the endoscopic visual field. Third, the transfacet approach did not destroy the bone-muscle-ligament complex structure of the spine and minimized the influence on the postoperative stability[24].

In this study, the CRP and body temperature after surgery were approximatively normal, postoperative low back pain and leg pain were relieved significantly, which indicated transfacet Endo-PLIF was a less invasive surgery and would not increase iatrogenic inflammation in the immediate postoperative period[25]. The operative time gradually shorten (range 370min-150min, Fig. 6) as the number of transfacet Endo-PLIF cases increased and the improvement of surgical experience. The VAS for back pain was significantly decreased postoperatively. It was for that reason that we did not use the electrocautery knives and minimized damage to sacrospinal muscles, which significantly decreased iatrogenic back pain[26]. In addition, the VAS and ODI scores of patients significantly descended at the last follow-up period. This explained transfacet Endo-PLIF could achieve a satisfactory long-term clinical outcomes.

The present research has some shortages. First, this research was not compared with open traditional surgery. Second, this is a novel minimally invasive technique, the number of cases were small. Third, we did not evaluate intervertebral space bone fusion rates. Therefore, a prospective, randomized control trial with larger sample sizes should be analyzed in the future.

Conclusion

Transfacet Endo-PLIF maximizes the benefits of minimally invasive spinal surgery with improved postoperative clinical outcomes, it will be a good alternative treatment for LDD in the future.

Declarations

Compliance with ethical standards: Informed consent was obtained from all individual participants included in the study.

Conflict of interest: All authors declare that they have no conflicts of interest.

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Figures

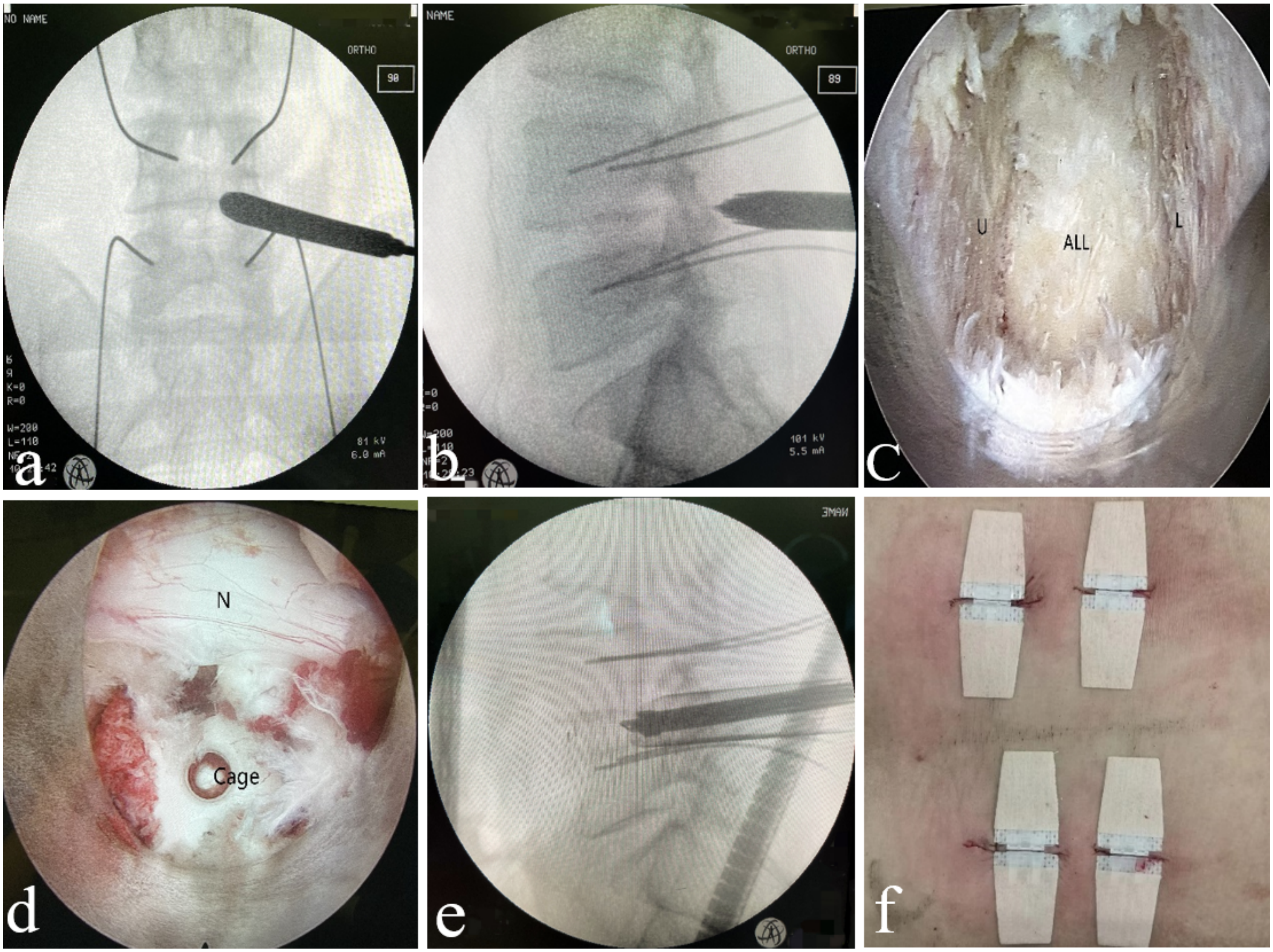

Figure 1

The anteroposterior and lateral radiograph (a, b) showed that the skin entry point was located at the pedicle of vertebral arch through fluoroscopic view. The anterior longitudinal ligament and endplate was visible when the intervertebral disc was removed (c). The nerve root and cage were checked before the endoscopy was withdrawn (d). The lateral (e) radiographs showed the position of the cage. The appearance of incisions (f). N: Nerve root. ALL: anterior longitudinal ligament U: upper endplate. L: lower endplate.

Figure 2

a: four guide wires fixed on surgical drape. b: sequential dilating catheters were inserted progressively and established the working channel. C: a series of endoscopic trephines stripped AP through primary tube. d: Endoscopic decompression and discectomy with the secondary protection cannula. e: bone graft with a funnel-shaped device. f: percutaneous pedicle screw fixation.

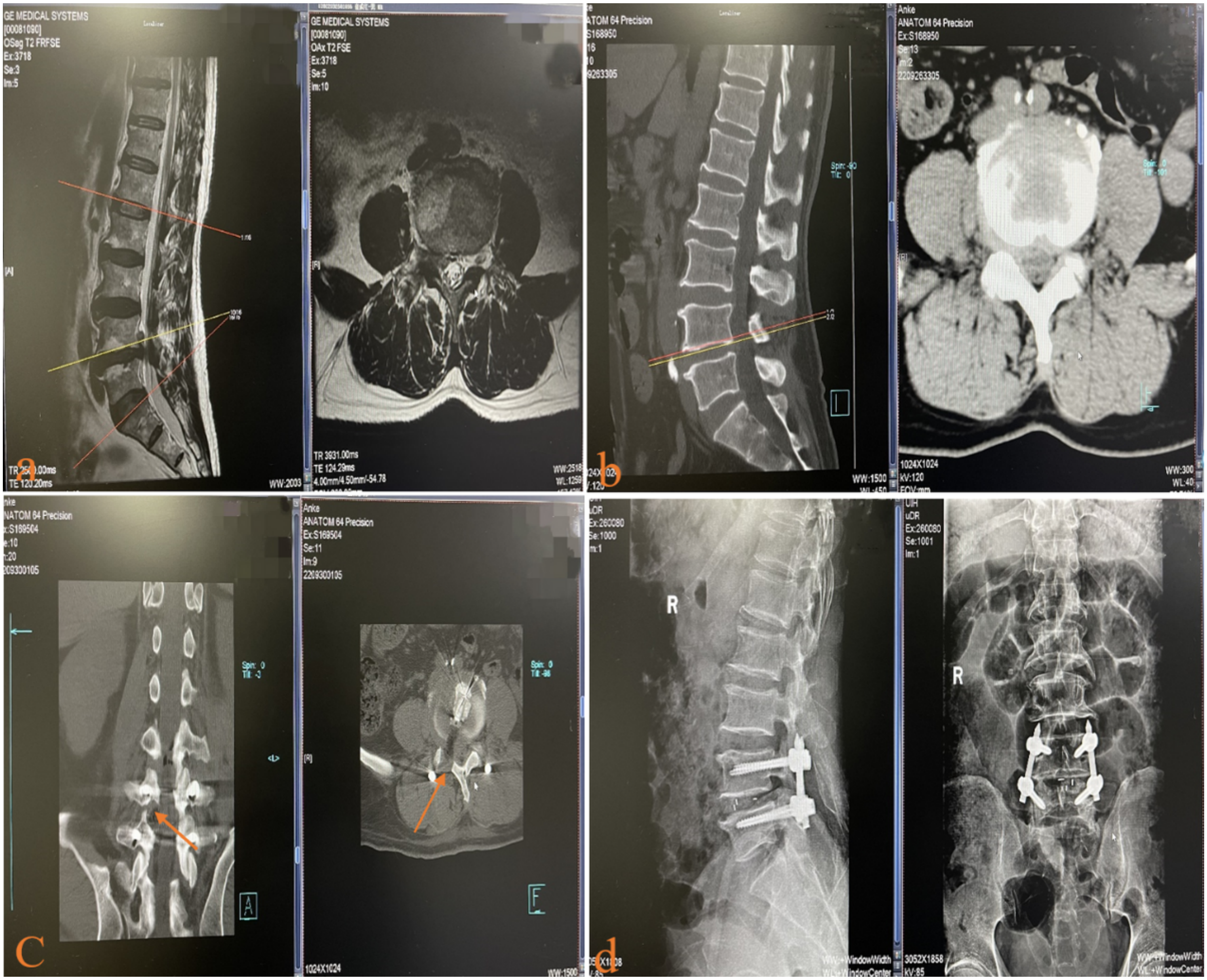

Figure 3

A 57-year-old male patient who had low back pain, right leg pain and numbness for 3 years. The preoperative sagittal MRI and CT (a, b) showed lumbar disc herniation with L4-5 vertebral endplate (Modic changes) infection. The postoperative CT reconstruction image (c) denoted partial AP were resected. The postoperative lateral and anteroposterior radiograph (d) showed a good implantation position. The red arrow denoted decompression through transfacet approach.

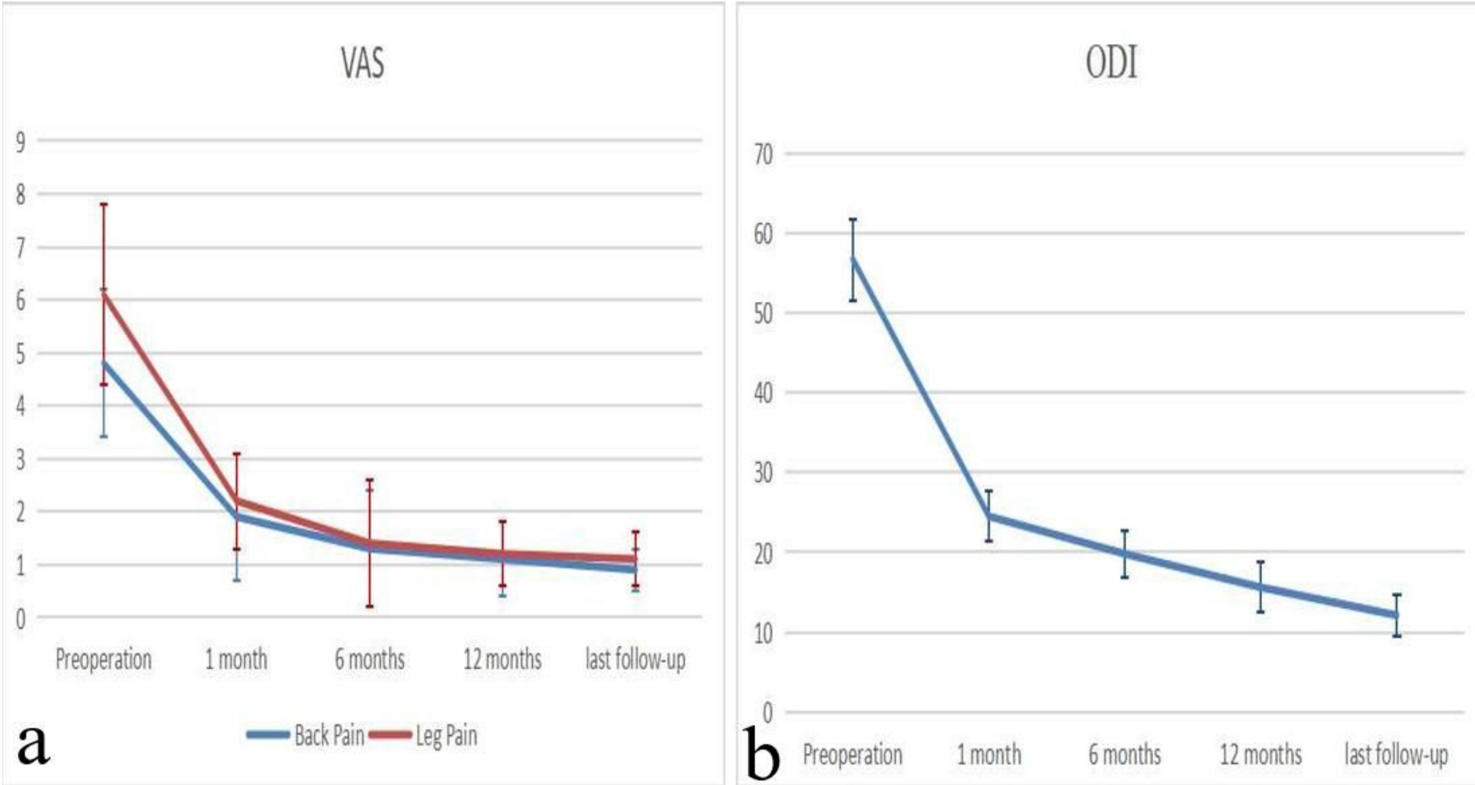

Figure 4

The VAS for back and leg pain (a), ODI score (b). VAS: visual analog scale; ODI: Oswestry Disability Index.

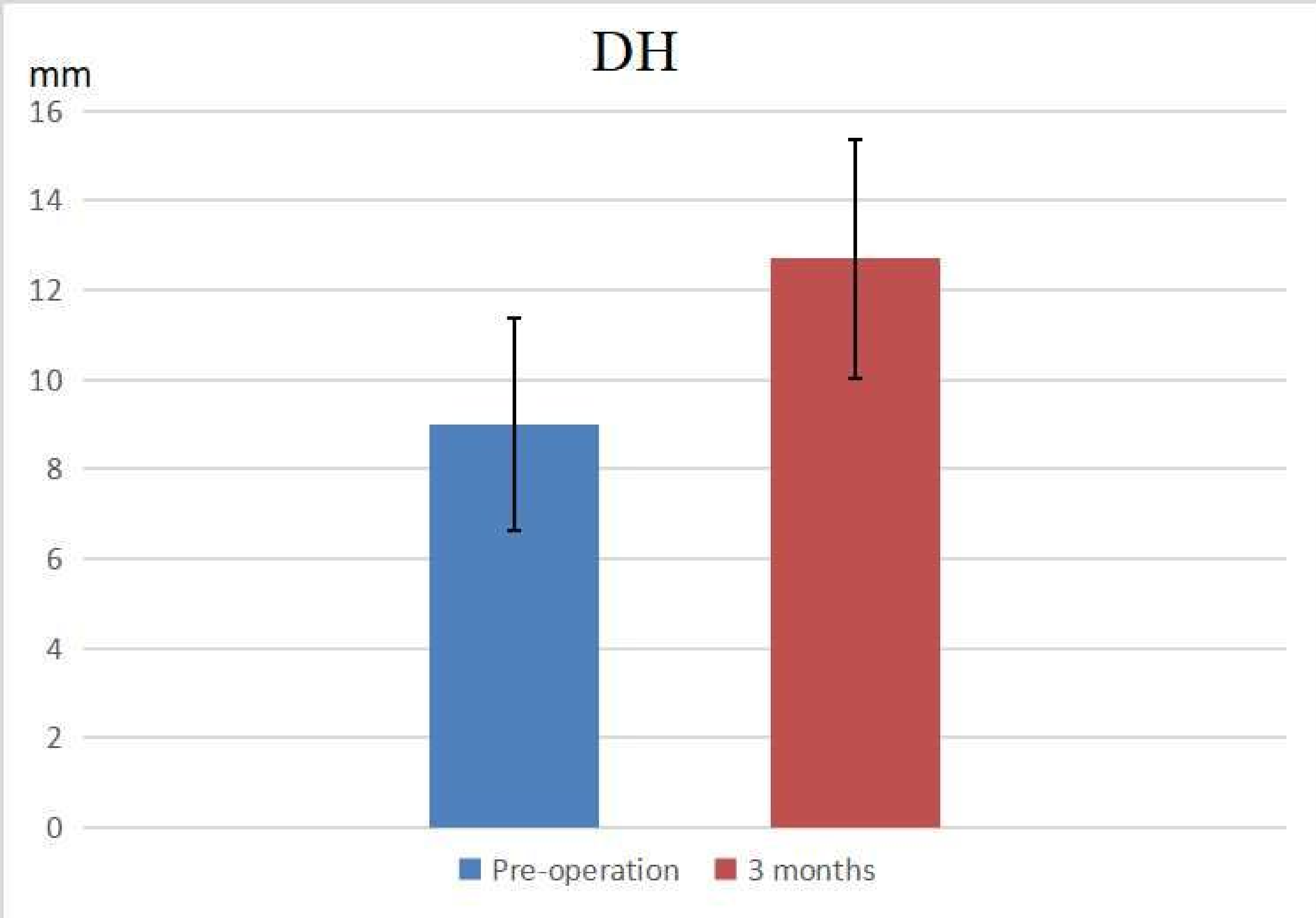

Figure 5

Significant improvement is seen in DH after surgery compared with before surgery. DH: disk height.

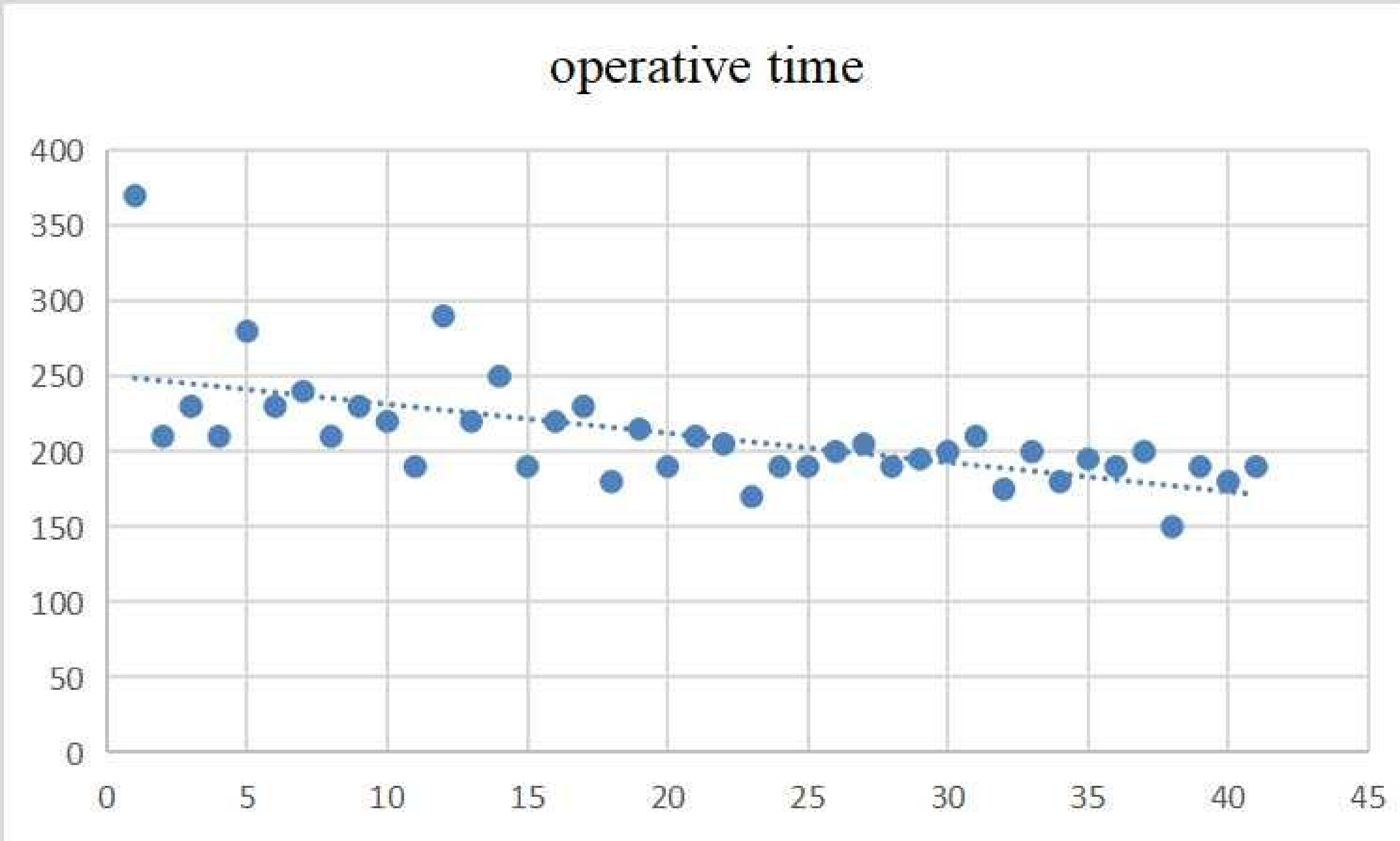

Figure 6

Temporal trends in transfacet Endo-PLIF surgery.