Therapeutics and Clinical Risk Management

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ORIGINAL RESEARCH

Comparison of outcomes between minimally invasive transforaminal lumbar interbody fusion and traditional posterior lumbar intervertebral fusion in obese patients with lumbar disk prolapse

This article was published in the following Dove Press journal:
Therapeutics and Clinical Risk Management
19 January 2017
Number of times this article has been viewed

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Objective: The aim of this study was to compare the curative effect between minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) and the posterior lumbar interbody fusion (PLIF) in obese patients with lumbar disk prolapse.

Patients and methods: In this study, 72 patients who underwent lumbar disk prolapse therapy in the Third Hospital of Hebei Medical University between March 2011 and 2015 were retrospectively analyzed and were divided into two groups, MIS-TLIF group (n=35) and PLIF group (n=37), according to different surgical procedures. Several clinical parameters were compared between these two groups.

Results: Compared with PLIF, MIS-TLIF was associated with longer operative time, less blood loss, less postoperative drainage and shorter postoperative time in bed; moreover, patients in the MIS-TLIF group had lower levels of serum creatine kinase on 1, 3 and 5 postoperative days. At the 3- and 6-month follow-up, Visual Analog Scale (VAS) scores of low back pain of patients in the MIS-TLIF group were significantly reduced and Japanese Orthopaedic Association (JOA) scores were increased, whereas the Oswestry Disability Index (ODI) showed no significant difference between the two groups.

Conclusion: Obese patients can achieve good efficacy with MIS-TLIF or PLIF treatment, but MIS-TLIF surgery showed longer operative time, fewer traumas and bleeding volume, less incidence of short-term pain, low complication rate and faster postoperative recovery.

Keywords: lumbar degenerative diseases, obesity, minimally invasive, spinal fusion, surgical complications

Introduction

Since the 1940s, posterior lumbar interbody fusion (PLIF) has been generally used in spinal surgery, and it is still regarded as one of the standard surgical procedures for the treatment of various diseases of the lumbar. However, the traditional PLIF requires large incision, extensive dissection of paraspinal soft tissue trauma and blood loss, which inevitably contributes to muscle denervation and atrophy.[1] Moreover, because of the removal of the bilateral vertebral plate, spinous process and ligament, the lumbar spine rear structural damage is large, and this surgery inevitably leads to postoperative adhesions, dural nerve roots and long-term low back muscle pain.[2] All these later complications seriously affect the clinical efficacy and decrease the patients' quality of life.

With the economic development and the change in people's work and lifestyle, the proportion of obese people is increasing. Notably, a number of studies[3–5] have

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pointed out that obesity has a significant correlation with the incidence of lumbar disk prolapse. However, for treatment of obese patients with lumbar disk prolapse, traditional PLIF surgery often requires extensive line of incision, thereby resulting in greater damage to muscle and soft tissue and increase in the amount of bleeding and the risk of infection.[4,6] Therefore, minimizing the operative incision in obese patients with lumbar disk prolapse, reducing perioperative complications and improving the clinical efficacy are tremendous challenges for spine surgeons.

In 2002, Foley et al[7] was the first to report the minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF). The author got through the spatium intermusculare into the surgery site by using a special working gap; the good minimally invasive effect of this surgery was achieved by removing side intervertebral joints and exposure of the posterolateral intervertebral disk.[8] Theoretically, its advantages can be applied to surgical treatment of obese patients with lumbar disk prolapse. However, the application of specific MIS-TLIF surgical procedures for obese population with lumbar disk prolapse is still lacking. Thus, the aim of this study was, for the first time, to compare the clinical efficacy between MIS-TLIF and traditional PLIF in obese patients with a body mass index (BMI) of >28 kg/m^2 and to verify whether MIS-TLIF surgery can achieve a satisfactory clinical efficacy for the treatment of obese patients with lumbar disk prolapse.

Patients and methods

Subjects and grouping

A total of 108 patients, who underwent lumbar disk prolapse therapy in the Third Hospital of Hebei Medical University between March 2011 and March 2015, were enrolled in the study, and the retrospective analysis was performed. The inclusion criteria were as follows: patients who 1) had single-segment lumbar disk degenerative changes, severe low back pain and lower extremity symptoms; 2) showed ineffective response to 6 months or more conservative treatment and received intervertebral fusion surgery; 3) presented the single segmental lumbar disk that is consistent to signs and symptoms performance by imaging manifestations and 4) had a BMI of >28 kg/m^2. Exclusion criteria were as follows: patients who 1) had multi-segmental lumbar disk degeneration; 2) had lumbar spondylolisthesis and spondylolysis and 3) had underwent lumbar spine surgery and had fractures, tumors, infections and other disease history. Based on these inclusion and exclusion criteria, a total of 72 cases of 108 patients were involved in the following retrospective analysis. The 72 patients were divided into the following two groups: MIS-TLIF (n=35) and PLIF (n=37). All the clinical data were collected after acquisition of written informed consent from the patients. The study was approved by the ethics committee of the Third Hospital of Hebei Medical University.

Surgical method

Surgeries of patients in the two groups were performed by the same surgeon.

MIS-TLIF group

Patient in prone position received general anesthesia, and a preoperative C-arm X-ray machine was used to locate the lesion segment. Longitudinal incision as the projection of the pedicle of the skin was the center point, and the length of it was ~5 cm. The skin, subcutaneous tissue and fascia were cut into the working channel of the posterior vertebral body. Surgical methods were as follows: laminectomy in addition to laminectomy, facet and part of the yellow ligament; nerve root decompression; showed nerve root; disk surgery after opening the nerve root, and end plate treatment. The offside underwent the same surgery with the placement of a sizeable interbody fusion cage. Under the C-arm X-ray machine, the pedicle screw was prospectively positioned for implantation, and both sides were fixed (Figure 1).

PLIF group

Patients received the same operative procedures, except the conventional posterior midline incision, implantation of pedicle screw, lamina decompression, removal of nucleus pulposus, intervertebral bone graft fusion and internal fixation (Figure 2).

For patients with hyperplastic facet joints or malformed vertebral body, the pedicle screw was implanted to the vertebral pedicle under the guidance of the O-arm navigation system (Figure S1). Before buying this device, the screw was implanted through true anteroposterior view screw-setting technique (Figure S2).

Observation parameters

1. The comparison between the two groups with respect to operative time, blood loss, postoperative drainage, bedridden time and occurrence of complications was performed.
2. Enzyme-linked immunosorbent assay (ELISA) was used to evaluate serum creatine kinase (CK) levels on preoperative day 1 and postoperative days 1, 3 and 5.
3. Visual Analogue Scale (VAS) score was used to evaluate the lumbago and backache on preoperative day 1 and postoperative months 3 and 6.

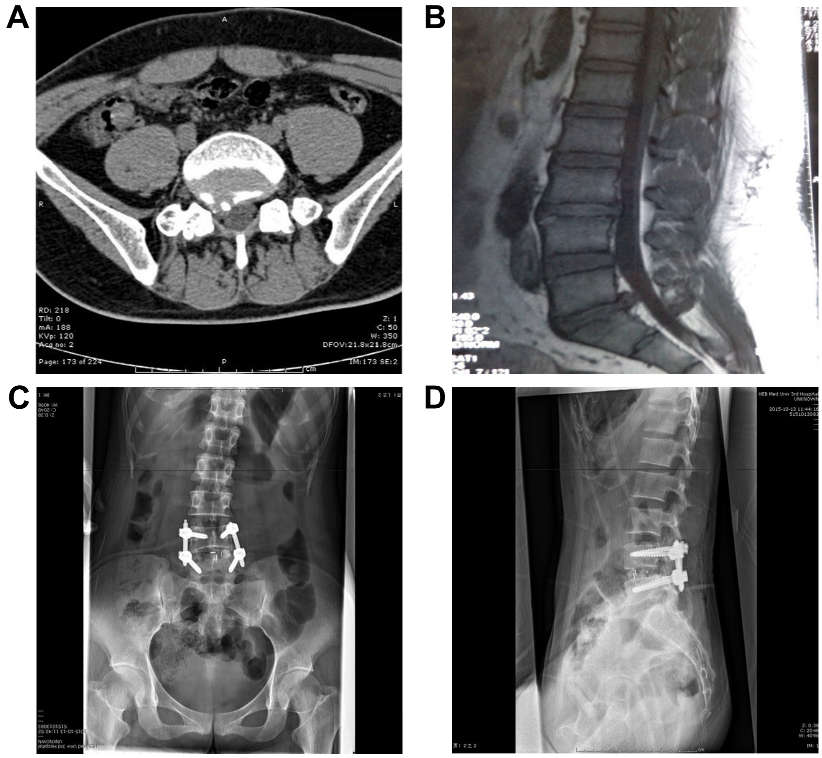

Figure 1 A case of MIS-TLIF surgery.

Notes: (**A**) Lumbar CT shows L5/S1 intervertebral disk prolapse. (**B**) Lumbar MRI shows L5/S1 intervertebral disk prolapse. (**C**) Frontal and (**D**) lateral X-ray image represents permanent position after 3 months.

Abbreviations: CT, computed tomography; MIS-TLIF, minimally invasive transformation lumbar interbody fusion; MRI, magnetic resonance imaging.

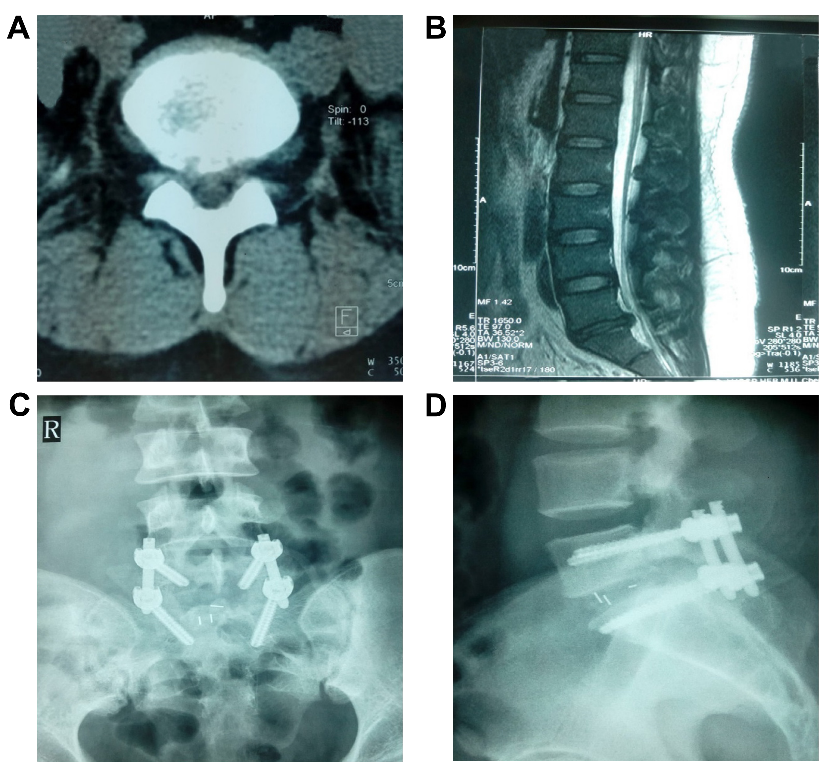

Figure 2 A case of PLIF surgery.

Notes: (**A**) Lumbar CT shows L5/S1 intervertebral disk prolapse. (**B**) Lumbar MRI shows L5/S1 intervertebral disk prolapse. (**C**) Frontal and (**D**) lateral X-ray image represents permanent position after 3 months.

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging; PLIF, posterior lumbar intervertebral fusion.

4. Oswestry Disability Index (ODI) was used to assess obstacles of daily life.
5. Japanese Orthopaedic Association (JOA) score was used to evaluate neurologic function on preoperative day 1 and postoperative months 3 and 6.

The 72 patients received outpatient follow-up in a period of 6 months.

Statistical analysis

Statistical analysis was performed using SPSS 19.0 statistical software package (SPSS Inc., Chicago, IL, USA). The comparison between the two groups in the preoperative and postoperative follow-up was performed as follows: normal distribution and homogeneity of variance using independent sample *t*-test and normal distribution and variance arrhythmia using *t*-test. Attribute data were analyzed using χ^2 test. *P*-value <0.05 was considered statistically significant.

Results

Demographic data of all patients

All patients received one segment of the lumbar spine fusion surgery. There was no significant difference ($P>0.05$) in the two groups in terms of gender, age, conservative treatment time and BMI differentials (Table 1). After 3 months, patients had successfully undergone surgery, and the image from lumbar lateral X-ray showed that permanent position is well (Figures 1C and D and 2C and D).

Perioperative indicators

Compared with PLIF, MIS-TLIF surgery was associated with more operative time, less blood loss and postoperative drainage volume and a shorter postoperative time in bed ($P<0.01$; Table 2).

Comparison of prognostic indicators in the two groups

The CK levels in all patients before surgery had no significant difference ($P>0.05$). After surgery, CK levels of MIS-TLIF patients were significantly lower than those of the PLIF group on postoperative days 1, 3 and 5 (Figure 3A). Based on VAS scores, we observed that MIS-TLIF surgery significantly improves lumbago and backache, indicated by lower scores than those with PLIF (Figure 3B). The functional recovery after 3 and 6 months of surgery for all patients was evaluated by ODI scores as shown in Figure 3C, and no statistically significant difference of ODI scores was observed between the two groups.

JOA scores were used to evaluate neurologic function, as shown in Figure 3D. We observed that MIS-TLIF results in a better curative effect on neurologic function at postoperative months 3 and 6.

Complications

Postoperative wound healing was delayed in three cases of the PLIF group (accounting for 9.38%), with a small amount of pale yellow oily liquid emanating from postoperative wound, which was confirmed as fat liquefaction. One case (accounting for 3.13%) was infected and then recovered after debridement, dressing and antibiotic treatment. The remaining patients had no significant complications.

Discussion

The prevalence of overweight and obesity is very grim. Epidemiological studies show that overweight or obese patients accounted for >30% of the population in China. The correlation between health damage induced by obesity and obesity-related diseases has become a hot issue worldwide. Obesity and disk disease are increasingly gaining more and more attention. Bayramoglu et al[9] pointed out that a higher BMI may be one of the causes of low back pain in women. Fanuele et al[10] found that an increased waist circumference is likely to contribute to obesity-induced backache (low back pain caused by obesity may be associated with an increased waist circumference). However, the traditional PLIF surgery for obese patients with lumbar disk prolapse requires excessive incision for the ease of sufficiently exposing the surgery area. The extensive incision inevitably causes large damage of muscle tissue, increase of bleeding volume and longer operative time. In addition, obesity is responsible for postoperative complications,

Table 1 Comparison of general information between the two groups of lumbar disk prolapse

Groups	N	Male	Female	L4–L5	L5–S1	Age (years)	CTT (U/L)	BMI (kg/m²)
MIS-TLIF group	35	19	16	12	23	51.3±6.4	11.9±3.3	34.8±2.1
PLIF group	37	25	12	16	21	52.3±7.1	10.7±4.5	33.7±3.3
Statistical value	–	χ^2=1.572		χ^2=0.685		t=0.839	t=1.187	t=1.554
P-value	–	>0.05		>0.05		0.118	0.482	>0.05

Abbreviations: BMI, body mass index; CTT, conservative treatment time; MIS-TLIF, minimally invasive transforaminal lumbar interbody fusion; PLIF, posterior lumbar interbody fusion.

Table 2 Perioperative indicators in the two groups of obese patients with lumbar disk prolapse

Indicator	MIS-TLIF	PLIF	Statistical value	*P*-value
Operative time (minutes)	152±56	103±31	*t'*=4.476	<0.01
Mean bleeding volume (mL)	136±18	364±23	*t'*=26.35	<0.01
Postoperative drainage (mL)	52±10	375±26	*t'*=61.73	<0.01
Bedridden time (days)	4.7±1.2	8.6±3.1	*t'*=6.76	<0.01

Abbreviations: MIS-TLIF, minimally invasive transformation lumbar interbody fusion; PLIF, posterior lumbar intervertebral fusion.

such as postoperative infection.[11–13] The possible reasons underlying the occurrence of postoperative complications is that poor blood supply in the adipose tissue causes slow postoperative healing, thereby erupting infection simultaneously; moreover, a wide usage of electric knife in spinal surgery easily leads to fat liquefaction, thus increasing the chances of postoperative intervertebral infection as well. Therefore, improving the efficacy of lumbar spine surgery in obese patients to reduce the probability of postoperative complications has important clinical significance.

The current study, for the first time, retrospectively compared the clinical curative difference between MIS-TLIF and PLIF treatment of lumbar disk prolapse in obese patients. With the development of minimally invasive spine surgery, quadrant channel MIS-TLIF-assisted surgery has become the ameliorative treatment of lumbar disk prolapse.[7] Compared with traditional PLIF, MIS-TLIF is performed with a smaller incision and requires less soft tissue dissection and the corresponding retain the spinous process ligaments. The less damage to the adjacent vertebral tissues behind the spine is beneficial for recovery of waist strength.[8] The data in our

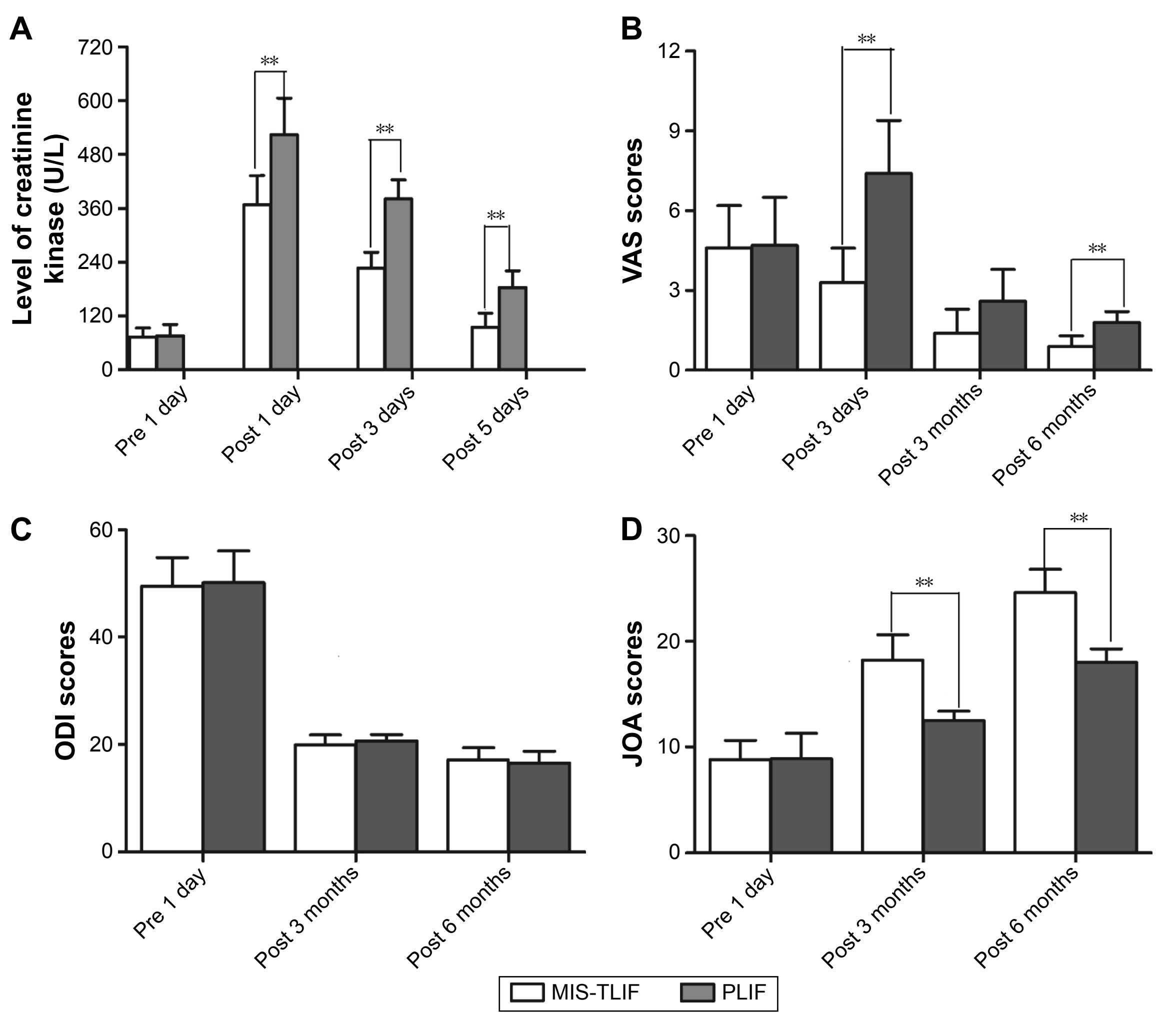

Figure 3 Comparison of (**A**) creatinine kinase, (**B**) VAS score, (**C**) ODI scores and (**D**) JOA scores between the MIS-TLIF and PLIF groups.

Notes: Pre 1 day, preoperative 1 day; post 1 day, postoperative 1 day; post 3 days, postoperative 3 days; post 5 days, postoperative 5 days; post 3 months, postoperative 3 months; post 6 months, postoperative 6 months. Data are presented as mean ± SD. $^{**}P<0.01$ compared with PLIF.

Abbreviations: ODI, Oswestry Disability Index; JOA, Japanese Orthopaedic Association; MIS-TLIF, minimally invasive transformation lumbar interbody fusion; PLIF, posterior lumbar intervertebral fusion; VAS, Visual Analog Scale.

study suggested that MIS-TLIF procedure for obese patients with lumbar disk prolapse achieved satisfactory clinical effect and to some extent reduced postoperative complications caused due to obesity.

In this study, blood loss, postoperative drainage and bed time in patients in the MIS-TLIF group were significantly lower than those in the PLIF group, suggesting that MIS-TLIF surgery for obese patients with lumbar disk prolapse has obvious advantages of a minimally invasive spine surgery. These results are consistent with previous studies.[14] Less blood loss and postoperative drainage may benefit from MIS-TLIF surgical approach for little muscle damage than the PLIF. Obese patients undergoing MIS-TLIF surgery can get out of bed early. This was highlighted by the following two reasons: 1) faster recovery of lower back muscle strength after MIS-TLIF surgery with less muscle and other soft tissue dissection helps strengthen the waist, capable of supporting a trunk during ambulation and 2) smaller trauma reduced the theoretical probability of hematoma in the incision and muscle compared with open surgery. However, as a type of minimally invasive surgery, MIS-TLIF requires more operative time than PLIF because of higher requirements for the operation. However, no patients experienced the catheter fracture and nerve root injury during surgery. We believe that with the increase in the number of surgical cases, improvement of surgical techniques and navigation equipment in spine surgery, MIS-TLIF surgery time will be shortened.

CK levels to some extent can be reflected in muscle damage surgery.[15] Generally, CK levels began to increase within 12 h after muscle injury, peaked by 1–3 days, and began to decline by 3–5 days. The slow decline induces more serious muscle damage. In this study, CK levels in the MIS-TLIF group were significantly lower than those of the PLIF group on postoperative days 1, 3 and 5, but with a faster recovery to a normal level than the PLIF group, indicating the smaller damage of MIS-TLIF surgery than the PLIF surgery.

Postoperative residual lumbago and backache are the disadvantages of traditional PLIF surgery.[2] Our data showed that MIS-TLIF reduced the back pain VAS scores 3 months after surgery in comparison with the PLIF. This suggests that MIS-TLIF surgery can significantly reduce the back pain symptoms of obese patients with lumbar disk prolapse after surgery. This is one of the advantages of MIS-TLIF. At the same time, we also found that there were no significant differences of ODI score in patients between preoperative and 3 and 6 months postoperative, which demonstrates the effectiveness of these two procedures in the treatment of obese patients with lumbar prolapse is quite comparable.

In terms of neurological recovery, JOA score of patients in the MIS-TLIF group was significantly higher than that of the PLIF group after 3 and 6 months of surgery, indicating that MIS-TLIF surgery can preferably restore nerve function in patients. In this study, bilateral decompression, decompression range spinal and nerve root canal in the MIS-TLIF group were similar to those in the PLIF group. Bilateral decompression can remove the nucleus from different directions avoiding overstretching of the dural sac and reducing nerve harassment, thereby reducing damage to the nerve roots and promoting early recovery of neurological function after surgery.

In this study, three patients in the PLIF surgery group had wound complications, whereas the MIS-TLIF surgery group had no significant complications. Patel et al[16] reported that BMI was an independent factor of perioperative complications. Studies have found that the line of spine surgery in obese patients had higher incidence of complications, especially wound complications. Wound healing is difficult for obese patients with a BMI of >30 kg/m^2 after spinal surgery, and the rate of wound infection is up to 33%.[16,17] Our study results suggest that MIS-TLIF surgery can significantly reduce postoperative wound complications of obese patients with lumbar disk prolapse.

This study has many limitations. First, it is a retrospective study with fewer patients and shorter follow-up time; an additional multicenter and prospective study with a large sample is needed in the future to confirm this inference. Second, patient selection in this study has some limitations; multiple lumbar canal stenosis and spondylolisthesis patients need further research. Third, the long-term effects of obesity surgery and fixation failure risk for patients remain to be further determined.

Conclusion

Overall, both MIS-TLIF surgery and PLIF surgery for obese patients with lumbar disk prolapse achieve good results. The advantages of MIS-TLIF group are less blood loss, shorter postoperative bed time, smaller muscle injury and lower incidence of postoperative back pain and incision complications. Our data suggested that MIS-TLIF procedure is worthy of wider application.

Disclosure

The authors report no conflicts of interest in this work.

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Supplementary materials

Figure S1 Image of O-arm equipment.

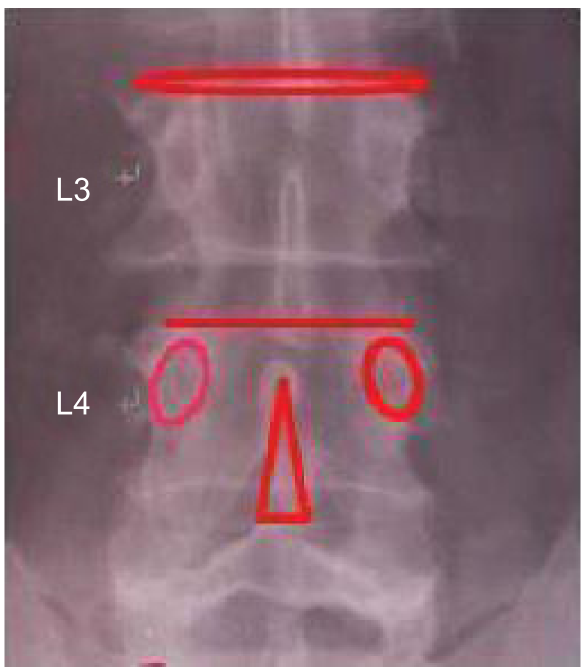

Figure S2 Image of L3 and L4 by true AP view.

Notes: Intraoperative radiograph showing the localizing spinal needle inserted in perfect alignment with the targeted L3 and L4 disc. C-arm fluoroscopic images were obtained to localize the true AP, when the anterior and posterior edges of vertebral end plates at L4 disc overlap in a line.

Abbreviation: AP, anteroposterior.