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Review Article

A retrospective study on the treatment of adult lumbar degenerative diseases by MIS-TLIF

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Abstract: Objective: To investigate the therapeutic value of MIS-TLIF treatment on adult lumbar degenerative diseases, and to verify the effectiveness and superiority of MIS-TLIF in clinical application. Methods: First, a total of 48 eligible patients with lumbar degenerative diseases admitted to the Department of Spine Surgery were selected as research subjects. The patients were divided into two groups according to different treatment methods, which were recorded as group A and group B. Patients in group A were treated with PLIF surgery. Patients in group B were treated with MIS-TLIF surgery. The general information, the number of surgical segments, the number of underlying diseases, the preoperative lumbago VAS scores, and the lumbar vertebra JOA scores of patients were used as observation indicators, and the clinical efficacy in both groups was compared. Compared to group A, the blood loss, drainage volume, postoperative bedtime, hospitalization days, postoperative VAS score of pain in the lumbar region and lower extremities of group B reduced significantly ($P<0.05$); meanwhile, the postoperative JOA score of pain in the lumbar region and lower extremities increased ($P<0.05$). In terms of postoperative surgical complications, a total of two patients in the MIS-TLIF group had surgical complications, but the MIS-TLIF group had fewer patients than the PLIF group. Conclusion: MIS-TLIF has good effects on the treatment of adult lumbar degenerative diseases. It has a certain clinical application value. Compared with other surgical methods, the clinical treatment of MIS-TLIF is more effective and can alleviate the pain of patients. Besides, the trauma is minimal, and the recovery effects are also excellent.

Keywords: MIS-TLIF, lumbar vertebra degenerative diseases, PLIF, perioperative period, clinical efficacy

Introduction

According to statistics of world demographics, in 2015, the population of the seniors over 65-years-old reached 600 million, and it is expected to exceed 700 million in 2020 [1, 2]. The problem of global aging is becoming more and more prominent. Due to the decrease of elastin content in the elderly, the posterior longitudinal ligament, the muscle strength of the trunk, the back muscles, the bone density of the vertebral column, and the incidence rate of lumbar degenerative diseases in the senior population is also significantly increased [2, 3]. A nearly 25-year study of vertebral column surgery at the Spinal Study Center of Japan Northeastern University showed that the number of vertebral column surgeries increased nearly four-fold linearly; the number of patients older than 70 and 80 years increased by 20-90 times. In addition, vertebral column degenerative diseases accounted for 90% of back pain in seniors, and the proportion of patients with lumbar spinal stenosis was the highest, accounting for 35.9%, followed by lumbar disc herniation, 27.7% [4, 5]. A statistical analysis from the UK investigating surgeries of vertebral column degeneration diseases showed that the number of patients aged 60-74 and over 75 years old had also increased by nearly 2.8 times [6]. It indicated that the number of senior patients treated by vertebral column surgeons will increase in the future, especially in countries with intense population aging [7, 8].

Lumbar degenerative diseases, common in middle-aged and senior people, can cause pain and numbness in the lumbar vertebra and lower extremities, or the dysfunction of the lower extremities and the trunk, which will affect the activities of patients; therefore, surgi-

cal treatments can reduce the pain, restore the function, and improve the quality of life [9, 10]. At present, the surgical plan for treating lumbar degenerative diseases is diversified. Posterior Lumbar Interbody Fusion (PLIF) is currently recognized as the standard treatment of lumbar degenerative diseases. However, conventional surgery often takes a posterior median incision, which requires extensive exfoliation of the paravertebral soft tissue, leading to adverse effects on postoperative recovery of muscles and unnecessary damage to the upper and lower adjacent vertebral joint capsules, making the patients prone to postoperative chronic lumbar pain and muscle atrophy [11-13]. With the continuous advancement and innovation of medical technologies and means, Minimally Invasive Lumbar Transforaminal Lumbar Intervertebral Fusion (MIS-TLIF) has been widely recognized and applied in clinical practice [14, 15].

Through a retrospective study on the treatment of adult lumbar degenerative diseases by MIS-TLIF, this study explored the value and effectiveness of MIS-TLIF in the treatment of adult lumbar degenerative diseases. A total of 48 patients with lumbar degenerative diseases were used as research subjects and were divided into different groups according to the different surgical methods received; i.e., MIS-TLIF surgery and PLIF surgery. The research results revealed that MIS-TLIF had an excellent clinical effect in the treatment of adult lumbar degenerative diseases. The trauma was less and also a rapid recovery of patients after surgery was enhanced. Besides, the amount of blood loss in the perioperative period was also very small, which could effectively improve the symptoms of patients. Therefore, this study is of great significance for the clinical treatment of lumbar degenerative diseases. Here we have shown that MIS-TLIF can be widely applied in clinical practice.

Materials and methods

Research subjects

In this study, a total of 48 eligible patients with lumbar degenerative diseases who were treated in the Spine Surgery Department from January 2018 to January 2019 were enrolled. There were 29 males and 19 females with an average age of 76.6 years. The average duration of the disease was 62.1 months. Among all the research subjects, there were 19 patients with lumbar disc herniation, 21 patients with lumbar spinal stenosis, and 8 patients with lumbar spondylolisthesis within 2 degrees. Before the surgery, the physical conditions of patients, as well as the risks and tolerance of the operation, were evaluated. Before the experiment, all patients and their families had signed the informed consent forms, and the experimental procedures were submitted for the approval of the ethics committee.

Inclusion criteria: patients whose age exceeded 75 years old; patients whose clinical symptoms were consistent with the imaging examination of the lumbar vertebrae and diagnosed with single-segmental disc herniation; patients who were diagnosed with lumbar spinal stenosis, lumbar disc herniation, and lumbar spondylolisthesis within 2 degrees.

Exclusion criteria: There were four exclusion criteria in total. First, patients who had undergone lumbar surgeries were excluded. Second, patients with poor physical conditions and could not tolerate the surgery were excluded. Third, patients with severe spinal scoliosis, deformity, and lumbar spondylolisthesis above degree III were excluded. Fourth, patients with lumbar tumors, infections, fractures, and severe osteoporosis were excluded.

Grouping: All patients were divided into the two groups according to the different surgical methods. The first group included patients who underwent PLIF surgery and was recorded as group A, with a total of 26 patients. The second group included patients who underwent MIS-TLIF surgery under the Quadrant channel and was recorded as group B, with a total of 22 patients.

This study was approved by Ethics Committee of Guizhou Orthopedic Hospital and was in accordance with the Helsinki Declaration, all participants and their families signed informed consent forms before carrying out the study.

MIS-TLIF surgery under the quadrant channel

First, the patient to be treated underwent general anesthesia. Then, the patient was placed in the supine position, and the C-shaped X-ray machine was used to locate the segmental intervertebral lesion. The surgical staff washed their hands and disinfected the operation towels. An incision was made in the skin 3 cm from the median line of the patient, and the fascia

was uniformly cut. After the longest muscle and multi-cleft muscle of the patient were separated, the Quadrant operating channel was installed in the gap between the muscles.

The free arm was used for fixation. At this time, the articular process and the outer edge of the lamina would be exposed under the channel. According to the proliferative osteophyte, the exposed joint space, and the root of the transverse process, the markers were located. Holes were drilled respectively in the direction of the upper and lower vertebrae bow of the patient, and the positioning pins were placed inside. Afterward, the cortex of the pedicle was removed from the pedicle of the patient. The probe and the tapping were used to prepare a complete nail preparation, which was sealed with bone wax. Then, the upper vertebral body articular process, the lateral vertebral plate, and part of the lower vertebral body joints were removed by using a bone chisel. Then, the proliferated ligamenta flava was removed. The outer dural sac and the running nerve root were separated, and the degree of pressure that the nerve root could withstand was detected. According to the result of the detection, the nerve root channel was further enlarged. Then, the nerve hook was applied to protect the dural sac and the nerve root. The posterior longitudinal ligament and the annulus fibrosus were cut. The degenerated nucleus pulposus tissue was removed. The cartilage endplate was scraped continuously until a slight oozing occurred. Next, the ventral side of the lateral dural sac was decompressed by a reverse scoop, and the outer edge of the lamina was removed uniformly toward the center. Thus, the contralateral nerve root was probed. After the end of the above operations, the autologous bone added in the intervertebral space was measured, which was continuously hit until it was tight. Then, an interbody cage was placed inside and the screw was screwed in. The appropriate length of the connecting rod was selected to add pressure and fix. The incision was closed. Then, the same method was applied to fix the contralateral nerve root. Then, the position of the verified in-plant was X-rayed. The surgical incision was cleaned. The surgical gauze and instruments were counted. In addition, on each side of the incision, a drainage tube was placed, and the incision was sutured [16, 17].

PLIF surgery

Anesthesia and positioning of the surgical segment before the formal procedures and steps were the same as those before the MIS-TLIF surgery. The incision of the median skin was consistently cut to the position of the fascia. Then, the paravertebral muscle were separated from the lateral part of the facet joint, the positioning mark was displayed, and the locating needle was placed in the drilled holes of the bilateral upper and lower pedicle directions. Then, the probe and tapping were jointly used to make a complete nail channel. The cortex of the pedicle isthmus was removed, and four screws were placed therein. Next, the spinous processes and the lamina were removed together, and the ligamenta flava of the responsible segment was removed. The crypt was decompressed, and then the nerve hook was used to protect the dural sac and nerve root. The posterior longitudinal ligament and the annulus were cut open, and the degenerated nucleus pulposus tissue was removed, then the cartilage endplate was continuously scraped until there was a slight oozing condition. The autologous bone added in the intervertebral space was measured and hit until it was tight. Then, an interbody cage was put into it, and the screw was screwed. Afterward, the position of the verified in-plant was X-rayed. The surgical incision was cleaned. On each side of the incision, a drainage tube was placed, and the incision was sutured layerwise [18, 19].

Postoperative treatment

Patients could use antibiotics one day and two days after the surgery. Within the first three to four days, water, hormones, and nerve nutrients were used for postoperative treatment. In addition, the drug was used in the same way as before. The drainage tube was pulled out within two to three days, but it must not be removed until the drainage volume was less than 30 mL. For patients with the dural tear, if the 24-hour drainage volume within 5 days to 7 days after surgery did not exceed 100 mL, it could be removed, and the patients were pressure bandaged. After the operation, the nursing staff observed the wound healing conditions of the patients in real time and instructed the patients who needed appropriate out of bed exercises to perform the correct functional exercises [20].

Observation indicators

The conditions of patients were observed after the operation, which were mainly the perioperative parameters, such as the operation time,

Table 1. The general materials of patients

General materials	Group A	Group B	t/2 values	*P* values
Quantity	26	22		
Age (yr)	76.77±1.70	77.23±1.74	-1.067	>0.05
Gender (male/female)	17/9	12/10	0.585	>0.05
Number of coexisting diseases	18	15	0.006	>0.05
Hypertension	7	6		
Coronary heart disease	2	1		
Diabetes mellitus	3	2		
Hypertension + coronary heart disease	4	2		
Hypertension + diabetes mellitus	2	4		
Hypertension + diabetes mellitus + coronary heart disease	2	0		
L3-L4	2	0		
L4-L5	19	16		
L5-S1	5	6	2.029	>0.05

the amount of blood transfusion during the operation, the drainage volume after the operation, and the number of hospital stays. Also, the postoperative conditions to be observed included surgical complications and the evaluation of the clinical efficacy. Pains in the lumbar vertebrae and lower extremities of patients were assessed by the Visual Analog Scale (VAS) before the operation, three days after the operation, three months after the operation, and one year after the operation. Functions of lumbar vertebrae and lower extremities of patients were assessed by the Japanese Orthopedic Association (JOA) scores before the operation, three days after the operation, three months after the operation, and one year after the operation.

Statistics analysis

The data were input into the statistical database. The statistical analysis of the data was performed by using SPSS 22.0 software. The measurement data were expressed as mean ± standard deviation ($\bar{x} \pm s$), the mean of the two samples was compared by t-test, the count data were expressed by the incidence rate n (%) and compared by χ^2 test. The experimental results were based on the *P* values, and P<0.05 indicated that the differences were statistically significant.

Results

Comparison of general information of the patients

As shown in **Table 1**, there were no statistically significant differences in gender, age, surgical stage, and underlying diseases between patients in the two groups (P>0.05).

Comparison of perioperative blood loss, postoperative drainage volume, postoperative bedtime, and hospitalization days of the patients

As shown in the figure below, compared with the intraoperative blood loss and postoperative drainage volume of group A, the blood loss and drainage volume of group B were less, and the two groups had a statistical difference (P<0.05). The postoperative bedtime and hospitalization days were compared between the two groups. It was found that the postoperative bedtime and hospitalization days in group B were shorter than those in group A, and there was a statistical difference between the two groups (P<0.05). There were no transfusions in the MIS-TLIF group, although three patients in the PLIF group experienced transfusions during surgery. The patients in the PLIF group experienced shorter times to finish the surgery, and patients in the MIS-TLIF group experienced a longer time to finish the surgery. **Figures 1-3**

Comparison of VAS scores and JOA scores of the patients

As shown in the figure below, after the operation, the VAS scores of pain in the lumbar vertebrae and lower extremities of patients in groups decreased, while the lumbar JOA scores of patients increased. The scores of patients in the two groups were greatly improved. The comparison of the JOA and VAS scores between the two groups showed statistical differ-

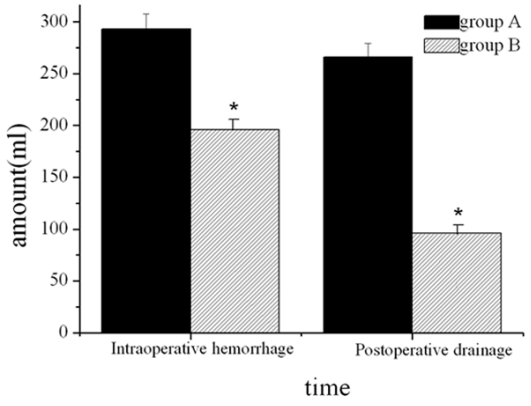

Figure 1. Intraoperative blood loss and postoperative drainage in the two groups of patients during the perioperative period.

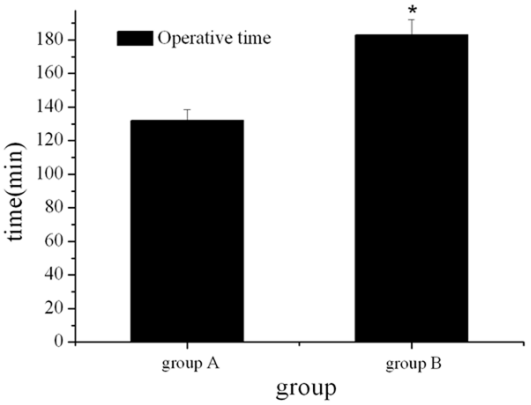

Figure 2. Surgery duration of patients in both groups.

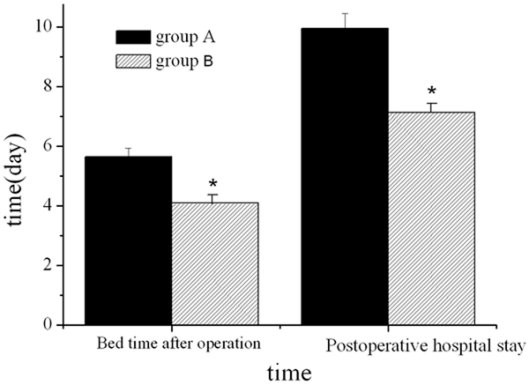

Figure 3. Postoperative bedtime and length of hospital stay of patients in both groups.

ences (P<0.05). The lumbar VAS scores of the MIS-TLIF group at three days and three months after operation were compared with those of

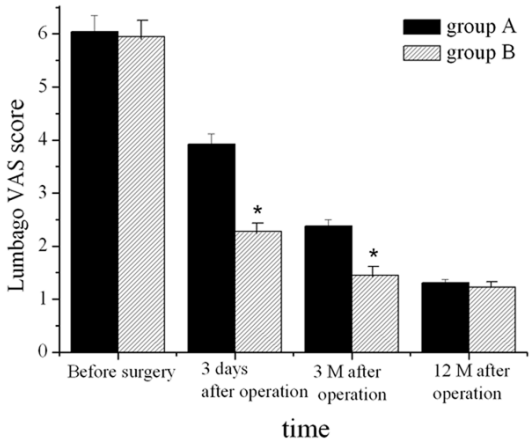

Figure 4. Lumbago VAS scores of patients in both groups.

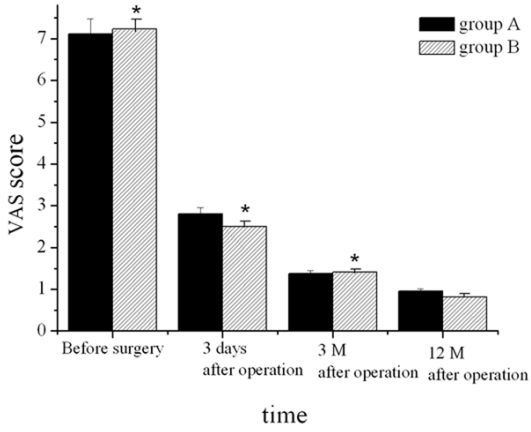

Figure 5. VAS scores of pain in lower extremities of patients in both groups.

the PLIF group. It was found that the scores of the MIS-TLIF group were lower, and the improvement was more obvious. There was a statistical difference between the two groups (P<0.05). In addition, the scores of the two groups were not much different at other times, with no statistical significance. **Figures 4-8**

Comparison of postoperative surgical complications of the patients

As shown in the figures below, in terms of the postoperative surgical complications, a total of two patients in the MIS-TLIF group developed surgical complications, and a total of six patients in the PLIF group developed surgical complications. In the MIS-TLIF group, one patient developed postoperative delirium. After

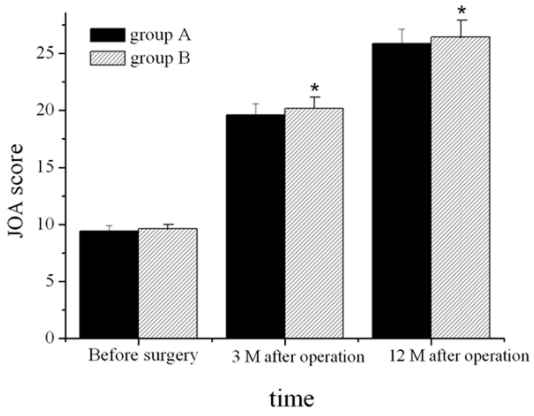

Figure 6. JOA scores of patients in both groups.

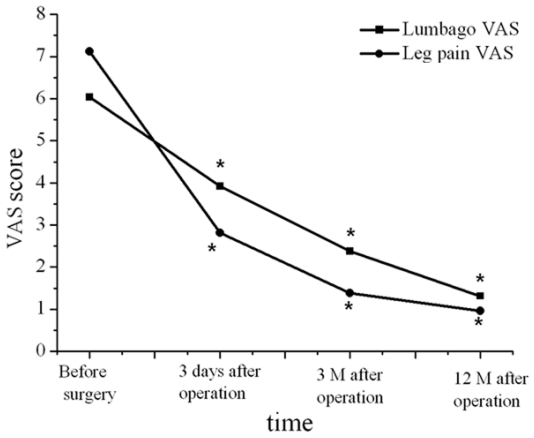

Figure 7. The VAS scores of pain in lower extremities of patients in group A and the tendency of VAS scores.

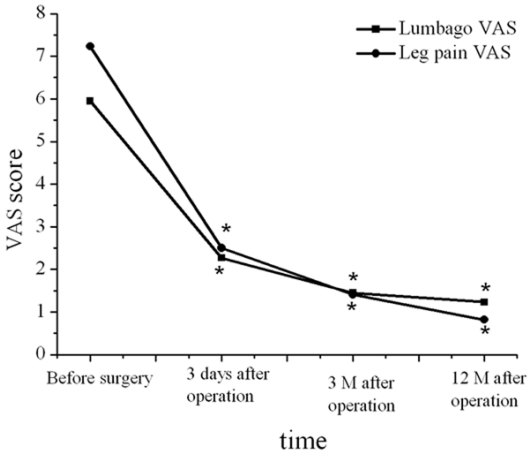

Figure 8. The VAS scores of pain in lower extremities of patients in group B and the tendency of VAS scores.

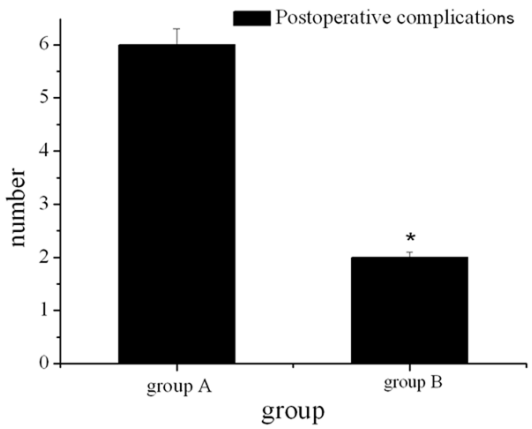

Figure 9. Cases of surgical complications in both groups.

the consultation in the Department of Neurology and Anesthesiology, the patient underwent a head imaging examination to exclude the possibility of cerebral infarction. Then, the patient recovered after receiving the treatment of diuresis and rehydration. One patient developed discomfort in the precordial area, and the condition gradually recovered after taking the nitroglycerin tablets and inhaling oxygen. In the PLIF group, a total of three patients developed the dural tears. After the suturing and pressure dressing, the drainage tubes of these patients were removed and the incisions of these patients were found to be healed. No epidural hematoma occurred. In addition, one patient had a previous history of venous thrombosis of the lower extremities. Therefore, a thrombus occurred during the operation. Finally, surgical treatment was performed. After the corresponding treatments, the patient recovered. One patient developed pneumonia and finally recovered after blood culture and antibiotic treatment. **Figure 9**.

Examination results of MRI and X-ray of the patients

One year after the operation, X-ray was used to diagnose the lumbar vertebral column of the patient, and all patients were found to have no cage displacement or sinking, pedicle screw displacement, nor fracture. **Figure 10** showed the preoperative MRI image of an individual case and the re-examination X-ray image after MIS-TLIF operation under the Quadrant channel.

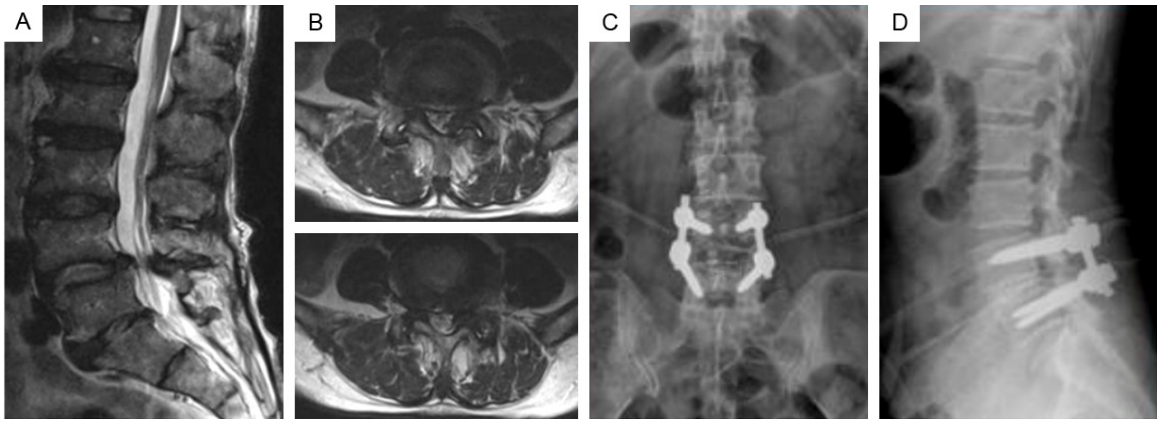

Figure 10. Preoperative MRI image and postoperative re-examination X-ray image of case 1. (A and B were preoperative MRI images of the lumbar spine; C and D were postoperative re-examination normal and lateral X-ray images of the lumbar spine).

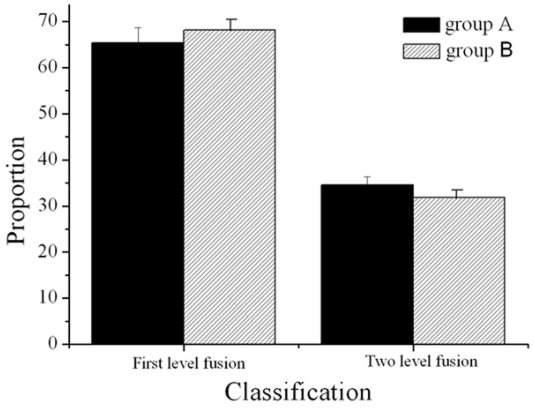

Figure 11. The comparison of grading fusion between the two groups of patients.

As shown in **Figure 10**, a preoperative MRI image showed that the L4 vertebra of this patient slipped forward with spinal canal stenosis and the dural capsule was compressed. The postoperative X-ray image showed that the position of the lumbar pedicle screw and interbody fusion cage was good; looseness did not occur, and bony healing was seen between the vertebrae.

According to the Bridwell grading criteria, as shown in the following **Figure 11**, a total of 15 patients in group B developed grade I fusion, accounting for 68.2% of the total number. In addition, 17 patients in group A developed grade I fusion, accounting for 65.4% of the total number. Also, in group A, there were 7 patients with grade II fusion, accounting for 31.8% of the total number; in group B, there were 9 patients developed grade II fusion, accounting for 34.6% of the total number. The two groups were compared and found to have no statistical significance (P>0.05). There were no cases of grade III and IV fusion in either group.

Discussion

The human vertebral column is multi-segmented and has an active tissue structure that maintains stability and posture. Its composition includes inactive vertebral bodies, active facet joints, ligaments, and intervertebral discs. The balance, stability, and maintenance of posture of the vertebral column also require support from strong extensors and flexors [21]. However, age and pathological states will change these components, especially the aging of the body caused by an increase in age will initially produce microscopic biochemical changes, and eventually accumulates into the degeneration of various structures of the vertebral column, the occurrence of annulus fibrosus, nucleus detachment, height loss of intervertebral space, hypertrophy of the ligamenta flava, small joint hyperplasia, and other pathological changes. Lumbar degenerative disease is the endpoint of degenerative changes of the vertebral column, which is manifested by the imbalance of the physiological structure of the vertebral column, the biomechanical changes of various components, lumbago, and neurological symptoms of lower extremities.

The global population is now aging, and the number of senior patients is rising. Conserva-

tive treatment is still the first choice for senior patients, but it is necessary to perform surgical treatment to reduce or improve the symptoms in senior patients whose conditions cannot be improved through conservative treatment [22]. The major purpose of surgery is to decompress the nerve roots and dura mater of the patient to maintain a normal spine sequence. However, the traditional surgical incision is bigger, the soft tissue of the patient needs to be stripped more, and the hemorrhage volume is larger. Minimally invasive surgery helps to fuse, and it is widely used in clinical practice and has a good treatment effect [23].

Through the retrospective study of MIS-TLIF surgery in the treatment of adult lumbar degenerative diseases, it was found that the blood loss and drainage volume in this group (B) were relatively small, and there was a statistically significant difference between the two groups. The postoperative bedtime and hospitalization days in group B were found to be shorter than those in group A, and there was a statistically significant difference between the two groups. After the operation, the VAS scores of pain in the lumbar region and lower extremities decreased after the surgery, and the lumbar JOA scores increased after the surgery; also, there was a statistically significant difference between the two groups. In terms of postoperative surgical complications, a total of two patients in the MIS-TLIF group had surgical complications, but the MIS-TLIF group had fewer patients than the PLIF group. Both MIS-TLIF and PLIF have positive effects on senior patients. MIS-TLIF surgery causes less blood loss, shorter postoperative bedtime, and shorter hospital stays. Besides, the postoperative lumbago is less severe, the incidence rate of surgical complications is low, and the operability is high. Therefore, MIS-TLIF is a minimally invasive surgery for senior patients with little trauma, high safety factor, fast functional recovery, and reliable efficacy. Rahmatullah et al. (2017) studied the clinical treatment effect of minimally invasive transforaminal lumbar interbody fusion with the single-segment instrument in patients with neurogenic symptoms of lumbar spondylolisthesis through retrospective case study and literature review. The results showed that the TLIF instrument was suitable for patients with neurogenic symptoms secondary to lumbar spondylolisthesis and was associated with an acceptable incidence of complications; also, its clinical efficacy and radiological results could last up to 5 years after surgery [24]. This was consistent with the viewpoint of this study. The experimental results of this study have achieved the expected results, but the analysis of the surgical outcomes of senior patients could have been more comprehensive since the sample size of this study was small. Nevertheless, the results can be used as a clinical reference. In subsequent research, the cases will be collected further, the sample size will be expanded, and the follow-up time will be extended for an in-depth exploration of the clinical efficacy of MIS-TLIF.

In summary, MIS-TLIF has obvious therapeutic effect and clinical application value in treating adult lumbar degenerative diseases. Compared with other surgical methods, the clinical treatment of MIS-TLIF is more effective, which can effectively reduce the pain of patients and it has less trauma and a good recovery effect.

Disclosure of conflict of interest

None.

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