Comparison of the short-term effects of Quadrant channel fenestration decompression and Delta large channel endoscopy in the treatment of elderly patients with lumbar spinal stenosis

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Research Article

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Abstract

Objective

To compare the clinical efficacy of Quadrant channel fenestration decompression and Delta large channel endoscopic spinal decompression in the treatment of elderly patients with lumbar spinal stenosis.

Methods

A total of 40 patients suffering from lumbar spinal stenosis whose age were over 75 years old were selected for the present study, which was admitted to the Department of Orthopedics from June 2019 to August 2021. The observation group received Delta large channel endoscopy treatment, the control group received Quadrant channel fenestration decompression. Count of general information, course of disease, operation time, intraoperative blood loss, visual analogue scale (VAS) preoperatively, 3 days postoperatively, 3 months postoperatively, and 6 months postoperatively and Oswestry dysfunction score (ODI) of the two groups of patients were recorded and compared.

Results

The duration of the disease course between the two groups was roughly the same, and the difference was not statistically significant ($P > 0.05$).The two groups of patients had high waist and leg pain and dysfunction index before operation, and the difference in VAS score and ODI index was not statistically significant ($P > 0.05$).The operation time and intraoperative blood loss of the observation group were less than those of the control group, and the difference was statistically significant ($P < 0.05$).There were no statistically significant difference in VAS scores and in ODI index at 3 and 6 months between the two groups of patients after surgery ($P > 0.05$), the difference at 3 days after surgery was statistically significant ($P < 0.05$).

Conclusion

Both the two surgical methods have a good clinical outcome in the treatment of lumbar spinal stenosis. However, the Delta large channel endoscopy technology has more clearer vision, less trauma, lower incidence of early postoperative low back and faster recovery time than that of Quadrant channel fenestration decompression.

Introduction

Lumbar spinal stenosis (LSS) refers to the stenosis of the lumbar spinal central canal, nerve root canal, lateral recess or intervertebral foraminal lumen due to various reasons，in turn, it causes compression of the spinal cord, dural sac, and nerves and blood vessels. The compression leads to corresponding clinical symptoms that mainly manifest as neurogenic intermittent claudication accompanied by lumbar pain and lower limb radiation pain, numbness, and fatigue. It is also called as Lumbar Spinal Canal Stenosis Syndrome[1]. In the past, the main treatment methods for LSS were divided into conservative treatment and posterior open surgical treatment. The conservative treatment refers to the management with drugs such as anti-inflammatory and analgesic agents that may only alleviate the associated pain. Especially for elderly patients, due to the long course of disease，the thickening and calcification of the ligamentum flavum and the osseous hyperplasia of the articular process were more serious，which caused poor effective of conservative treatment. Open surgery can perform adequate decompression, reduction, fusion and fixation by fully exposing the posterior structure of the lumbar spine. However, due to the disadvantages of open surgery, such as large trauma, high complication rate, and slow postoperative recovery, most of the elderly patients cannot tolerate open surgery. The emergence of Quadrant channel fenestration decompression surgery has solved this contradiction very well, and while fully decompressing, it also greatly reduces the trauma of the operation. However, with the continuous advancement of minimally invasive technology, Delta large channel endoscopy has also emerged and has been used for minimally invasive treatment of elderly LSS. However, there were currently few studies on the clinical effects of Delta large channel endoscopy and Quadrant channel fenestration decompression in the treatment of elderly LSS. This study retrospectively analyzed 40 elderly patients with LSS who underwent minimally invasive surgical treatment with Delta large channel endoscopy and Quadrant channel fenestration decompression respectively. It is hoped that through comparison, the clinical effect of the Delta large channel endoscopy and Quadrant channel fenestration decompression in the treatment of senile LSS can be evaluated.

Materials And Methods

***General materials*:** A total of 40 patients with LSS over the age of 75 who came to the Department of Orthopedics from June 2019 to August 2021 were selected and included in this study.

***Inclusion criteria for cases*:** (1) over the age of 75;(2) the clinical symptoms are neurogenic intermittent claudication, with or without radiculopathy, and single-segment LSS diagnosed by imaging examination; (3) after systematic conservative treatment, symptoms such as low back pain and intermittent claudication were not improved (more than 3 months);(4) absence of surgical contraindications;(5) able to complete the 6-month follow-up;(6) patients and their family members voluntarily sign informed consent forms;(7) obtained the approval of our hospital's ethics committee.

***Exclusion criteria*:** (1) Patients with a previous history of lumbar spine surgery or fracture history;(2) patients with spinal tumors and infectious diseases such as tuberculosis;(3) those with severe heart, liver, and kidney dysfunction diseases;(4) symptomatic multi-segment lesions of the lumbar spine;(5) those who were unable to cooperate with the completion of 6-month follow-up.

According to the inclusion criteria and the different treatment methods, all patients were divided into two groups with 20 patients in each group, the observation group and the control group. Among them, the patients in the observation group underwent Delta large channel endoscopy, and those in the control group underwent Quadrant channel fenestration decompression. In the observation group, 5 male patients and 15 female patients; age range 75-86 years old; the course of disease was 5-24 years. In the control group, 5 male patients and 15 female patients; age range 75-91 years old; the course of disease was 3-26 years.

Treatment methods

Observation group: After successful general anesthesia, with the patient in prone position on the operating table, cushions were used to secure the chest and hips, the body surface was positioned and the L4-5 intervertebral space plane and the L4-5 spinous process about 1.5 cm to the left were determined. After routine iodophored disinfection of the skin on the back for 3 times, spreaded the sheet and started the operation. Two incisions were made at an interval of 2 cm, with a length of 1 cm at about 1.5 cm on the left side of the L4-5 gap. Following which the back of the lower 1/3rd of the left lamina of L4 was punctured with a guide needle and rotated into the working channel after establishing a Delta endoscopic channel. Thereafter, a progressive expansion sleeve was inserted and the working channel was fixed. The soft tissue from the left lamina of L4 to the medial surface of the right facet joint was scraped with a curette, exposing the space between the lower edge of the L4 lamina and the upper edge of the L5 lamina, one-time grinding and drilling to remove 1/3rd of the lower edge of the lumbar lamina to the left side recess, exposing the ligamentum flavum. The upper and lower attachments of the ligamentum flavum were cut off with a nerve probing hook, and the nucleus pulposus clamp was used to remove the ligamentum flavum. The lumbar 5 nerve roots and the dural sac were exposed. No obvious pulsations were seen in the dura mater.Bited the left lamina of L4 upward and expanded the spinal canal.Bited the lamina laterally to the left lateral recess, and then bited the bone upward and downward along the lateral recess to expand the nerve root canal. The nerve root and dural sac were blocked with a retractor, and the hyperplastic tissue around the nerve root was ground away with a disposable radiofrequency ablation blade. After decompression, the nerve root was loosened and the dural sac wave recovered. After washing the wound with normal saline for 3 times, a disposable radiofrequency ablation blade was used to achieve hemostasis, and the bleeding was stopped by compression with Ai Weiting and gelatin sponge. The incision was flushed with normal saline, and the dura mater was built-in to protect the dura. Further, presence of active bleeding in the incision or any foreign body was ruled out following the placement of a negative pressure drainage. Finally, the instruments and gauze were checked, and the incision was closed layer by layer，as shown in Figure 1.

Control group: After the general anesthesia was successful, the patient lied prone on the operating table, with pillow cushioned on the chest and hips. The body surface was located and the plane of the L4,5 intervertebral space was determined about 1.5 cm on the side of the L4,5 spinous process. After disinfecting the skin on the lower back 3 times with conventional iodine and alcohol, and draping the patient, the surgery was initiated; In the L4,5 gap about 1.5 cm on the right side of the guide needle, the back of the lower 1/3rd of the left side of the L5 lamina was punctured, the skin was incised approximately 3 cm longitudinally, the progressive expansion sleeve was inserted, and rotated it into the working channel to fix the work aisle. The curette scraped the soft tissues from the right lamina of L5 to the inner surface of the left facet joint, exposed the space between the lower edge of the L4 lamina and the upper edge of the L5 lamina. An electric grinder was used to grind and drill to remove 1/3rd of the bone from the lower edge of the L4 lamina to the right-side crypts to expose the ligamentum flavum. The nerve probe picked off the upper and lower attachments of the ligamentum flavum, the nucleus pulposus clamp was used to remove the ligamentum flavum, revealing the L5 nerve roots and the dural sac. The dural sac was seen without obvious pulsations.Bited up part of the bone in the lateral recess of the nerve root canal to the base of the lumbar spinous process to expand and decompress the L5 nerve root. After decompression, the dural sac and the right nerve root were seen to relax. The brain cotton sheet protected the L5 nerve roots and dural sac up and down, and a nerve probe was used to slowly separate the adhesion between the ligamentum flavum and the dural sac along the base of the spinous process of the L4 to the opposite side and bited off the hyperplastic and hypertrophic ligamentum flavum along the inner surface of the left lamina of L4 with the vertebral rongeurs to decompress the left spinal canal. After washing the wound with normal saline 3 times, the bleeding was stopped by gelatin sponge. If the wound was bleeding, it was acceptable to spray it with kampaite glue to stop the bleeding. The incision was rinsed with normal saline and absence of active bleeding in the incision and remaining foreign body was confirmed. After checking the instruments and gauze, the incision was closed layer by layer，as shown in Figure 2.

Efficacy and scoring standards

The patient characteristics such as gender, age, course of disease, operation time, and intraoperative blood loss between the two groups were recorded and compared; The VAS score of pain before surgery, 3 days, 3 months, and 6 months after surgery in the two groups were recorded, and ODI index was used to assess the ability of daily living of the two groups of patients before, 3 days, 3 months, and 6 months after surgery.

Statistical method

The collected patient data were analyzed by software SPSS25.0, and presented as mean±standard deviation. The general data of patients and postoperative clinical indicators were compared by independent sample t-test, and the difference was statistically significant with $P<0.05$.

Results

General information

There were no statistically significant differences in gender, age, and duration of disease between the two groups ($P > 0.05$), as shown in Table 1.

Table 1
General Information of Patients in Both Groups

Group	Gender (male/female)	Age (year)	Course (year)
Observation group		81.10 ± 3.44	11.85 ± 5.08
Control group		82.65 ± 5.12	13.80 ± 7.40
t-value	0.000	-1.123	-0.972
p-value	1.000	0.269	0.337

General results

The operation time and intraoperative blood loss of the observation group were less than those of the control group, and the difference was statistically significant (P < 0.05), as shown in Table 2.

Table 2
General Situation of the Two Groups of Patients During Perioperative Period

Group	The Operation Time (Min)	Blood Loss (mL)
Observation group	59.93 ± 10.46	21.06 ± 4.59
Control group	77.66 ± 12.44	51.00 ± 10.02
t-value	-4.878	-12.151
p-value	0.000	0.000

Comparison of VAS Score

The VAS scores of the observation group and the control group were not statistically different before and after the operation (P > 0.05);The postoperative VAS scores in each group were significantly lower compared with before the operation (P < 0.05), as shown in Table 3.

Table 3
Comparison of VAS Score Between the Two Groups (□, x□±s)

Group	Before Operation	3 Days After Operation	3 months After Operation	6 months After Operation
Observation group	6.05 ± 1.19	1.90 ± 0.85	1.10 ± 0.31	1.25 ± 0.44
Control group	6.40 ± 1.47	2.00 ± 1.08	1.20 ± 0.41	1.30 ± 0.57
t-value	-0.829	-0.326	-0.872	-0.309
p-value	0.412	0.746	0.389	0.759

Comparison of ODI Index

There was no significant difference between the two groups in terms of preoperative ODI index($P > 0.05$), the difference at 3 days after surgery was statistically significant (P□0.05), the difference was not statistically significant at 3 and 6 months after operation ($P > 0.05$), as shown in Table 4.

Table 4
Comparison of ODI Index Between the Two Groups (□, x□±s)

Group	Before Operation	3 Days After Operation	3 months After Operation	6 months After Operation
Observation group	0.78 ± 0.07	0.33 ± 0.06	0.28 ± 0.06	0.21 ± 0.07
Control group	0.74 ± 0.07	0.37 ± 0.05	0.30 ± 0.05	0.22 ± 0.04
t-value	1.740	-2.394	-1.526	-0.773
p-value	0.090	0.022	0.189	0.444

Discussion

LSS is a common degenerative disease of the lumbar spine, which is characterized by intermittent claudication. With the progression of disease, the distance the patient walks is gradually shortened, which eventually affects the patient's quality of life[2].It is the main cause of low back pain and even paralysis of both lower limbs in the elderly[3]. Further, blood circulation dysfunction caused by compression and the influence of inflammatory factors leads to the development of LSS in elderly patients. As the lumbar vertebrae bone and surrounding soft tissues have undergone morphological changes, the internal pressure of the spinal canal is increased, resulting in compression of the spinal cord or nerve roots, which in turn leads to aggravation of the disease[4]. Clinical treatment methods of LSS include conservative treatment and surgical treatment. The conservative treatment can only temporarily relieve the condition; however, it cannot solve the problem fundamentally. The surgical treatment includes traditional open posterior surgical treatment and minimally invasive channel treatment. For elderly patients with LSS, performing safe surgeries is deemed necessary as elderly patients may have existing comorbidities such as significantly reduced physiological functions, poor tolerance to surgery, high risk of surgery, high incidence of complications, and high chance of dural injury. Therefore, it is necessary for the surgeon to make a reasonable choice of the surgical approach according to the surgical indications, so that the elderly patients can also receive the surgical treatment. The traditional open surgery results in a large area of exposure that causes a large amount of blood loss, increases the risk of infection, and destroys the structure of the facet joints. The surgical trauma is not conducive to the stability of the patient's spine, and the probability of low back pain after surgery is greatly increased, thus making it difficult for elderly patients to tolerate it, and negatively affects the patients' recovery. Therefore, orthopedic surgeons must recognize a new surgical approach considering the limitations of open surgery. With the advances in medical technology, minimally invasive channel surgery has gained popularity. Minimally invasive microscopic or endoscopic decompression surgery can fully expand the spinal canal, which avoids the shortcomings of large opening and incomplete decompression in traditional posterior open surgery[5]. At present, surgical treatment of LSS in the elderly is controversial. Compared to traditional posterior open surgery, Quadrant channel fenestration has the advantages of shorter operation time, lesser intraoperative bleeding, lesser postoperative lumbar spondylolisthesis, and lower postoperative infection rate[6], thus making it an effective treatment modality. However, during the installation of the step-by-step expansion channel, with longer operation times, a large squeezing force on the surrounding soft tissues is applied that causes necrosis of the local skin and subcutaneous tissue at the operation site, which may affect the healing of the incision. In addition, when the channel is installed, there will be varying degrees of muscle and joint capsule tissue at the bottom of the channel due to the influence of the articular process. Therefore, in order to obtain a better exposure, the soft tissue at the bottom of the channel needs to be removed inevitably during the surgery, which may damage the muscle attachment points and joint capsules of the operation segment and may result in postoperative chronic low back pain. At the same time, limited by the channel, the surgical field of view is small, coupled with intraoperative blood oozing, the clarity and comfort of the surgical field of view are not good, and it is often necessary to resort to a special operating microscope, which increases the technical difficulty of the operation for the operator. Researchers have suggested that a “precision” fenestration operation for decompression should be performed under the foraminal lens, which aims to effectively relieve the disease with minimal trauma[7]. However, the foraminoscope cannot fully decompress the severe lumbar spinal stenosis. The emergence of Delta's large channel endoscopy technology conformed to the requirements of development. The Delta large channel endoscope has a large diameter, easy to operate, and has a field of view similar to that of open surgery [8], thus avoiding the limitation of the channel in the Quadrant channel fenestration decompression operation. Moreover, the operation space is large, and the damage to the muscle attachment point and joint capsule of the operation segment is small, so that the probability of low back pain after operation is greatly reduced. The Delta large channel endoscopy technology has a significant effect on the treatment of lumbar spinal stenosis. It can not only relieve the compression of the dural sac and the bone around the nerve roots on the nerves, but also relieve the compression of the intervertebral disc, posterior longitudinal ligament and ligamentum flavum and other soft tissues, without obvious damage to the lumbar spine[9], thereby effectively alleviating the radiation pain of the patient's lower back and both lower limbs, and improving the function of the patient's body. It can shorten the operation time and reduce the amount of intraoperative blood loss, and the operating medium is water to make the field of vision clearer. The continuous saline irrigation and flushing during the operation can wash away various inflammatory media around the diseased intervertebral disc and the by-products left by electrocoagulation, which can relieve postoperative pain[10].

In this study, all the 40 patients successfully underwent uneventful surgery. Among the 20 patients in the observation group, 19 had no postoperative complications, and 1 had an infection at the surgical site, which was cured after symptomatic treatment with anti-inflammatory and standardized dressing changes. Of the 20 patients in the control group, 15 patients had no postoperative complications, and 1 patient had cerebrospinal fluid leakage. The patient was instructed to stay in bed and was cured after conservative treatment with antibiotics; 3 patients with back pain were cured after administration of anti-inflammatory analgesics; 1 patient with localized necrosis of the skin edge of the surgical incision was cured after dressing change. We used an ultrasonic bone knife during the Quadrant channel fenestration decompression, the heat generated by the ultrasonic bone knife burnt the contacted skin, which caused the skin infection and necrosis.

In summary, Quadrant channel fenestration decompression can shorten the operation time, reduce intraoperative blood loss, and reduce surgical trauma[11], with a shorter learning curve, and a strong sense of three-dimensionality and overall sense during the operation. However, a special operating microscope is required as the surgical field of view is small, and the chance of chronic low back pain after surgery is relatively high. The emergence of Delta large channel endoscopy technology has made up for the limitations of the Quadrant channel fenestration decompression, and induces less surgical trauma with better curative effect. It has obvious advantages in relieving low back pain and improving the daily life of patients. The time of bed rest and hospitalization is greatly shortened, the incidence of complications is low, and the quality of life of patients is greatly improved. In addition, it is worthy of clinical promotion, although the Delta large channel endoscopy technology has certain limitations[12], as an improvement and optimization of the total spine endoscopy, it has a certain development potential in terms of trauma, visual field and work efficiency. There are still some shortcomings in this study. The number of observation cases is small and the clinical observation time is short. There may be some deviations in the report on the treatment effect. Further research is needed in the later. In the treatment, it should be considered comprehensively according to the patient's physical condition and economic conditions.

Declarations

Conflict of Interest: The authors did not receive support from any organization for the submitted work and have no relevant financial or non-financial interests to disclose.

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Ethics approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Bioethics Committee of the Nanjing Hospital of Chinese Medicine Affiliated to Nanjing University of Chinese Medicine. Informed consent was obtained from all patients to participate in the study.

Consent for publication: Patients signed informed consent regarding publishing their data and photographs.

Availability of data and materials: All data generated or analysed during this study are included in this published article.

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Authors' contributions:

Jianing Zhang：Writing – original draft

Weiqing Qian：Writing – review & editing

Dingjie Liang：Investigation

Mengmeng Xu：Methodology

Kun Yan：Data curation

Dapeng Zhang：Formal Analysis

References

1. Luo H, et al, Discussion on the Treatment Status and Prospect of Lumbar Spinal Stenosis. OURNAL OF LIAONING UNIVERSITY OF TCM, 2020. 22(12): p.104–110. https://doi.org/10.13194/j.issn.1673-842x.2020.12.025
2. Zhao X.B., et al., Percutaneous Endoscopic Unilateral Laminotomy and Bilateral Decompression for Lumbar Spinal Stenosis. Orthop Surg, 2021. 13(2): p. 641–650. https://doi.org/10.1111/os.12925. Epub 2021 Feb 9.
3. Anderson, D.B., et al., A critical appraisal of clinical practice guidelines for the treatment of lumbar spinal stenosis. Spine J, 2021. 21(3): p. 455–464. https://doi.org/ 10.1016/j.spinee.2020.10.022. Epub 2020 Oct 26.
4. Han H.Y, Comparison of Conservative Treatment and Surgical Treatment of Senile Lumbar Spinal Canal Stenosis. Smart Healthcare, 2017. 3(07): p.125–126. https://doi.org/10.19335/j.cnki.2096-1219.2017.07.58
5. Korge, A., C. Mehren and S. Ruetten, [Minimally invasive decompression techniques for spinal cord stenosis]. Orthopade, 2019. 48(10): p. 824–830. https://doi.org/10.1007/s00132-019-03732-7.
6. Scholler, K., et al., Lumbar Spinal Stenosis Associated With Degenerative Lumbar Spondylolisthesis: A Systematic Review and Meta-analysis of Secondary Fusion Rates Following Open vs Minimally Invasive Decompression. Neurosurgery, 2017. 80(3): p. 355–367. https://doi.org/10.1093/neuros/nyw091.
7. Kong C, et al, Safety and efficacy of surgical treatment for aged patients with degenerative lumbar spinal stenosis. Chinese Journal of Spine and Spinal Cord, 2018. 28(11): p.1004–1010 + 1019. https://doi.org/10.3969/j.issn.1004-406X.2018.11.07

8. Wang H.J, Wu Z.P, Comparison of single channel-spinal endoscopy (Delta) and unliateral biportal endoscopic technique for the treatment of senile lumbar spinal stenosis. Journal of Xi'an Jiaotong University(Medical Sciences), 2021. 42(06): p.797–801. https://doi.org/10. 7652/jdyxb202106001
9. Zhang J.J., et al., Clinical Efficacy Study of the Quadrant Channel and Delta Large Channel Technique in the Treatment of Lumbar Degenerative Diseases. Int J Gen Med, 2021. 14: p. 2437–2447. https://doi.org/10.2147/IJGM.S309272. eCollection 2021.
10. Zhao D.D, et al, Efficacy of iLESSYS Delta Endoscopic System and Microendoscopic Discectomy in the Treatment of Lumbar Spinal Stenosis. Mil Med J S Chin, 2020. 34(02): p.82–87. https://doi.org/10.13730/j.issn.1009-2595.2020.02.003
11. Zhang K, Comparison of curative effect between minimally invasive channel and traditional surgery in the treatment of lumbar spinal stenosis. Shenzhen Journal of Integrated Traditional Chinese and Western Medicine, 2017. 27(15): p.129–131. https://doi.org/10.16458/j.cnki.1007-0893.2017.15.060
12. Tang Z.H, et al, Clinical Study of Translaminar Approach under Delta Channel of Spinal Endoscopy in the Treatment of Lumbosacral 1 Disc Herniation. World Latest Medicine Information (Electronic Version), 2019. 19(63): p.29–30 + 32. https://doi.org/10.19613/j.cnki.1671-3141.2019.63.014

Figures

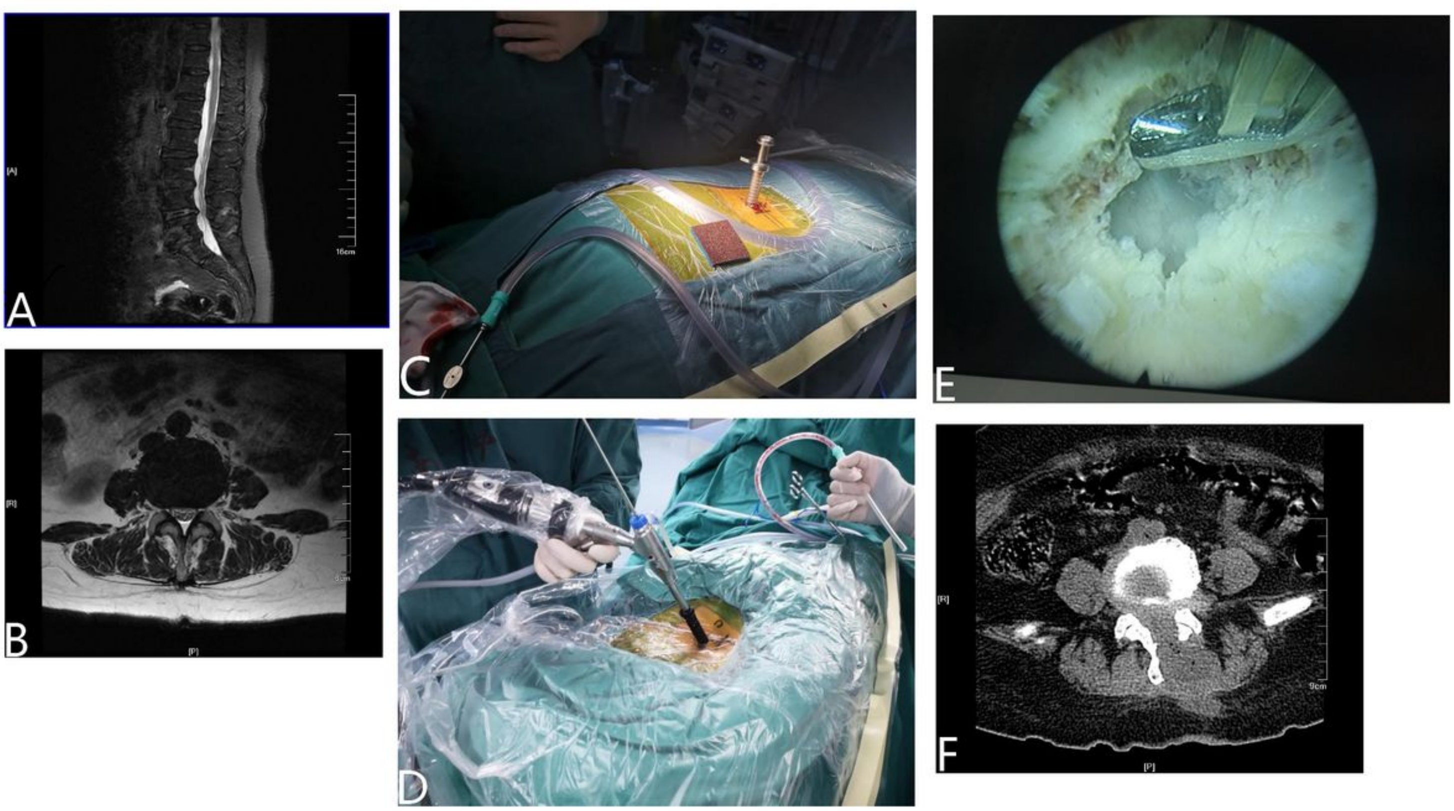

Figure 1

The imaging data of a 76-year-old woman with lumbar spinal stenosis treated by Delta large channel endoscopy

A□B□Preoperative MRI showed L4/5 spinal canal stenosis□C□D□Patient's position and established operating channel□E□Expose the nerve roots and dural sac of the L4/5 segment□F□Postoperative cross-sectional CT showed adequate decompression of the L4/5 spinal canal.

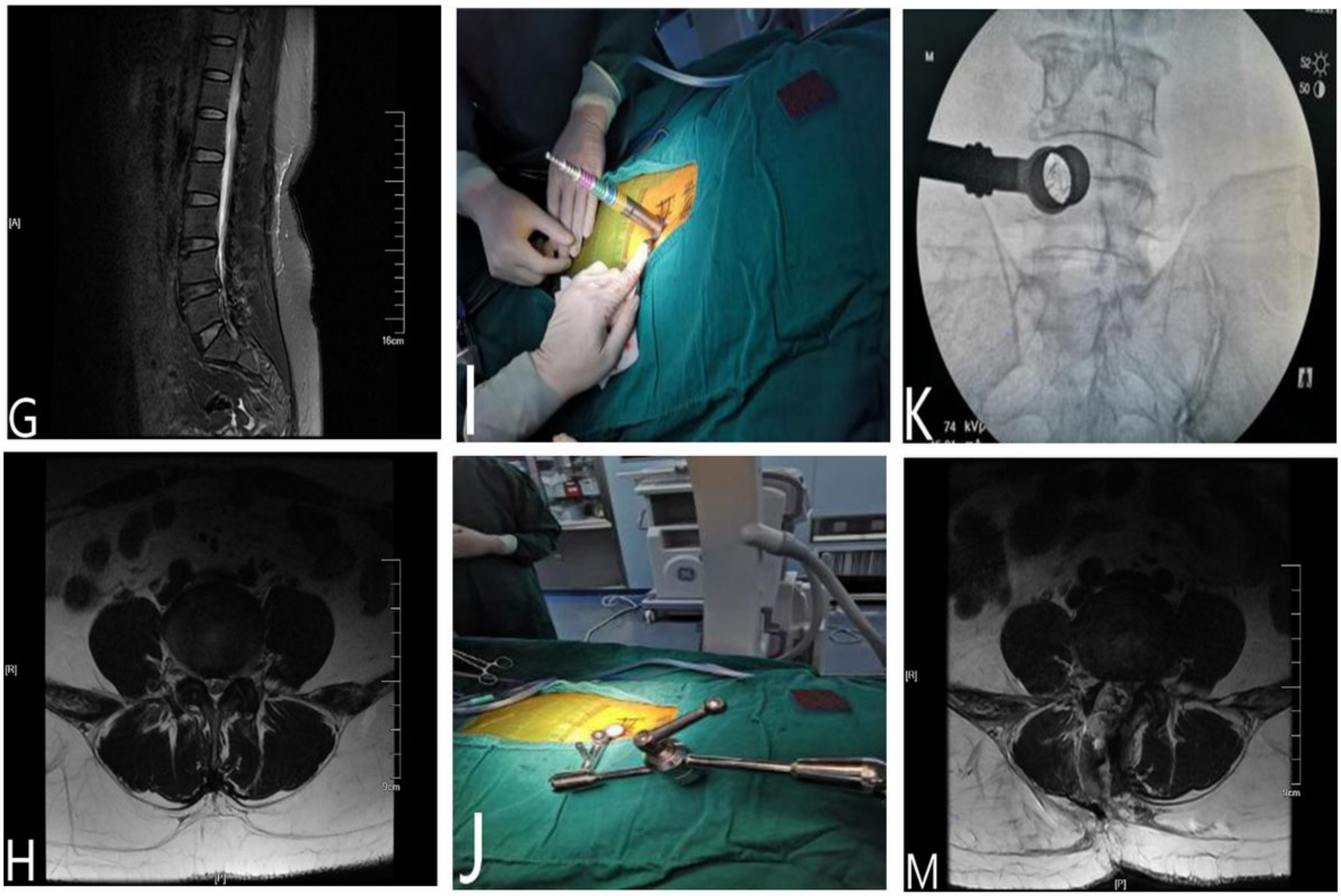

Figure 2

The imaging data of a 78-year-old man with lumbar spinal stenosis treated with quadrant channel fenestration decompression

G□H□Preoperative MRI showed L4/5 spinal canal stenosis□I□J□The patient's posture and operating channel and fixing devices□K□Intraoperative X-ray positive and lateral view shows the situation of the tube placement□M□Postoperative cross-sectional CT showed adequate decompression of the L4/5 spinal canal