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Original Article

Application of improved fixed nerve retractor in posterior surgery of lumbar disc herniation

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Abstract: This study aimed to discuss the potential intraspinal surgery value of fixed nerve retractor. This retrospective analysis was performed on a total of 80 patients with monosegment lumbar disc herniation (LDH) combined with lumbar spine instability, from December 2013 to December 2015. Patients in group A (n = 40) were treated using traditional nerve retractor to obstruct nerve roots. Patients in group B (n = 40) were treated using fixed nerve retractor to fix nerve roots. Visual analogue scale (VAS) and Japanese Orthopaedic Association (JOA) scores were used to estimate potential differences in patients in pre-operation, post-operation, and follow up visits at the first month, third month, sixth month, and twelfth month, respectively. Simultaneously, detailed operation times of actual tractive, intraoperative hemorrhages, and operation times in each patient were recorded. No significant differences in age, gender, distribution of lesion segments, illness course, VAS, and JOA scores before the operation were detected between groups A and B. In group B, in the first month and third month, VAS and JOA scores were improved compared to group A, but no significant differences were detected at sixth months and twelve months. Moreover, tractive times of nerve roots in group B were shorter than in group A. Amount of intraoperative hemorrhages and operation times were also less. Compared to the traditional method, fixed nerve retractor are more effective in the treatment of segment LDH. The main reason may be significantly reduced tractive times, amount of bleeding, and operation times, which contribute to early recovery.

Keywords: Fixed nerve retractor, lumbar disc herniation (LDH), visual analogue scale (VAS), Japanese Orthopaedic Association (JOA) scores

Introduction

Lumbar disc herniation (LDH) is a syndrome with main symptoms of stimulating and oppressing nerve roots and cauda equina, caused by lumbar degenerative disease, annular disruption, and herniation of the nucleus pulposus. LDH is a common and frequently-occurring disease. It is one of the main reasons leading to back and leg pain [1]. This disease is usually given conservative treatment, but treatment cycles are long and the disease is prone to relapse. With the development of living standards, increasing numbers of patients have selected operative treatment [2, 3]. Since Miter and Barr first operatively verified a cure of LDH in 1934, operative treatment of LDH has been performed for over 70 years, being largely developed and innovated [4]. LDH manifests as low back pain radiating to the lower limbs with a distribution area corresponding to dermatomes of the nerve roots. In industrialized countries, back pain due to LDH or other degenerative osteodiscal changes is the leading cause of occupational absenteeism. It is one of the main reasons for consultation in primary care and one of the most prevalent causes of chronic pain, second only to headaches. The usual clinical manifestation of LDH is sciatica. Some 30-40% of the population suffers from sciatica, at some point, especially between the fourth and fifth decades of life. The typical case of sciatica, caused by LDH (generally dorsolateral), is unilateral pain starting in the posterior medial-gluteal area or lumbar area that radiates through the lateral aspect (L5) or posterior aspect of the thigh (S1) to the foot. Hernias that compress the L4 nerve root tend to cause pain through the anterolateral aspect of the thigh. Pain may be bilateral in some hernias with a preferentially central location or in cases of associated stenosis or spondylolisthesis and

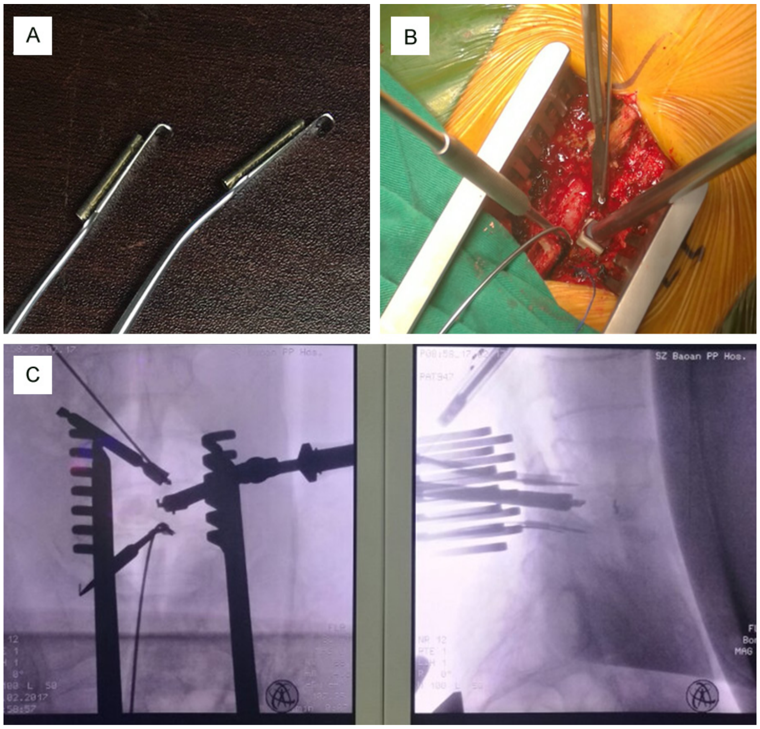

Figure 1. A. The improved nerve retractor has prefabricated pipeline in the surface of the nerve stripper or hook, and the kirschner wire can pass through it to fix the retractor on the vertebral body. B. The intervertebral space was exposed by the fixed retractors by the side of two pedicle. C. It showed the anteroposterior and lateral radiographs during operation.

may be part of a syndrome of neurogenic claudication. Currently, combined methods of posterior interbody fusion and pedicle screw fixation have been widely applied in clinic treatment of LDH. Its security and effectiveness have been validated by many clinical studies [2]. Exposing nerve roots and remove disc materials, the nerve root retractor has been a useful surgical instrument.

However, the operation has certain risks [5]. Nerve injury is one of the most common complications in fixed fusion surgery [6]. Nerve injury may be a transient paralysis or may be continual damage. To remove outstanding nucleus pulposus or implant fusion cage in intervertebral spaces after excision of nucleus pulposus, nerve root retractors are used to stretch nerve roots. This can cause nerve tractive damage [7]. Krishna et al. reported that nerve damage caused by excessive traction possessed 56% nerve damage and it was the most common reason [8]. Therefore, avoiding tractive nerve damage has been an urgent problem for spinal surgery.

Nerve root retractors are a necessary instrument in surgery of nucleus pulposus removal [7]. However, the old version of nerve root retractors, once commonly used in clinics, can cause nerve root injuries due to various reasons, including excessive traction [9, 10]. Previous studies have shown that improved nerve tractive methods may ideal in reducing nerve damage [7, 9, 11]. At present, widely used new-style nerve root retractors, such as the Love nerve root retractor, have not been recommended for clinical use due to their complex structure and poor clinical utility. Therefore, discovering a safe and effective method to retract nerve roots and expose disc space would be of great value.

This present study used an improved nerve hook to fix nerve roots and expose intervertebral discs. This study aimed to discuss the operation value of this method in intraspinal operations.

Materials and methods

Patients

A total of 80 patients with monosegment LDH, accompanied by illnesses that were unstable and suitable for PLIF treatment, from December 2013 to December 2015, in Shenzhen Baoan Hospital, were selected at last. They were randomly divided into 2 groups, group A and group B (n = 40 in each group). These patients were examined, diagnosed, and operated on by the same spine surgeons. Some indexes were examined before operation, including history-taking, neurological examinations, lumbar positive side, and hyperextension as well as X-ray examinations of hyperflexion, CT, and MRI examination. According to inclusion and exclusion criteria, these patients were obviously diagnosed.

Inclusion criteria: (1) Imaging results indicated monosegment LDH and unstable illnesses.

According to FryMoyer criteria [12], X slice of anteflexion-rear protraction indicated shifting more than 3 mm or adjacent vertebral body enlarged, L5S1 segment was larger than 20°, and other segments more than 15° were unstable; (2) Clinical features were serious lumbocrural pain. Patients had obvious radiculopathy symptoms, no lumbar injury, or history of lumbar spine surgery. These patients were cured and left the hospital via first regular operation (such as lumbar surgery) or they needed operative treatment because they had poor therapeutic effects after half a year via conservative treatment; and (3) Patients were required to coordinate follow up scores according to the study design. Exclusion criteria: (1) Patients diagnosed as protrusion of LDH combined with lumbar spondylolisthesis and lumbar spinal stenosis; (2) Patients diagnosed with LDH combined with other serious internal medicine diseases and patients with poor physical quality; and (3) Included subjects that could not finish clinical research and follow up.

The trial was approved by the Shenzhen Baoan Hospital Ethics Committee, Guangdong, China.

Operative technique

All patients were given general anesthesia in the prone position. Vertebral plates and zygopophysis of patients were exposed by separating paravertebral muscles in two sides via layer-by-layer cutting using a posterior midline approach based on the center of lesion segments. Four pedicle screws were implanted into intervertebral space of vertebral lesions. They were validated under C-Arm X-medical equipment. Vertebral plates were cut, narrow lateral recess was enlarged, and dural sac and relevant nerve roots were exposed by stripping intervertebral discs from nerve roots and dural sac using nerve hooks. About 1.5 cm of nerve root was released to obtain suitable nerve root tension. Posterior-lateral fibrous rings were exposed after slightly opening the dural sac and nerve roots. Knives were used to cut fibrous rings and the incision indicated square. Nucleus pulposus clamps were used to chop intervertebral tissues. Annular scrapers were used to chop cartilage plates from intervertebral discs and subchondral cortical bone was sustained and chopped to rough surface. In these processes, annular curets were ensured not to exceed to forward fibrous rings, avoiding damage to blood vessels and nephric ducts in front of the lumbar spine. Interbody fusion cages were used to confirm suitable type. Appropriate crushbones were implanted into intervertebral discs and then interbody fusion with crushbones were implanted into intervertebral discs. The two sides were suppressed to approved depths using an embedder. The detailed cage position was perspective identified and pedicle screws were screwed into the centrum and pressurized fixed. Finally, cases were further perspective identified to verify stable cages and no broken crushbones or nucleus pulposus and other compressive things existing in the canalis spinalis.

During surgery, there were two methods to pull nerve roots and dural sacs to expose intervertebral discs. In group A, traditional nerve retractors including nerve hooks and nerve dissectors were used to expose annulus fibrosus fibrocartilaginis intervertebralis by stretching nerve roots and dural sacs to the spinal canal line. In group B, two improved nerve retractors were used to slightly pull nerve roots and dural sacs. Next, two kirschner wires were fixed in two vertebral bodies, respectively, via prefabricated pipelines in the end of nerve dissectors or hooks. Nerve roots and dural sacs were split with intervertebral discs. Terminus of kirschner wires were fixed in an operation towel using hemostatic forceps (**Figure 1**). Brain cottons were put between nerve retractors and nerve roots. Real tractive times were reduced as far as possible. Tractive times, intraoperative hemorrhages, and operative times were detailed and recorded. After the operation, hormone, trophic nerve, and improved microcirculation drugs were given. Drainage tubes were removed if the amount of drainage was less than 50 mL/24 hours. Patients could resume ground activity after 3-5 days with protection in the waistline. After 12-14 days, patients stitches were removed. They began to train back muscles after 2 weeks. Waistline protection was worn for 1 month and aggravating activities were avoided for 3 months.

Clinical evaluation

Patients were required to provide background information and finish visual analogue scale (VAS) scores to estimate release of lumbago and skelalgia. Japanese Orthopedic Association (JOA) scores estimated the functional condition

Table 1. General information about patients in the study

Indexes	Group A	Group B
Age (Years old)	41±12	44±13
Gender (male/female)	23/17	25/15
Segmental lesions		
L4-L5	19	23
L5-S1	21	17
Course of disease (m)	66±9	63±12

Table 2. Comparison of tractive time, intraoperative hemorrhage, and operation time in the two groups

Indexes	Group A	Group B
Tractive time of nerve root (min)*	11.45±1.56	9.05±2.07
Intraoperative hemorrhage (ml)*	425±45	376±43
Operation time (min)*	140±21	125±18

*: Group A compared with Group B, $p < 0.05$.

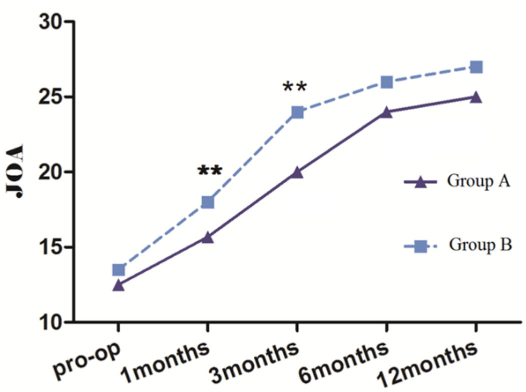

Figure 2. Comparison of pre- and post-operative JOA scores at different follow-up time points between Group A and B. **: Group A compared with Group B, $p < 0.05$.

of the spine. VAS and JOA scores were recorded before the operation and in the first month, 3rd month, 6th month, and 12th month after the operation.

Statistical analysis

SPSS 13.0 software was used to perform statistical analysis. Tractive times, intraoperative hemorrhages, and VAS and JOA scores after the operation were analyzed using *t*-test. VAS and JOA scores before and after the operation at different time points were analyzed using AMOVA analysis. Inspection level α was set 0.05 and $P < 0.05$ is considered a statistically significant difference.

Results

Operations were successfully completed in all patients and detailed operation processes were recorded. Serious complications, such as nerve injury, large vascular injuries, embolisms, and perioperative death, were not detected. Subdural leakage was found in 2 patients in group A and 1 patient in group B. The situation was covered with gelatin sponges. Drainage tubes were removed after 5-7 days. Drain entrances were sewn and notches were I-level healed.

Statistical analysis showed that the two groups had no significant differences in age and gender composition, distribution of lesion segments, and course of disease before the operation ($P > 0.05$, **Table 1**), indicating that the two groups could be compared. Compared with group A, group B had less tractive time, intraoperative hemorrhages, and operative time ($P < 0.05$, **Table 2**). In the two groups, no obvious post-operative complications were found.

All patients were performed outpatient reviews and finished follow ups via telephone or e-mail. Compared with group A, JOA and VAS scores were significantly improved in group B in the first and 3rd month after operation. However, in the 6th month and 12th month, no significant differences were detected. In every group, JOA and VAS scores after the operation were significantly changed ($P < 0.05$, **Figures 2**, **3**).

Discussion

Incidence of LDH has gradually increased with increasing population age. Strict conservative treatment can respite symptoms, but this does not satisfy patients because it does not respite the origin of the symptoms. Therefore, operations are a necessary treatment method [2]. Since lamina resection of nucleus pulposus with excision, reported by Nagayama et al. [12], was successfully performed, it has been the most common surgical method in spine surgery. Most patients can be improved regarding nerve root pain using this surgery. However, the effects of surgery are not always perfect. Some patients may experience postoperative residual low back pain, numbness of lower limbs, and muscle weakness. This may be due to tractive

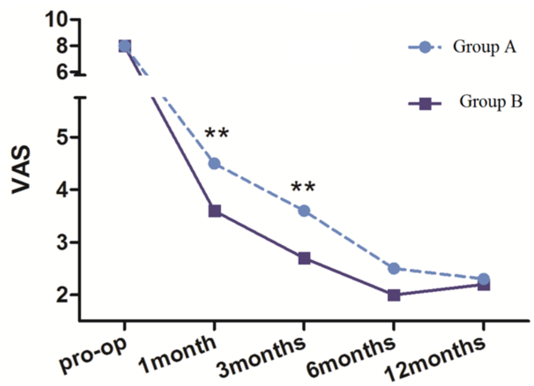

Figure 3. Comparison of pre and post-operative VAS scores at different follow-up time points between Group A and B. **: Group A compared with Group B, $p < 0.05$.

damage in nerve roots [13, 14]. Compared with peripheral nerves, nerve roots lack protection of epineurium and beam membranes. Both strength and stiffness are lower than peripheral nerves, therefore, nerve roots are prone to be influenced by mechanical stretching [15, 16]. How to reduce tractive damage in nerve roots has attracted much attention, including intraoperative nerve detection, intraoperative awakening experiment [17], and redevelopment of nerve hooks [7, 11]. In this study, fixed nerve retractors improved from the nerve strippers and hooks were used to fix nerve roots to expose intervertebral discs. This study aimed to discuss the potential operative value of these retractors in canalis spinalis.

In clinic, lumbar disc herniation with lumbar vertebrae unsteadiness is common, due to degeneration of lumbar intervertebral discs [18]. With more lumbar disc degeneration, the higher the incidence of lumbar instability will be [19]. Simple nucleus pulposus removal may generally aggravate instability of the lumber spine, further leading to long-term lower back pain [20]. Therefore, in treatment, effective decompression and rebuilt stability of the spine are ideal operative methods of improving long-term effects [21]. In this study, patients with LDH and lumbar instability were involved. They were performed using PLIF to lumbar interbody fusion. The aim of this operation was to remove compression factors of nerve roots or dural sac factors, simultaneously stabilizing the spine.

In PLIF surgery, it is necessary that the assistant pulls the nerve roots in epidural capsule to the offside using nerve retractors to expose intervertebral disc fiber rings, then dealing with intervertebral space. Generally, hook indicates L type and front end indicates plate right hook. It can be tractive in the surface of fibrous rings and have tractive and protection roles in epidural sacs and nerve roots [7]. However, operations in intervertebral space may be performed with nerve hooks, which may lead to movement of nerve hooks and damage nerves. Therefore, the assistant must keep their posture and continuously pull the nerve hooks. It is very strenuous. The process may cause movement of nerve hooks and pulling of nerves, causing damage if the assistant feels arm numbness due to long-term maintenance of the same posture. Addressing this problem, this study used two improved nerve retractors to replace the traditional hook. Kirschner wires were used to fix them in two vertebral bodies by surface rebuilt pipelines. Thus, nerve roots and dural sacs can be split with intervertebral discs. No additional pulling was needed, compared with traditional the hook, as kirschner wires can fix the responding positions after nerve epidural is pulled to specific positions. The position of hooks cannot be moved by human factors. The operating position is exact and fixation is reliable and secure. Moreover, this method can help assistants to concentrate on other operations, effective hemostatic, and reduce operative times. This present study found that improved nerve retractors can significantly reduce tractive times, intraoperative hemorrhages, and operative times.

Matsui et al. [22] reported that the degree of damage via nerve pull is related to tractive time and intensity. This conclusion was by studying relationships of nerve roots pull and neural symptoms after operations. Gentle operations and reduced tractive times may be crucial in reducing nerve damaging symptoms. However, Feltes et al. [23] found that, although larger nerve root pulling intensities were involved than that in Matsui's study, follow up results showed that no significant nerve damaging symptoms were detected. Feltes et al. believed that the difference may be derived from the shorter time of pulling nerves [23]. Based on these, this study speculated that reducing tractive time will have a common role in improving nerve symptoms. This study showed that both VAS and JOA scores in group B were improved in the first month and 3rd month after the operation, indicating that improved nerve retractors can reduce tractive times of nerve roots and contribute to nerve functional recovery by optimizing surgical processes. Interestingly, no significant differences in these scores were detected in the 6th month and 12th month between the two groups. This may be due to the fact that regeneration of nerve fibers is always detected within 6 months after being damaged [24].

Although this study showed the advantages of using modified nerve root retractors, some limitations should be noted. For example, the technique used in this study only applies to the PLIF operation, not the more widely used TLIF operation. Also, whether it can be used in percutaneous procedures that use tubular retraction systems requires further investigation. In addition, the sample size in the present study was small. A further study with a larger cohort will be needed to further corroborate the present observations. The long-term benefits of modified retractors require further study.

Compared with the traditional method, improved fixed nerve retractors are more effective in treating LDH, thanks to significantly reduced tractive times, intraoperative hemorrhages, and operative times. These can promote early recovery.

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Disclosure of conflict of interest

None.

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