Retrospective Clinical Research Report

Journal of INTERNATIONAL MEDICAL RESEARCH

Journal of International Medical Research
48(7) 1–8

DOI: 10.1177/0300060520938966
journals.sagepub.com/home/imr
SAGE

A surgical decompression procedure for effective treatment of calcified lumbar disc herniation

Dawei Wang[1], Jianqiang Xing[1], Bin Shao[1], Hongmin Su[2], Xiaomei Zhang[1], Wei Zhao[1], Qingmin Fang[1], Jinchuan Sun[3], Zheng Zhang[1], Daijie Zhang[1] and Tianqi Zhang[1]

Abstract

Objective: To present our experience in managing calcified lumbar disc herniation (cLDH) using a surgical decompression procedure.

Methods: Patients who had low back pain radiating to the leg, were preoperatively diagnosed with cLDH by computed tomography and/or magnetic resonance imaging, and were treated with a surgical decompression procedure were studied. Those without cLDH or who were treated with a method other than decompression were excluded. The treatment outcome was analyzed using the visual analog scale (VAS) score, Oswestry Disability Index, and modified Macnab criteria.

Results: Thirty-seven patients aged 60.5 ± 9.6 years were evaluated. The VAS scores were significantly decreased 1 day after surgery and remained low at the 3-month and 1-year follow-ups. The Oswestry Disability Index was also significantly lower at the 3-month and 1-year follow-ups. Ninety-four percent of patients rated the results as "excellent" or "good" according to the modified Macnab criteria at the 3-month follow-up. The patients developed few postoperative complications and no recurrence during 1 year of follow-up.

Conclusion: Our data suggest that the decompression approach is effective for management of cLDH at least in the short term (1 year) with respect to reducing pain and improving patient satisfaction with few complications.

[1]Department of Spine Surgery, Binzhou Medical University Hospital, Binzhou, Shandong Province, China
[2]Department of Spine Surgery, Heze Municipal Hospital, Heze, Shandong Province, China
[3]Department of Hand and Foot Surgery, Binzhou People's Hospital, Binzhou, Shandong Province, China

Corresponding author:
Xiaomei Zhang, Department of Spine Surgery, Binzhou Medical University Hospital, 661 Huanghe Second Road, Binzhou, Shandong Province 256603, China.
Email: zhangxiaomei64@outlook.com

Keywords
Lumbar disc herniation, calcification, radiculopathy, decompression, discectomy, visual analog scale, Oswestry Disability Index, Macnab criteria

Date received: 1 December 2019; accepted: 9 June 2020

Introduction

Lumbar disc herniation (LDH), the most common type of intervertebral disc herniation, primarily affects people aged 30 to 50 years and more often develops in men than women.[1,2] Natural degeneration of the intervertebral disc occurs with aging, which is associated with LDH.[3–6] Herniated discs can result in local inflammation and mechanically deform surrounding nerve roots, causing radiculopathy, which requires treatment with either surgical or nonsurgical approaches.[7–11]

The surgical indications for LDH are well defined. If the patient has imaging-confirmed LDH that is refractory to initial conservative management such as medications and physical therapy and/or symptoms of radiculopathy are severe and persistent, surgical removal of the herniated disc material can achieve great relief of pain and a high degree of patient satisfaction with minimal risks.[8–12] Various surgical techniques have been used for the treatment of LDH to date, including macrodiscectomy, microdiscectomy, and percutaneous endoscopic lumbar discectomy (PELD).[13–19] Microdiscectomy involves the introduction of an operating microscope during surgery for better visualization of the operative field, which entails a smaller incision and makes the procedure less traumatic.[20] Compared with macrodiscectomy, microdiscectomy requires a shorter operation time and causes less bleeding, leading to a shorter hospital stay, less postoperative pain, and faster recovery.[13] Percutaneous endoscopic procedures have been increasingly gaining popularity, and many studies have shown high success rates with PELD.[17–19] However, PELD has a steep learning curve, and its superiority over other methods remains unresolved because of the lack of randomized controlled trials with large samples.[21–23] Therefore, microdiscectomy is still the standard treatment method for LDH.[23,24]

Calcified LDH (cLDH) is poorly described.[25] It can manifest as low back pain radiating down the leg, severely limiting normal activity and impairing quality of life. The pathology of cLDH is not yet clear. Infection, microtrauma, impaired blood flow, and metabolic diseases are thought to contribute to calcification of intervertebral discs.[25] Research has suggested that calcification may complicate surgical treatment of herniated discs.[26] Resection of calcified herniated lumbar discs in adults has been rarely documented to date. Two groups have described the use of PELD for the removal of calcified herniated lumbar discs in middle-aged patients: Kim et al.[25] employed either the interlaminar or the transforaminal approach and Dabo et al.[27] performed only interlaminar discectomy. Calcification causes the disc to harden, and resection of the calcified disc is challenging. A high incidence of postoperative complications (e.g., dysesthesia) associated with nerve root injury during surgery has been reported.[27] The objective of this study was to examine the effect of a surgical

decompression procedure for the treatment of cLDH. This procedure involves the resection of all structures surrounding the nerve root except the calcified disc.

Methods

Patients and data collection

A retrospective study was conducted to investigate the effect of a surgical decompression procedure for the treatment of cLDH. The electronic medical records of all patients who underwent surgical treatment of cLDH in our department from November 2014 to November 2017 were retrospectively reviewed. All patients presented with low back pain radiating to one or both legs. Despite conservative treatments such as acupuncture, physiotherapy, and medication (e.g., nonsteroidal anti-inflammatory drugs, mecobalamin) for at least 6 months, the pain was persistent or recurrent and affected daily activities. A preoperative diagnosis of cLDH was confirmed by computed tomography and/or magnetic resonance imaging. Patients without cLDH or who were treated with a method other than surgical decompression were excluded from this study. All operations were completed by surgeons with more than 5 years of experience. Demographic information, clinical data, and follow-up results were retrieved and analyzed.

This study was approved by the Medical Research Review Committee of Binzhou Medical University Hospital, Binzhou, Shandong Province, China (No. 2019-010-01, approved on 8 March 2019), in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki). Because this was a retrospective study, the Committee waived the requirement for obtaining informed consent from patients.

Surgical procedure

We performed an open microsurgical foraminal decompression procedure without resection of the herniated discs by focusing on removing other structures that contribute to nerve compression. The procedure was performed as follows. The patient was placed in the prone position and given general anesthesia, and the affected segment was located by fluoroscopy. A vertical incision extending from approximately 1.0 cm superior to the spinous process of the affected upper lumbar vertebra to the spinous process of the lower vertebra was made. After incision of the aponeurosis, the multifidus was retracted to the lateral side to expose the spinous process, lamina, ligamentum flavum, and medial border of the superior facet. The ligamentum flavum was then dissected and excised. Next, hemi-laminectomy of both the inferior edge of the superior lamina and the superior edge of the inferior lamina was performed, and the partial medial border of the superior facet was resected. After the surrounding structures were removed, the nerve root and dural sac were separated and released from the adherent tissue with a hook. Finally, the aponeurosis, subcutaneous fascia, and skin were closed with absorbable sutures. The same procedure was performed for the other side if affected, and corsets were applied. The patient was discharged on postoperative day 2.

Outcome assessment

Leg pain before and after the operation was assessed by a visual analog scale (VAS) with a score ranging from 0 to 10.[28] Functional disability before and after the operation was measured by the Simplified Chinese Version of the Oswestry Disability Index (ODI), version 2.1a.[29] Surgical outcomes were also evaluated following the modified Macnab criteria as previously described.[30]

Follow-up

Patients were followed up at 3 months and 1 year after surgery. The VAS score and ODI were obtained at both follow-ups, while outcome evaluation according to the Macnab criteria was only performed at the 3-month follow-up.

Statistical analysis

Statistical analysis was performed using SPSS version 13.0 software (SPSS Inc., Chicago, IL, USA). Data normality was tested using the Shapiro–Wilk test. Parametric data are expressed as mean ± standard deviation, while nonparametric data are presented as median (interquartile range). The VAS score and ODI before and after surgery were analyzed by the paired Student's t test. A P value of <0.05 was considered statistically significant.

Results

Forty-one patients were treated with the surgical decompression procedure and 4 were lost to follow-up. Therefore, 37 patients (21 men, 16 women; mean age, 60.5 ± 9.6 years) were included in this study. The patients' demographics, clinical characteristics, and operative parameters are shown in Table 1. All patients had cLDH as confirmed by preoperative computed tomography and/or magnetic resonance imaging. The herniated disc caused left leg pain in 10 patients, right leg pain in 12 patients, and bilateral leg pain in 15 patients. A single disc was affected in 10 patients, 2 discs were affected in 24 patients, and 3 discs were affected in 3 patients. The median operating time was 40 minutes/disc, and the median blood loss during surgery was 60 mL/disc. One patient developed significant pain on postoperative day 2, possibly due to nerve injury during aggressive release of the nerve root. Anti-inflammatory and neurotropic medications were administered to this patient, and the pain was subdued 1 week later and had disappeared by the 3-month follow-up.

Table 1. Patient demographics, clinical characteristics, and operative parameters.

Sex, male/female	21/16
Age, years	60.5 ± 9.6
Affected discs	
One disc	10
Two discs	24
Three discs	3
Leg pain	
Left	10
Right	12
Bilateral	15
Operation time, minutes/disc	40 (35)
Blood loss, mL/disc	60 (78)

Data are presented as number of patients, mean ± standard deviation, or median (interquartile range).

Table 2. Visual analog scale score for leg pain before and after surgery.

Before surgery	6.9 ± 0.9
Second day after surgery	3.2 ± 1.0*
3-month follow-up	2.1 ± 0.7*
1-year follow up	1.6 ± 0.7*

Data are presented as mean ± standard deviation.
*$P < 0.01$ compared with before surgery.

We determined the VAS scores for leg pain before the surgery and 1 day after the surgery. The VAS scores for leg pain were also measured at the 3-month and 1-year follow-ups. As shown in Table 2, the mean VAS score was 6.9 ± 0.9 before the operation and significantly decreased to 3.2 ± 1.0 on postoperative day 2 ($P < 0.01$), indicating that the patients' leg pain was substantially relieved by the procedure. At the 3-month and 1-year follow-ups, the mean VAS scores were 2.1 ± 0.7 and 1.6 ± 0.7, respectively (Table 2).

The ODI data are shown in Table 3. The mean ODI was significantly lower at the 3-month follow-up ($10.8\% \pm 5.3\%$) than

Table 3. Oswestry Disability Index before surgery and during follow-up.

Before surgery	48.9% ± 6.9%
3-month follow-up	10.8% ± 5.3%*
1-year follow-up	6.9% ± 3.4%†

Data are presented as mean ± standard deviation.
*$P < 0.05$ and †$P < 0.01$ compared with before surgery.

before surgery (48.9% ± 6.9%) ($P < 0.05$). At the 1-year follow-up, the mean ODI was 6.9% ± 3.4%.

Surgical outcomes evaluated according to the modified Macnab criteria showed that at 3 months after surgery, 43.6% of the patients reported the results as "excellent," 50.4% as "good," 6.0% as "fair," and 0.0% as "poor."

Discussion

While the herniated disc compresses the nerve root anteriorly, other surrounding structures contribute to nerve compression from other directions. In view of this, we applied a surgical decompression approach to treat cLDH. This method does not involve resection of the calcified disc, which can be very challenging. Instead, we removed the ligamentum flavum and partial medial border of the superior facet and performed hemi-laminectomy of both the inferior edge of the superior lamina and the superior edge of the inferior lamina to relieve the pressure on the nerve root. We found that 1) this approach could be completed in less than 1 hour per affected disc, 2) the leg pain subsided substantially 1 day after surgery as shown by the markedly lower VAS scores, 3) the disability status was remarkably improved after surgery as reflected by the decreased ODI, 4) the surgical outcomes assessed by the modified Macnab criteria indicated that 94% of patients rated the results as excellent or good, and 5) the patients had developed few complications and no recurrence by the 1-year follow-up.

Kim et al.[25] reported the treatment of cLDH by PELD in 31 patients; they used the interlaminar approach in 15 patients and the transforaminal approach in 16. They found that sensory change occurred in 6.5% of patients, transient mild motor weakness in 3.2%, and recurrence of herniation in 3.2% during the average follow-up period of 26.5 months.[25] These data demonstrated a higher complication rate than that in our series. Notably, however, the average follow-up time was approximately 2.2 years in the study by Kim et al.,[25] which is longer than the 1-year follow-up in our study. Dabo et al.[27] treated 30 patients with cLDH using PELD and found that interlaminar discectomy was effective in significantly alleviating the symptoms of radiculopathy. However, more than half of the patients (16/30) had developed lower extremity dysesthesia by 3 months after surgery. Additionally, the average duration of hospitalization was 6 days,[27] compared with 2 days in our series. The high rate of motor weakness and dysesthesia observed by both Kim et al.[25] and Dabo et al.[27] was probably due to nerve injury that occurred while releasing the adherent nerve root caused by calcification. We also encountered difficulty in the release of the adherent nerve in one patient, and aggressive separation resulted in significant pain after surgery. Therefore, forceful release of an adherent nerve root should be avoided if freedom of the nerve root is found to be satisfactory during the decompression surgery.

Lee and Lee[31] explored the PELD learning curve for a senior surgeon who had performed more than 200 microdiscectomy operations without previous exposure to PELD. For training in PELD, the surgeon observed 15 PELD procedures, practiced epidural block via the transforaminal route for 3 months, and participated in

two PELD workshops using a silicon model in one and a cadaver in the other. The surgeon then began treating patients with PELD. The results showed that only after completion of at least 17 PELD procedures did the surgeon become familiar with the procedure and significantly shorten the operation time. Additionally, among the first 51 cases, PELD failed in four patients who had to then undergo open discectomy.[31] In another study, Kafadar et al.[32] investigated the PELD learning curve and showed a high failure rate (33.3%, 14/42) among the first 42 PELD procedures. Taken together, these data suggest that PELD carries a steep learning curve. In contrast, our procedure is simple and easy. Additionally, we performed hemilaminectomy and did not resect the disc, which avoids possible postoperative lumbar instability that can occur after discectomy.[13]

Older adults with LDH generally have more postoperative complications, slower recovery, and worse quality of life after discectomy than young adults.[33] We demonstrated that the decompression approach without removal of the disc resulted in few complications and dramatically decreased the ODI after surgery, indicating improvement in the patients' quality of life. This foraminal decompression method might be suitable for older adults with cLDH.

This study had several limitations. First, it was a retrospective study. Second, only 37 patients were included in the study, and the small sample size might limit the generalizability of the results. Third, the follow-up time was short. Finally, this was a single-center experience.

In conclusion, our results suggest that the surgical decompression approach is effective in the management of cLDH at least in the short term (1 year) for reducing pain and improving patient satisfaction with few complications. However, the long-term effects need to be examined.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ORCID iD

Xiaomei Zhang https://orcid.org/0000-0003-4641-8181

References

1. Jordan J, Konstantinou K and O'Dowd J. Herniated lumbar disc. *BMJ Clin Evid* 2011; 2011: pii: 1118.
2. Cummins J, Lurie JD, Tosteson TD, et al. Descriptive epidemiology and prior healthcare utilization of patients in the Spine Patient Outcomes Research Trial's (SPORT) three observational cohorts: disc herniation, spinal stenosis, and degenerative spondylolisthesis. *Spine (Phila Pa 1976)* 2006; 31: 806–814.
3. Boos N, Weissbach S and Rohrbach H. Classification of age related changes in lumber intervertebral discs. *Spine (Phila Pa 1976)* 2002; 27: 2631–2644.
4. Urban JPG and Roberts S. Degeneration of the intervertebral disc. *Arthritis Res Ther* 2003; 5: 120–130.
5. Kalb S, Martirosyan NL, Kalani MYS, et al. Genetics of the degenerated intervertebral disc. *World Neurosurg* 2012; 77: 491–501.
6. Colombier P, Clouet J, Hamel O, et al. The lumbar intervertebral disc: from embryonic development to degeneration. *Joint Bone Spine* 2014; 81: 125–129.
7. Saal JA and Saal JS. Nonoperative treatment of herniated lumbar intervertebral disc with radiculopathy. *Spine (Phila Pa 1976)* 1989; 14: 431–437.
8. Hoffman RM, Wheeler KJ and Deyo RA. Surgery for herniated lumbar discs: a literature synthesis. *J Gen Intern Med* 1993; 8: 487–496.

9. Buttermann GR. Treatment of lumbar disc herniation: epidural steroid injection compared with discectomy: a prospective, randomized study. *J Bone Joint Surg Am* 2004; 86: 670–679.
10. Lurie JD, Tosteson TD, Tosteson AN, et al. Surgical versus nonoperative treatment for lumbar disc herniation: eight-year results for the spine patient outcomes research trial. *Spine (Phila Pa 1976)* 2014; 39: 3–16.
11. Weinstein JN, Lurie JD, Tosteson TD, et al. Surgical vs nonoperative treatment for lumbar disk herniation: the Spine Patient Outcomes Research Trial (SPORT) observational cohort. *JAMA* 2006; 296: 2451–2459.
12. Arts MP, Kuršumović A, Miller LE, et al. Comparison of treatments for lumbar disc herniation: systematic review with network meta-analysis. *Medicine (Baltimore)* 2019; 98: e14410.
13. Katayama Y, Matsuyama Y, Yoshihara H, et al. Comparison of surgical outcomes between macro discectomy and micro discectomy for lumbar disc herniation: a prospective randomized study with surgery performed by the same spine surgeon. *J Spinal Disord Tech* 2006; 19: 344–347.
14. Shamji MF, Bains I, Yong E, et al. Treatment of herniated lumbar disk by sequestrectomy or conventional diskectomy. *World Neurosurg* 2014; 82: 879–883.
15. Yeung A and Tsou P. Posterolateral endoscopic excision for lumbar disc herniation: surgical technique, outcome, and complications in 307 consecutive cases. *Spine (Phila Pa 1976)* 2002; 27: 722–731.
16. Hoogland T, Schubert M, Miklitz B, et al. Transforaminal posterolateral endoscopic discectomy with or without the combination of a low-dose chymopapain: a prospective randomized study in 280 consecutive cases. *Spine (Phila Pa 1976)* 2006; 31: E890–E897.
17. Ruetten S, Komp M, Merk H, et al. Full-endoscopic interlaminar and transforaminal lumbar discectomy versus conventional microsurgical technique: a prospective, randomized, controlled study. *Spine (Phila Pa 1976)* 2008; 33: 931–939.
18. Kim HS, Paudel B, Jang JS, et al. Percutaneous endoscopic lumbar discectomy for all types of lumbar disc herniations (LDH) including severely difficult and extremely difficult LDH cases. *Pain Physician* 2018; 21: E401–E408.
19. Jiang X, Zhou X and Xu N. Clinical effects of transforaminal and interlaminar percutaneous endoscopic discectomy for lumbar disc herniation: a retrospective study. *Medicine (Baltimore)* 2018; 97: e13417.
20. Yasargil MG. Microsurgical operation of herniated lumbar disc. *Adv Neurosurg* 1977; 4: 81–82.
21. Morgenstern R, Morgenstern C and Yeung AT. The learning curve in foraminal endoscopic discectomy: experience needed to achieve a 90% success rate. *SAS J* 2007; 1: 100–107.
22. Hsu HT, Chang SJ, Yang SS, et al. Learning curve of full-endoscopic lumbar discectomy. *Eur Spine J* 2013; 22: 727–733.
23. Postacchini F and Postacchini R. Operative management of lumbar disc herniation: the evolution of knowledge and surgical techniques in the last century. *Acta Neurochir Suppl* 2011; 108: 17–21.
24. Maroon JC. Current concepts in minimally invasive discectomy. *Neurosurgery* 2002; 51: S137–S145.
25. Kim HS, Adsul N, Ju YS, et al. Full endoscopic lumbar discectomy using the calcification floating technique for symptomatic partially calcified lumbar herniated nucleus pulposus. *World Neurosurg* 2018; 119: 500–505.
26. Shao J, Yu M, Jiang L, et al. Differences in calcification and osteogenic potential of herniated discs according to the severity of degeneration based on Pfirrmann grade: a cross-sectional study. *BMC Musculoskelet Disord* 2016; 17: 191.
27. Dabo X, Ziqiang C, Yinchuan Z, et al. The clinical results of percutaneous endoscopic interlaminar discectomy (PEID) in the treatment of calcified lumbar disc herniation: a case-control study. *Pain Physician* 2016; 19: 69–76.
28. Downie WW, Leatham PA, Rhind VM, et al. Studies with pain rating scales. *Ann Rheum Dis* 1978; 37: 378–381.
29. Liu H, Tao H and Luo Z. Validation of the simplified Chinese version of the Oswestry

Disability Index. *Spine (Phila Pa 1976)* 2009; 34: 1211–1216.
30. Lee SH, Choi WG, Lim SR, et al. Minimally invasive anterior lumbar interbody fusion followed by percutaneous pedicle screw fixation for isthmic spondylolisthesis. *Spine J* 2004; 4: 644–649.
31. Lee DY and Lee SH. Learning curve for percutaneous endoscopic lumbar discectomy. *Neurol Med Chir (Tokyo)* 2008; 48: 383–388.
32. Kafadar A, Kahraman S and Akbörü M. Percutaneous endoscopic transforaminal lumbar discectomy: a critical appraisal. *Minim Invasive Neurosurg* 2006; 49: 74–79.
33. Strömqvist F, Strömqvist B, Jönsson B, et al. Surgical treatment of lumbar disc herniation in different ages-evaluation of 11,237 patients. *Spine J* 2017; 17: 1577–1585.