

Treatment of gas-containing lumbar disc cysts via a combination of posterior and extraforaminal approaches in arthroscopic-assisted uni-portal spine surgery: a case report and literature review



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Abstract

Background Gas-containing lumbar disc cysts (LDCs) are a rare spinal pathology that frequently manifest as sciatica and exhibit clinical features akin to those observed in lumbar disc herniation. Their radiological presentation closely resembles that of synovial cysts, which can result in misdiagnosis, and their development is hypothesized to be associated with the 'vacuum phenomenon' observed in degenerative discs. Previous literature has documented various treatment modalities for disc cysts. In this report, we successfully excised the lesion using a combination of a posterior approach and an extraforaminal approach, facilitated by arthroscopy-assisted uniportal spinal surgery.

Case presentation An 85-year-old male patient developed persistent low back pain one month prior, accompanied by radiating discomfort in both lower extremities, predominantly on the right. Lumbar magnetic resonance imaging (MRI) and computed tomography (CT) scans revealed hypertrophy of the ligamentum flavum at the posterior margin of the L4/5 level, accompanied by spinal canal stenosis, and a gas-containing cyst on the right side extending into the extraforaminal region, which resulted in neural compression and functional impairment. The patient was treated using the AUSS technique. During the procedure, a unilateral posterior approach was initially employed to achieve unilateral laminotomy for bilateral decompression (ULBD) and excision of the intracanal cyst, followed by resection of the cysts in the foraminal and extraforaminal regions via an extraforaminal approach.

Conclusion Although gas-containing lumbar disc cysts are rare, the combined dual-approach AUSS technique has yielded favorable clinical outcomes. Postoperatively, the patient experienced marked improvement in lower limb pain and numbness; CT imaging confirmed complete cyst resection and adequate decompression of the dural sac and nerve roots.

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Keywords Gas-containing lumbar disc cysts, Arthroscopy-assisted uni-portal spinal surgery, Extraforaminal approach, Posterior approach

Introduction

Lumbar disc cysts are located in the epidural space and are contiguous with the intervertebral disc, making them susceptible to misidentification as synovial cysts. Most prior reports have concentrated on synovial cysts [1], whereas only a limited number have documented cysts linked to the intervertebral disc [2]. The pathogenesis of these cysts is strongly associated with intervertebral disc degeneration and the vacuum phenomenon. Imaging findings and intraoperative observations in this case suggest that the lesion originated from the intervertebral disc rather than the joint synovium. The presence of gas within the cyst in this case suggests a possible correlation with gas accumulation secondary to the vacuum phenomenon in degenerative discs, a phenomenon rarely documented in the literature [3].

The current standard for managing lumbar disc cysts is predominantly conservative. While this approach alleviates symptoms in most patients, it is associated with prolonged treatment duration, delayed therapeutic efficacy, and a high recurrence rate [4, 5]. Thus, in patients with persistent or recurrent symptoms, surgical excision becomes necessary. Open cyst resection combined with decompression remains the primary surgical approach [6]. Furthermore, with recent advancements in minimally invasive techniques, cyst excision under microscopy [7] and transforaminal endoscopic removal of cysts causing neural compression [8] have been reported.

Case presentation

The patient was an 85-year-old male who presented one month earlier with low back pain accompanied by radiating pain affecting both lower extremities, with greater intensity on the right side. Imaging studies revealed hypertrophy of the ligamentum flavum at the posterior margin of the L4/5 level, resulting in secondary spinal canal stenosis, with a gas-containing cyst extending from the intracanal region through the foraminal area into the extraforaminal space; however, the two cystic portions were not completely contiguous (Fig. 1). Prior to admission, the patient had undergone six weeks of conservative management, including bed rest, physical therapy, and oral analgesics, but experienced no significant symptom relief. Therefore, surgical intervention was performed after admission. Initially, a posterior approach was employed. Under C-arm fluoroscopic guidance, a longitudinal incision of approximately 2.0 cm was made (Fig. 2). Subsequently, under arthroscopic guidance, unilateral laminotomy for bilateral decompression, during which the intracanal cyst was exposed, dissected, and excised (Fig. 3). An extraforaminal approach was then adopted. The target area was localized, and an incision was made (Fig. 4), facilitating the exposure of the right L4 exiting nerve root and the cyst. Adhesions between the nerve root and the cyst wall were meticulously dissected, and the extraforaminal cyst was excised, ensuring complete decompression (Fig. 5). The procedure resulted in an estimated blood loss of approximately 20 mL and a total operative duration of approximately 1 h and 30 min. Sixty hours postoperatively, after the drainage tube was removed, the patient began early mobilization, with the Visual Analog Scale (VAS) score decreasing from 7 to 1. Postoperative CT imaging confirmed the complete resection of the cysts within the spinal canal and intervertebral foramen, ensuring adequate decompression of the dural sac and nerve roots (Fig. 6). Histological examination of the excised cyst wall demonstrated cystic cavities of varying sizes, consistent with the pathological characteristics of gas-containing lumbar disc cysts (Fig. 7).

Discussion

Lumbar disc cysts are a rare clinical entity, with fewer than 200 cases documented in the literature worldwide. The diagnosis is primarily based on imaging studies and discography, with definitive confirmation necessitating histopathological examination. The pathogenesis of these cysts remains poorly understood, though several potential mechanisms have been suggested. One proposed mechanism suggests that the cyst may develop as part of the resorption process of a herniated disc [9]. Another hypothesis posits that disc herniation may cause rupture and hemorrhage of the epidural venous plexus, with subsequent hematoma resorption leading to cyst formation [10]. Additionally, focal disc herniation and inflammatory responses have been suggested as contributing factors in cyst formation [11]. Furthermore, annular rupture secondary to lumbar disc degeneration may lead to cyst formation, resembling an extruded disc in morphology [12]. In this case, the lesion originated from the intervertebral disc, clearly differentiating it from a synovial cyst. This diagnosis was corroborated by both imaging and intraoperative findings. Studies have indicated that gas-containing lumbar disc cysts are frequently associated with the "vacuum phenomenon" on imaging, with nitrogen as the predominant gas component [13]. It has been hypothesized that intervertebral disc degeneration, trauma, or other factors contribute to disc injury, leading to gas leakage, encapsulation by surrounding tissues, and ultimately the formation of gas-containing cysts. Specifically, in patients exhibiting the vacuum phenomenon, strenuous



Fig. 1 Preoperative imaging findings of the patient. The red arrows highlight the gas-containing cyst, whereas the green arrows indicate the "vacuum phenomenon" within the intervertebral disc. (**A**, **B**) Preoperative flexion and extension X-rays. (**C**, **D**) Preoperative sagittal CT images reveal intraspinal and foraminal cysts, demonstrating their close proximity to the intervertebral disc while maintaining a considerable distance from the osseous structures of the facet joint. (**E**) Preoperative coronal CT imaging illustrates the extension of the gas-containing cyst from the spinal canal into both intra- and extraforaminal regions. (**F**) Preoperative axial CT images reveal that the intraspinal and foraminal cysts are not entirely interconnected. (**G**) Axial T2-weighted MRI. (**H**) Sagittal T1-weighted MRI. (**J**) Sagittal fat-suppressed T2-weighted MRI



Fig. 2 Intraoperative C-arm fluoroscopy was utilized for accurate localization. (A) An anteroposterior radiograph reveals the localization needle positioned at the midpoint of the pedicle projections of the L4–5 vertebrae, while the dilator is placed at the junction of the spinous process and lamina. (B) The lateral radiograph illustrates the dilator positioned nearly parallel to the intervertebral space. (C) An arthroscope and a radiofrequency probe were inserted through the surgical incision



Fig. 3 Surgical images obtained through the posterior approach under arthroscopy. (A) Exposure and resection of the ligamentum flavum (outlined by the green ellipse). (B) Sufficient decompression of the spinal canal (highlighted by the blue ellipse). (C) Exposure of the right intervertebral disc (marked by the green arrow), with successful decompression of the right L5 nerve root. (D) Exposure of the left intervertebral disc (marked by the green arrow), with successful decompression of the left L5 nerve root. (E-G) Exposure of the intraspinal cyst, followed by exploration, dissection, and excision using radiofrequency plasma, nucleus forceps, and a nerve dissector (outlined in the green box). (H) Complete excision of the intrathecal gas-containing cyst, ensuring sufficient decompression



Fig. 4 C-arm fluoroscopy imaging during the extraforaminal approach. (A) Anteroposterior view illustrating the guide rod in contact with the isthmus of the L4 vertebral body (marked by the red arrow). (B) Lateral view demonstrating the dilator aligned parallel to the L4/5 intervertebral space. (C) Schematic representation of the dual-approach incisions



Fig. 5 Arthroscopic visualization of the extraforaminal approach. (A) Exposure of the L4 isthmus with a radiofrequency probe (outlined in red). (B) Resection of the lateral facet apex with a burr (outlined in green), exposing the ligamentum flavum overlying the nerve root. (C–E) Comprehensive exposure of the gas-containing cyst encasing the extraforaminal nerve root; adhesions between the nerve root and cyst dissected using a nerve dissector; excision of both intra- and extraforaminal portions of the cyst performed with a nucleus forceps (outlined in green)

physical activity may cause gas to escape through annular fissures, become entrapped within the spinal canal, and subsequently form a cystic structure. This hypothesis was supported by preoperative CT imaging, which demonstrated identical signal characteristics between the intervertebral space and the cyst in this case.

Conservative treatment modalities include bed rest, physical therapy, analgesia, and nerve root blocks [14]. Although these approaches can offer symptomatic relief, recurrence rates remain elevated. Aydin et al. [2] reported that the clinical presentation of lumbar disc cysts closely resembles that of lumbar disc herniation, with surgical resection effectively relieving nerve compression. The primary objective of surgery is the complete excision of the cyst and associated proliferative tissue. However, conventional open surgery is linked to considerable trauma and prolonged recovery. With advancements in minimally invasive spinal surgery, endoscopic techniques have emerged as the preferred approach for discogenic spinal disorders. These techniques provide several advantages, including minimal invasiveness, shorter operative time, reduced intraoperative bleeding, improved visualization, and faster postoperative recovery. Currently, commonly used techniques include microscopic surgery, transforaminal endoscopy, and unilateral biportal endoscopy. Relevant reports are summarized in Table 1. Although these surgical approaches effectively resect the lesion and alleviate symptoms, each has inherent limitations. Kang et al. [15] employed percutaneous CT-guided aspiration to treat eight patients with lumbar disc cysts.



Fig. 6 Postoperative follow-up radiological assessment. (A) Three-dimensional CT reconstruction illustrating partial resection of the L4/5 lamina. (B–E) Sagittal, coronal, and axial CT images demonstrating the complete excision of both intraspinal and extraforaminal cysts. (C, E) Sagittal and axial CT images depicting minimal bone removal from the right L5 superior articular process and its ventral aspect



Fig. 7 Postoperative histopathological smear. The specimen demonstrates significant proliferation and degeneration of collagen fibers and adipose tissue, interspersed with thick-walled blood vessels. Moreover, scattered lymphoplasmacytic infiltration and multinucleated giant cell reactions are evident. In addition, cystic cavities of varying sizes are present

Table 1	Previous	case reports	and	treatment	modalities	for
lumbar c	lisc cysts					

Author	Year	Treatment Method	Outcome
Takeshima et al. [5]	2011	Conservative treatment	Spontaneous cyst regression
Kang et al. [9]	2008	CT-guided percutaneous aspiration	Symptom relief but recurrence
Koga et al. [10]	2003	CT-guided percutaneous as- piration with steroid injection	Symptom relief
Wang et al. [7]	2013	Microscopic cyst excision	Symptom relief
Zhu et al. [8]	2021	Endoscopic transforaminal cyst and disc excision	Symptom relief
An et al. [11]	2019	Unilateral biportal endoscop- ic (UBE) excision of extrafo- raminal cyst	Symptom relief

Postoperatively, clinical symptoms improved; however, one patient experienced recurrence and required subsequent surgical intervention. Additionally, since this technique is performed under indirect visualization, there is a potential risk of neural injury, thus making surgical excision the preferred option. Koga et al. [16] employed CT-guided aspiration combined with corticosteroid injection, which also provided symptomatic relief. However, it remains unclear whether combining these two modalities yields superior outcomes compared to their individual use, warranting further investigation. Wang et al. [7] performed microscopic cyst excision in nine patients. While this technique permits more comprehensive exposure of the lesion, it necessitates a larger incision, causes greater tissue trauma, and is associated with a prolonged recovery period. Zhu et al. [8] performed

transforaminal endoscopic discectomy in three patients, all of whom experienced significant symptom relief. However, transforaminal endoscopy is associated with a steep learning curve, limited visualization, constrained operative space, and a relatively high recurrence rate [17]. An et al. [18] used unilateral biportal endoscopy (UBE) to treat a patient with an L5 nerve root compressed by a cyst. The patient's symptoms improved significantly postoperatively. Despite UBE being an advanced and widely employed technique, its dual-channel design presents challenges in muscle plane separation, fluid irrigation, and results in considerable soft tissue trauma due to the two-port incisions.

In 2021, Professor Song En introduced arthroscopyassisted uni-portal spinal surgery (AUSS), also known as uni-portal non-coaxial spinal endoscopic surgery (UNSES). AUSS facilitates percutaneous bimanual operation through a single incision, with one hand controlling the endoscope and the other manipulating surgical instruments, thereby combining the working and observation channels within the same incision. The AUSS technique integrates arthroscopic triangulation with coaxial translation and pivoting mechanics of spinal endoscopy, further advancing a unique non-coaxial rotation maneuver. Furthermore, depending on intraoperative conditions, the surgeon can interchange the arthroscope and instruments between hands, thereby expanding the operative field and enhancing surgical flexibility. AUSS overcomes the limitations of conventional transforaminal endoscopic techniques and reduces soft tissue trauma relative to biportal approaches [19]. Its high-resolution arthroscopic imaging system offers detailed visualization of the lamina, ligaments, neural structures, and microvascular anatomy, ensuring precise lesion localization, comprehensive decompression, and effective hemostasis [20, 21].

In this case, the patient presented with both an intradural lesion and an extraforaminal cyst, along with spinal canal stenosis caused by ligamentum flavum thickening. To achieve comprehensive lesion removal and alleviate the bilateral lower limb radicular pain, we employed a combined posterior approach and extraforaminal dualentry strategy. This approach allows for precise definition of the lesion's extent from multiple angles, ensuring complete excision of both the spinal canal and extraforaminal lesions. At the same time, it maximizes the preservation of normal tissue, reduces the risk of neural and dural injury, and contributes to maintaining postoperative spinal stability.

Conclusion

This case report suggests that arthroscope-assisted single-port spinal surgery (AUSS), combined with the interlaminar and extraforaminal dual-entry approach, yields favorable clinical outcomes in the treatment of gas-containing lumbar disc cysts. Postoperative improvements were observed in the patient's lower limb pain and numbness, and imaging confirmed complete cyst excision. The limitations of this report include its single-case design, short follow-up period, and the lack of larger sample data to validate the long-term efficacy and safety of the AUSS combined with dual-entry approach in managing such lesions. Future multi-center, large-scale, and long-term follow-up studies are required to further assess its therapeutic effectiveness and potential for broader application.

Abbreviations

LDCs Lumbar discal cysts

- AUSS Arthroscopic-assisted Uni-portal Spine Surgery
- UNSES Uni-portal Non-coaxial Spinal Endoscopy Surgery
- UBE Unilateral biportal endoscopic
- MRI Magnetic Resonance Imaging
- CT Computed tomography
- VAS Visual analogue scale
- ULBD Unilateral laminotomy for bilateral decompression

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Author contributions

Guijun Zhang and Shengjun Shen contributed equally to this study and should both be considered as first authors. Shengjun Shen and En Song share the role of corresponding authors. ZGJ: Literature search, data collection, follow-up, and manuscript writing. RL: Supervision and manuscript revisions. SE: Surgical technique assistance and support. SSJ: Supervision, manuscript revisions, and final approval. All authors approved the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declaration

Ethics approval and consent to participate

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 principles of the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Voluntary written informed consent was obtained from the patients prior to the report.

Consent for publication

All authors approved the manuscript. Written informed consent for the publication of this case report and any accompanying images was obtained from the patient.

Competing interests

The authors declare no competing interests.

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References

- 1. Ramhmdani S, et al. Synovial cyst as a marker for lumbar instability: A systematic review and Meta-Analysis. World Neurosurg. 2019;122:e1059–68.
- Aydin S, Abuzayed B, Yildirim H, Bozkus H, Vural M. Discal cysts of the lumbar spine: report of five cases and review of the literature. Eur Spine Journal: Official Publication Eur Spine Soc Eur Spinal Deformity Soc Eur Sect Cerv Spine Res Soc. 2010;19:1621–6.
- Chen Y, Yu SD, Lu WZ, Ran JW, Yu KX. Epidural gas-containing pseudocyst leading to lumbar radiculopathy: A case report. World J Clin Cases. 2021;9:7279–84.
- Demaerel P, Eerens I, Goffin J, Wilms G. Spontaneous regression of an intraspinal disc cyst. Eur Radiol. 2001;11:2317–8.
- Takeshima Y, et al. Lumbar discal cyst with spontaneous regression and subsequent occurrence of lumbar disc herniation. Neurologia medico-chirurgica. 2011;51:809–11.
- Jeong GK, Bendo JA. Lumbar intervertebral disc cyst as a cause of radiculopathy. Spine Journal: Official J North Am Spine Soc. 2003;3:242–6.
- Wang ES, Lee CG, Kim SW, Kim YS, Kim DM. Clinical analysis of microscopic removal of discal cyst. Korean J Spine. 2013;10:61–4.
- Zhu K, He D. Transforaminal percutaneous endoscopic discectomy for symptomatic gas-filled discal cysts-report of three cases and literature review. J Orthop Surg Res. 2021;16:251.
- 9. Tokunaga M, et al. Lumbar discal cyst followed by intervertebral disc herniation: MRI findings of two cases. J Orthop Science: Official J Japanese Orthop Association. 2006;11:81–4.
- 10. Chiba K, et al. Intraspinal cyst communicating with the intervertebral disc in the lumbar spine: discal cyst. Spine. 2001;26:2112–8.
- Kobayashi S, et al. Pathogenesis of the discal cysts communicating with an adjacent herniated disc. Histological and ultrastructual studies of two cases. Joint Bone Spine. 2010;77:184–6.
- 12. Lee HK, et al. Discal cyst of the lumbar spine: MR imaging features. Clin Imaging. 2006;30:326–30.

- 13. Resnick D, Niwayama G, Guerra J Jr., Vint V, Usselman J. Spinal vacuum phenomena: anatomical study and review. Radiology. 1981;139:341–8.
- 14. Kim SY. Radiculopathy caused by discal cyst. Korean J Pain. 2014;27:86–9.
- Kang H, Liu WC, Lee SH, Paeng SS. Midterm results of percutaneous CTguided aspiration of symptomatic lumbar discal cysts. AJR Am J Roentgenol. 2008;190:W310–314.
- Koga H, Yone K, Yamamoto T, Komiya S. Percutaneous CT-guided puncture and steroid injection for the treatment of lumbar discal cyst: a case report. Spine. 2003;28:E212–216.
- 17. Pan M, et al. Percutaneous endoscopic lumbar discectomy: indications and complications. Pain Physician. 2020;23:49–56.
- An JW, Lee CW. Surgical treatment of extraforaminal Gas-Containing pseudocyst compressing L5 nerve root by using unilateral biportal endoscopy. World Neurosurg. 2019;124:145–50.
- Wang F, Wang R, Zhang C, Song E, Li F. Clinical effects of arthroscopic-assisted uni-portal spinal surgery and unilateral bi-portal endoscopy on unilateral laminotomy for bilateral decompression in patients with lumbar spinal stenosis: a retrospective cohort study. J Orthop Surg Res. 2024;19:167.
- Aygun H, Abdulshafi K. Unilateral biportal endoscopy versus tubular microendoscopy in management of single level degenerative lumbar Canal stenosis: A prospective study. Clin Spine Surg. 2021;34:E323–8.
- Kim SK, Kang SS, Hong YH, Park SW, Lee SC. Clinical comparison of unilateral biportal endoscopic technique versus open microdiscectomy for single-level lumbar discectomy: a multicenter, retrospective analysis. J Orthop Surg Res. 2018;13:22.

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