Case Report

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A Case Report and Literature Review on PTED Treatment for a Rare Massive Dorsal Extruded Herniated Nucleus Pulposus with Free Fragment: A Singel Case Study

Wang Dong[1]*, Tong Qiaoli[1], Huang Chaoren[1], Zheng Xiaolong[1] and Fang Hongwei[2]

[1]*Department of Pain Medicine, Yongkang First People's Hospital, Yongkang 321300, China*

[2]*Department of Pain Medicine, Renji Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai 200127, China*

***Corresponding author:** Wang Dong, Department of Pain Medicine, Yongkang First People's Hospital, Yongkang 321300, China

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ABSTRACT

Objective: To evaluate the diagnostic approach and the efficacy of percutaneous transforaminal endoscopic discectomy (PTED) for managing rare massive extruded dorsal epidural disc herniation.

Methods: We present a case of a 45-year-old male with severe low back and left lower limb radicular pain. MRI revealed a massive (>25mm) L4-5 disc fragment causing spinal stenosis and nerve root compression. A multidisciplinary team confirmed the diagnosis. The lesion was excised via a transformational endoscopic approach.

Results: PTED successfully achieved complete removal of the free nucleus pulposus and annular fragments from the dorsal epidural space, which was confirmed by pathology. The transformational approach provided direct access without laminectomy. The patient's symptoms were significantly alleviated postoperatively, with a favorable prognosis at one-month follow-up.

Conclusion: Massive dorsal epidural disc herniation is rare and requires careful differential diagnosis from intraspinal tumors. This case demonstrates that PTED is a safe and effective minimally invasive alternative to traditional open laminectomy for this condition. It allows direct targeted removal with rapid recovery, though meticulous technique is essential to manage epidural adhesions and avoid nerve injury.

Keywords: PTED; Lumbar Disc Herniation; Minimally Invasive; Nucleus Pulposus Sequestration; Spinal Canal Stenosis

Abbreviations: PTED: Percutaneous Transforaminal Endoscopic Discectomy; SLR: Straight Leg Raise; NRS: Numeric Rating Scale; ODI: Oswestry Disability Index; IVDD: Intervertebral Disc Degeneration; MRI: Magnetic Resonance Imaging; T1WI: T1-Weighted Imaging; T2WI: T2-Weighted Imaging; MDT: Multidisciplinary Team

Introduction

Lumbar disc herniation, characterized by pathological changes such as annular rupture, nucleus pulposus extrusion, intervertebral space narrowing, and calcification, is a common etiological factor for spinal canal stenosis and nerve root compression (which can, in severe cases, lead to spinal cord compression). The extruded disc fragments located dorsally in the epidural space, resulting in free nuclear material, are relatively rare and can cause nerve root compression symptoms (sometimes accompanied by spinal cord compression). The earliest report of dorsal epidural free nucleus pulposus protrusion was by Kesslerla, et al. in 1961 [1], and to date, over 40 cases have been documented. The proportion of free nuclear material extending into the dorsal epidural space accounts for only approximately 0.5% to 2. 1% of all extruded lumbar disc herniations [2,3]. The majority of these cases have been managed through traditional open surgical procedures for removal, with some misdiagnosed preoperatively as intraspinal tumors, and postoperative pathological examina-

tion confirming degenerative nucleus pulposus tissue. To date, there have been no formal reports on minimally invasive pain management interventions for this condition. Differentiation of dorsal epidural free nucleus pulposus herniation from other causes of spinal canal stenosis—such as intraspinal tumors, infections, or acute epidural hematomas—is essential. On May 1, 2025, the author treated a case involving a large dorsal epidural free nucleus pulposus protrusion.

This review of relevant literature aims to explore the pathogenesis, differential diagnosis, imaging characteristics, and minimally invasive pain intervention strategies for dorsal epidural free nucleus pulposus herniation. The following report is presented accordingly.

Case Report

The patient is a 45-year-old male who was admitted due to severe lumbar and back pain accompanied by radiating pain to the left lower limb and difficulty walking for two weeks. The symptoms appeared without any obvious precipitating factors two weeks prior to admission. The patient experienced excruciating lumbar and back pain, radiating to the left lower limb, with associated left lower limb weakness and occasional numbness, resulting in gait difficulties. Following bed rest and oral administration of analgesic and anti-inflammatory medications, the symptoms were slightly alleviated. The patient has a documented history of type II diabetes mellitus and coronary artery disease. He has been on long-term regular medication including metformin, glimepiride, and sustained-release metoprolol. Blood glucose levels are well-controlled. Three months prior to admission, he underwent laparoscopic cholecystectomy for acute cholecystitis, with an uneventful postoperative recovery. Specialized spinal examination revealed preserved physiological lumbar curvature. Lumbar range of motion was restricted in flexion and extension. Tenderness was noted on percussion and pressure over the L4 -L5 spinous processes (+). The straight leg raise (SLR) test was positive on the left side at 45°, with increased pain upon further testing. Neurological assessment indicated sensory deficits: decreased sensation in the skin of the lateral aspect of the left lower leg; motor strength was rated as grade 4+ in the left iliopsoas, quadriceps, and dorsiflexor muscles.

Reflex examination showed normal bilateral patellar and Achilles tendon reflexes, with no pathological signs such as Babinski 's sign. Lumbar spine function assessment yielded a pain Numeric Rating Scale (NRS) score of 5 for lumbar pain and 6 for leg pain. The Oswestry Disability Index (ODI) score was 45 out of 100, indicating moderate disability. Laboratory investigations revealed normal lipid profile, liver function tests, creatine kinase, serum homocysteine, renal function, and electrolyte levels. Pancreatic β -cell function was evaluated through insulin and C-peptide measurements: at 0 minutes, serum insulin was 10.100 μ U/mL and C-peptide was 4.650 ng/mL; at 3 minutes, serum insulin was 49.310 μ U/mL and C-peptide was 2.940 ng/mL; at 5 minutes, serum insulin was 29.420 μ U/mL. The insulin and C-peptide levels indicate preserved pancreatic β -cell function. Insulin (4 minutes) 41.300 uU/mL, C-peptide 4 minutes 4.470 ng/mL; Insulin (5 minutes) 35.590 uU/mL, C-peptide 5 minutes 4.360 ng/mL; Complete blood count + CRP + SAA, ESR, glycosylated hemoglobin (HbA1c): 7.9% ↑ ; Platelet count 199 × 10^9/L, Hemoglobin 157 g/L, Red blood cells 5.09 × 10^12/L, Neutrophil count 3.44 × 10^9/L, Neutrophil percentage 62. 1%, White blood cells 5.53 × 10^9/L, Large platelet ratio 30.7%, Serum amyloid protein <8.00 mg/L, Rapid C-reactive protein <1.60 mg/L, Erythrocyte sedimentation rate 3 mm/h, Lymphocyte percentage 33.2%;

Computerized multi-lead electrocardiogram:

1. Sinus rhythm
2. T-wave changes (V4, V5, V6 flattened).

Color Doppler ultrasound of the neck vessels: bilateral carotid atherosclerosis with plaque formation; Color Doppler ultrasound of the limb vessels: bilateral lower limb arterial atherosclerosis with plaque formation; Dynamic MRI of the pituitary gland: partially empty sella. The partially empty sella shows a flattened pituitary gland, with no significant abnormal signals observed within it; dynamic enhancement scanning of the pituitary anterior lobe reveals no abnormal enhancement areas, and the pituitary stalk shows no displacement. Lumbar MRI upon admission demonstrates L4-5 segment, secondary spinal canal stenosis, and an intraspinal occupying lesion (mass diameter >25 mm), compressing the left nerve root. T1-weighted imaging shows slightly high signal, T2-weighted imaging shows isointense mixed signals, measuring approximately 1.7 cm × 2.8 cm, with clear margins, and the dural sac is compressed and displaced to the right, with significant ring enhancement observed post-contrast (Figure 1). Following a multidisciplinary team consultation involving pain management, radiology, and spinal surgery, a surgical treatment plan was devised by the pain management department, proposing an endoscopic left L4/5 foraminal approach for free intervertebral disc herniation excision and nerve root decompression. The procedure was performed under non-intubated general anesthesia, with the patient in a right lateral position for lumbar puncture through the "safe triangle" at the L4/5 foramen under fluoroscopy.

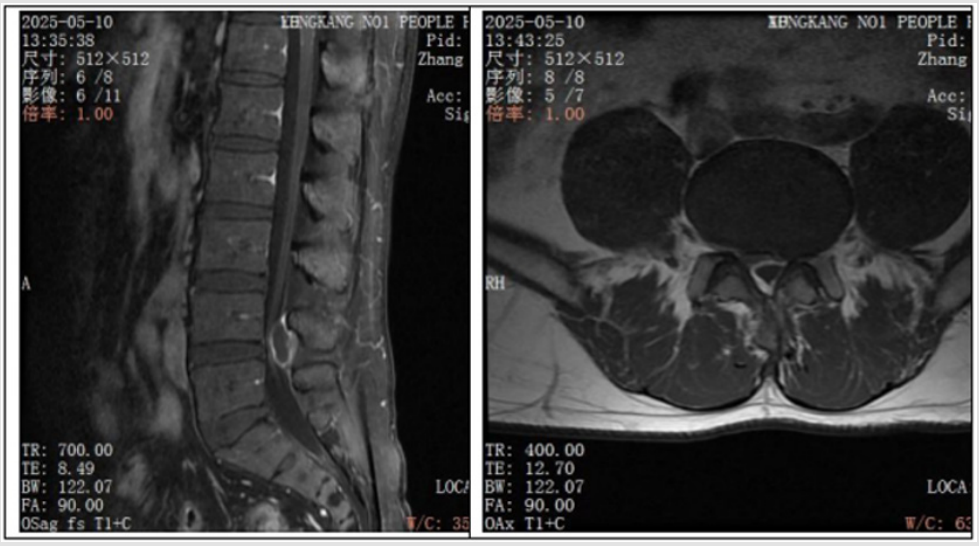

Figure 1: MRI images of preoperative free dorsal epidural herniation at L4-L5.

The nerve root entry point was enlarged using a trephine, and the yellow ligament was incised under endoscopic guidance. A mass with a maximum diameter of approximately 2.0 cm was observed on the dorsal side of the epidural space. After thorough hemostasis using bipolar coagulation, the mass was carefully dissected and completely removed via the puncture pathway and a segmental excision strategy. The excised fibrous tissue and mass were sent for pathological examination, which revealed a large amount of free annular fragments with adhesion to the dorsal epidural space. Postoperative pathology indicated degenerative cartilage tissue, consistent with the characteristics of a free-type intervertebral disc (Figure 2). Postoperatively, the patient reported the disappearance of radiating pain in the left lower limb, with numbness significantly alleviated compared to preoperative status. Motor and sensory functions in both lower limbs were normal. On the second postoperative day, the patient was able to ambulate, and a lumbar brace was used for two weeks. Two months post-surgery, the patient's symptoms had largely resolved, with unrestricted mobility and occasional lumbar soreness; the low back pain NRS score decreased to 0, and the leg pain NRS score decreased to 1, with an ODI score of 99. During postoperative follow-up, the patient exhibited good recovery, with no radiating pain or numbness in the lower limbs.

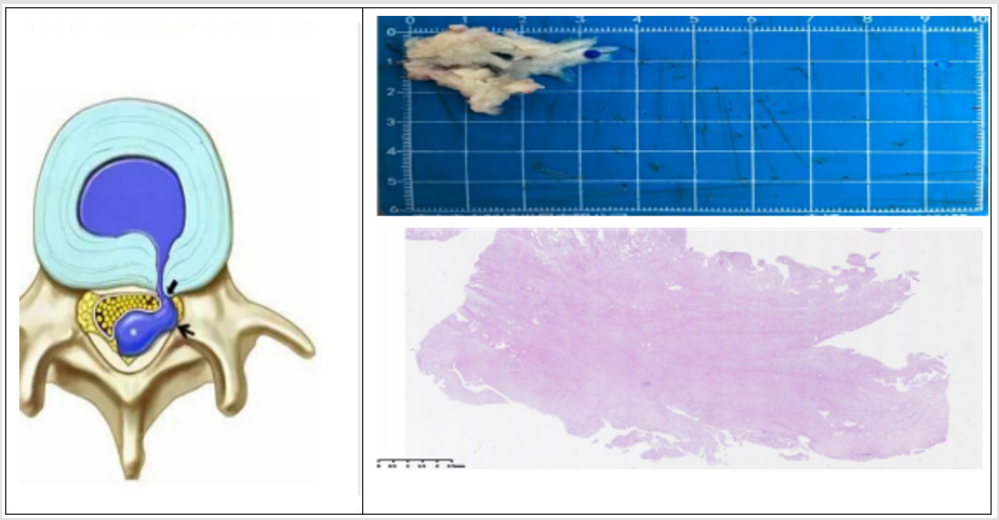

Figure 2: Schematic diagram of free dorsal extradural herniated disc at L4-L5 and its postoperative pathology.

Discussion and Literature Review

Extradurally free-type posterior herniation of intervertebral discs is a rare variant of lumbar disc herniation and constitutes a potential cause of nerve root or spinal cord compression in clinical practice. The mechanism underlying the formation of extradurally free-type posterior herniation of intervertebral discs is Intervertebral disc degeneration (IVDD), mechanical rupture, fragment migration, and the chain reaction of amplified inflammation often lead to conditions such as spinal canal stenosis, spinal instability, and low back and leg pain [4]. When the annulus fibrosus is completely ruptured, the nucleus pulposus can dislodge through the lumbar spinal canal into the dorsal extradural space, resulting in stenosis; if the spinal cord's tolerance is poor, the symptoms become more severe, although such occurrences are exceedingly rare. The flow of cerebrospinal fluid within the epidural space and the flexion-extension movements of the spine facilitate the migration of disc fragments toward the dorsal side, where resistance is lower. Additionally, the dorsal epidural space is rich in adipose tissue and has a loose structural composition, providing space for fragment migration. Narrowing of the dorsal epidural space can lead to direct compression of the cauda equina or nerve roots, with more than 40% of cases presenting with cauda equina syndrome; in severe cases, this can result in paralysis [5,6].

It has been reported that primary hospitals encounter difficulties in the preoperative diagnosis of massive extradural free-type intervertebral disc herniation. Enhanced magnetic resonance imaging (MRI) is considered the optimal imaging modality for assessing free-type disc herniation, as it can more clearly delineate the trajectory of the free nucleus pulposus. However, distinguishing it from intradural occupying lesions such as tumors, hematomas, and abscesses based solely on MRI can be challenging. The primary points of differentiation are as follows:

1) The signal of the free intervertebral disc is generally similar to that of the parent disc, and abnormalities in the disc signal corresponding to the segment can be observed in the intervertebral space adjacent to the neighboring disc. Enhanced MRI scans reveal irregular ring-like enhancement signals of granulation tissue surrounding the disc within the spinal canal, while the nucleus pulposus center does not exhibit enhancement, differing from the MRI signals of intradural tumors;

2) Free nucleus pulposus is often accompanied by signs of narrowing of the parent intervertebral space, voids in the nucleus pulposus, and disc degeneration, appearing slightly higher than cerebrospinal fluid on T1-weighted imaging (T1WI), while T2-weighted imaging (T2WI) shows variable signals, predominantly low to mid signals. In contrast, vertebral body destruction and foraminal enlargement are often associated with intradural tumors;

3) Intramedullary tumors, neurogenic tumors, hemangiomas, lymphomas, and accessory bone tumors typically present as persistent, homogeneous, or heterogeneous mass-like enhancements. Neurogenic schwannomas may exhibit a dumbbell-shaped appearance, while meningiomas demonstrate enhancement characterized by the "dural tail sign";

4) The portion of the herniated disc is discontinuous with the intervertebral space, and the disc may move a certain distance in the same plane or above/below, often located within the extradural space (posterior to the posterior longitudinal ligament). Clinical signs and examinations can further clarify the diagnosis [7].

With the development and maturation of spinal endoscopic techniques, the advancement of minimally invasive pain intervention methods, improvements in imaging diagnostics, and increased clinical attention, there have been fewer reports of missed or misdiagnosed cases of this type of disc herniation in recent years. Surgery remains the preferred treatment modality for patients with dorsal extraforaminal disc herniation involving free nucleus pulposus. Based on previous studies [8-11], the surgical approach has traditionally involved open procedures aimed at excising the herniated disc material. The primary surgical objectives are decompression of the spinal canal via laminectomy and removal of the disc nucleus; in cases accompanied by vertebral instability, posterior pedicle screw fixation combined with bone grafting and fusion are performed. Relief of symptoms through the decompression of the spinal cord or nerve roots [12]. During the surgical intervention for lumbar disc herniation via the open posterior approach, commonly employed decompression techniques include total laminectomy, unilateral partial laminectomy, bilateral partial laminectomy (with preservation of the spinous process), and facetectomy, all of which can yield satisfactory clinical outcomes. However, the percutaneous transforaminal endoscopic discectomy (PTED) technique, which utilizes a transforaminal approach to remove free nucleus pulposus material that has migrated into the epidural space, demonstrates excellent safety and efficacy in achieving complete nucleectomy.

This approach, employing a puncture pathway and segmental removal strategy, allows direct access to the dorsal epidural space via the intervertebral foramen. PTED employs a posterior-lateral transforaminal route and involves precise resection of a portion of the superior articular process (foraminoplasty), thereby directly accessing the dorsal epidural region while avoiding bony obstructions associated with traditional posterior approaches [13]. This method effectively addresses large free nucleus pulposus fragments in the dorsal epidural space, presenting advantages over conventional open laminectomy under general anesthesia, which typically involves resection of the L4 spinous process and laminectomy to access and excise the herniated nucleus pulposus. PTED offers minimally invasive benefits and rapid recovery; however, meticulous technique is required to prevent epidural adhesions and potential nerve injury, with blunt

dissection combined with saline irrigation employed to mitigate the risk of tearing. The transforaminal approach via endoscopy is closer to the nerve roots, thus providing advantages in the management of foraminal stenosis or extreme lateral disc herniations. Due to anatomical constraints and limitations of surgical instruments, the interlaminar approach poses increased difficulty for the treatment of such disc herniations, resulting in a scarcity of literature reporting on the interlaminar approach for the treatment of highly migrated free nucleus pulposus [14].

Consequently, the transforaminal endoscopic approach presents considerable advantages over traditional open surgical techniques. Misdiagnosis or missed diagnosis; this case study explores the clarification of diagnosis through a multidisciplinary team (MDT) consultation involving preoperative pain management, radiology, spinal surgery, and neurosurgery. This approach aligns with minimally invasive interventional pain management and has the potential to enhance patient satisfaction regarding pain treatment [15].

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