ISSN 2706-6819 Vol.6, Issue 2: 16-22, DOI: 10.25236/IJFM.2024.060203

Open revision after minimally invasive lumbar transforaminal endoscopic surgery: A case report and literature review

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Abstract: *Lumbar disc herniation (LDH) is a prevalent degenerative lumbar disease in spine surgery, characterized by pain and discomfort in the lower back and lower limbs, accompanied by limited mobility. This not only significantly impacts patients' quality of life but also imposes a substantial economic burden on both society and individuals. The clinical management of lumbar disc herniation includes non-surgical and surgical approaches. Surgical intervention is typically necessary when conservative treatment proves ineffective or in cases of progressive and substantial weakness in the lower limbs or cauda equina syndrome. In recent years, minimally invasive surgery has gained prominence in the field of spine surgery in China and has become one of the leading surgical methods for treating LDH. Percutaneous Endoscopic Lumbar Discectomy (PELD) has demonstrated remarkable clinical efficacy in LDH treatment, although some patients still experience complications after the operation, particularly postoperative recurrence. In this article, we present a case of recurrent LDH following PELD and its subsequent treatment with open surgical revision. Additionally, we discuss the risk factors associated with postoperative recurrence of LDH to provide insights for clinical practice.*

Keywords: *Lumbar disc herniation, Transforaminal endoscopic discectomy, Minimally invasive surgery, Lumbar vertebrae, Renovation*

1. Introduction

Lumbar Disc Herniation (LDH) is more prevalent among middle-aged and elderly individuals. It is a clinical syndrome caused by the degeneration of lumbar intervertebral disc tissue and the stimulation or compression of nerve roots due to the rupture of the annulus fibrosus and the protrusion of the nucleus pulposus as a result of various factors [1]. Major signs and symptoms of LDH include radicular pain, paresthesia, and weakness in the distribution of one or more lumbosacral nerve roots. Additionally, focal paralysis, limited trunk flexion, and increased leg pain with sitting or exertion, coughing, and sneezing are indicative of an attack [2]. Non-surgical treatment is the preferred approach for most LDH patients. Nonsurgical management should encompass a multimodal approach, including the use of anti-inflammatory drugs, patient education, and physical therapy. If conservative treatment proves ineffective, or if there is progressive and pronounced lower limb weakness or cauda equina syndrome, surgical intervention is typically necessary [3]. With the continuous advancement of spinal surgery theory, the development of minimally invasive technology, and the use of endoscopic visualization, Percutaneous Endoscopic Lumbar Discectomy (PELD), one of the minimally invasive spine techniques, has shown remarkable results in the treatment of LDH [4]. Despite the success achieved in LDH treatment using this technology, some patients still experience complications following surgery, particularly postoperative recurrence [5]. Therefore, identifying the factors related to PELD recurrence and subsequent open surgical revision is essential in improving the surgical success rate and reducing the postoperative recurrence rate in LDH patients [6]. In this paper, we present a case of a patient with

ISSN 2706-6819 Vol.6, Issue 2: 16-22, DOI: 10.25236/IJFM.2024.060203

recurrent LDH treated with PELD, who underwent open surgery revision and achieved a positive therapeutic outcome. We summarize the treatment experience of this case as follows:

2. Case report

The patient, Mr. Wu, a 49-year-old male, presented with a history of chronic low back pain for the past 5 years, along with radiating pain and numbness in the left lower limb for the past 7 days. Due to these complaints, the patient was admitted to the hospital. 5 years ago, the patient experienced intermittent and severe low back pain without an obvious cause. This pain was accompanied by numbness in both lower limbs, with more pronounced symptoms on the left side. The patient also experienced mild difficulty in walking, along with reflex pain and numbness in both lower limbs, which worsened after physical exertion and improved with rest. During this time, the patient did not experience pain at night but reported poor appetite, fatigue, low-grade fever in the afternoon, and night sweats, which are typical symptoms of tuberculosis poisoning. Although the details of the minimally invasive treatment are unknown, the patient experienced relief of symptoms after the procedure. However, the patient started experiencing reflex pain and numbness in the lower back and left lower limb again, following physical labor 7 days ago. These symptoms were persistent and ranged from moderate to severe. Consequently, the patient was admitted to our hospital with a diagnosis of "recurrent lumbar disc herniation."

Plain X-ray films of the lumbar spine obtained at our hospital demonstrated proper alignment and no evidence of significant vertebral body displacement in hyperextension and flexion positions. The lumbar 4-sacral 1 vertebral bodies appeared pointed at the edge, while the L5/S1 intervertebral space was narrowed. Additionally, no abnormalities were observed in the paravertebral soft tissues (Figure 1). Computed tomography (CT) and magnetic resonance imaging (MRI) revealed lumbar degenerative disease and herniation of the L5/S1 disc with accompanying spinal stenosis (Figures 2, 3). Physical examination indicated a normal physiological curvature of the spine, tenderness at the spinous process of the L5/S1 vertebrae, and no percussion pain. Sensation to pain and touch in both lower limbs was normal, and the strength of the bilateral iliopsoas muscle, quadriceps femoris, tibialis anterior and posterior muscle group, and extensor hallucis dorsi was assessed as grade 4. Muscle tension in both lower limbs was within normal limits, and the left leg straight raising test was positive while the right leg straight raising test was negative. The bilateral knee reflexes were (++) and bilateral ankle tendon reflexes were (+), whereas both the bilateral Babinski sign

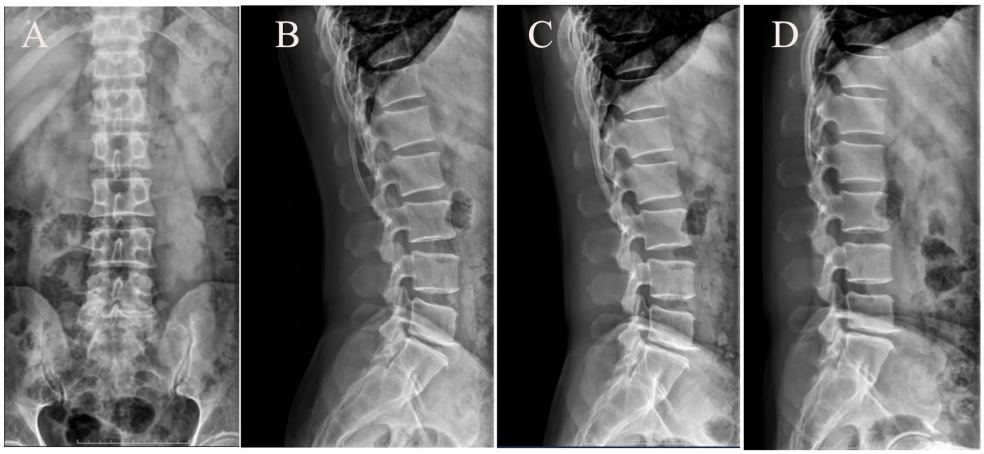

Figure 1: Preoperative X-ray films (A: anteroposterior view; B: lateral view; C: hyperextension position; D over-flexion position)

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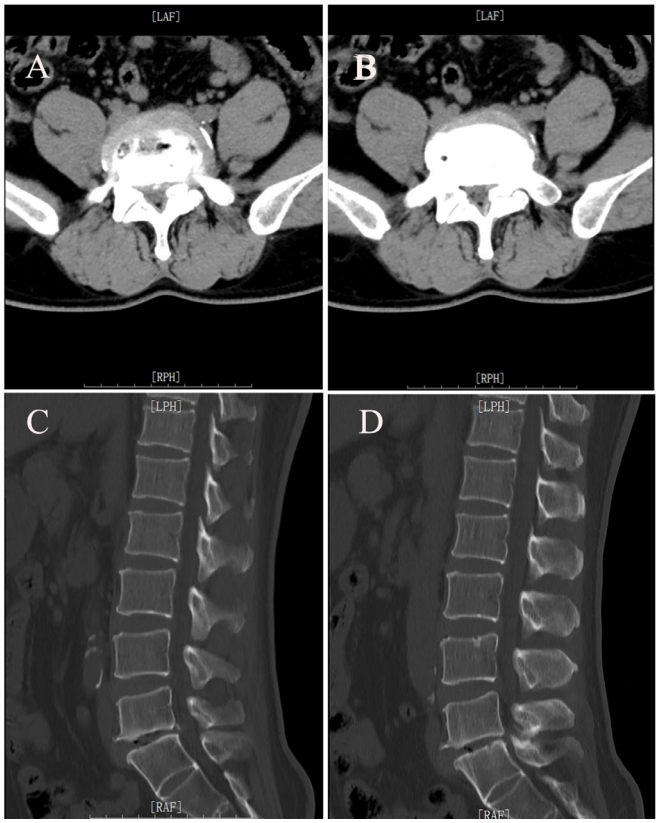

Figure 2: Preoperative plain CT scan of the patient

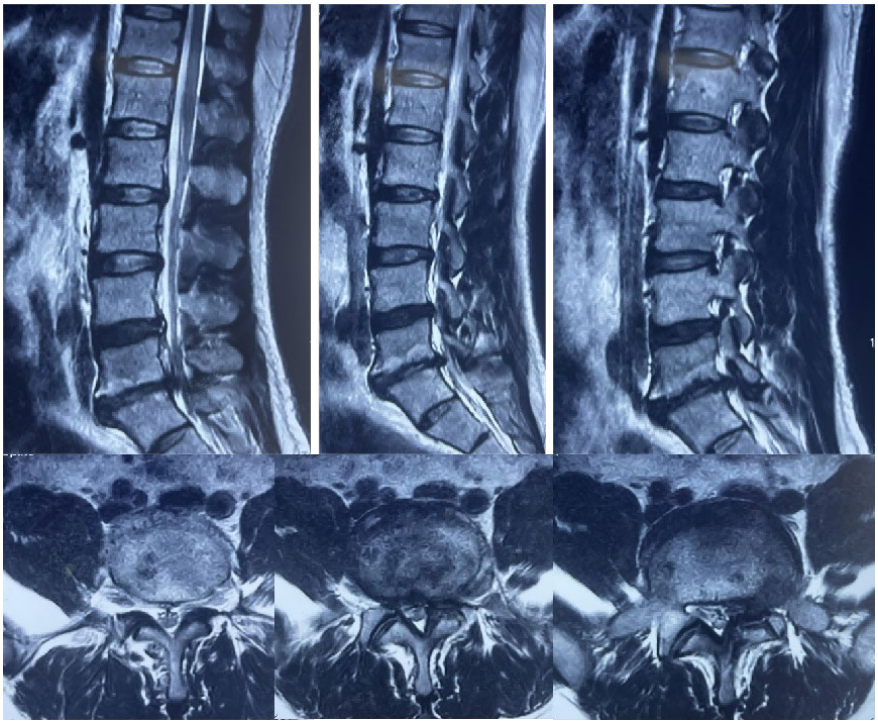

Figure 3: Preoperative MR Plain scan of the patient

The patient had a three-year history of tauroderma without receiving any specific treatment. He reported no prior diagnoses of hypertension or diabetes. Additionally, there was no record of renal disease, coronary heart disease, or cerebrovascular accident. The patient denied any history of trauma, blood transfusion, hepatitis, tuberculosis, infectious diseases, unknown vaccination records, as well as any history of food or drug allergies.

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The patient was a middle-aged manual worker who had been experiencing long-term low back pain and leg pain. He had previously undergone minimally invasive surgery, but recently, after engaging in manual labor, his low back pain and leg pain persisted and worsened despite bed rest. The severity of his pain was a 7 on the Visual Analog Scale (VAS), and the Degree of Improvement (DOI) score for low back pain was 52. Laboratory tests including blood routine, blood type, biochemistry, coagulation, blood transfusion, electrocardiogram, and chest and lumbar CT examination were conducted, all of which indicated no surgical contraindications. Active communication was established with both the patient and his family.

On the first day post-surgery, the patient reported significant relief of radiation pain in the left lower limb compared to the preoperative level; however, numbness persisted. Intramuscular administration of ketorolac tromethamine through the incision provided pain relief, resulting in a VAS score of 3. The patient's mental state, sleep, and diet were all satisfactory. Surgery effectively alleviated the pain in the patient's left lower limb, indicating successful decompression. However, due to the extended duration of nerve compression, the recovery of skin sensation would require additional time. To reduce nerve edema, mannitol was administered intravenously at a dosage of 125ml twice a day. Moreover, oral mecobalamin was prescribed at a dosage of 0.5mg three times a day to promote nerve function recovery.

On the second day following the surgical procedure, the patient continues to experience persistent numbness in their left lower limb. This numbness can be attributed to prolonged compression and the patient's medical history, which resulted in nerve adhesion. Consequently, the decompression procedure during the operation required the removal of scar tissue from the adhesions, inadvertently exacerbating the nerve injury. Subsequently, significant numbness lingers post-surgery. As a recommended course of action, the patient is advised to continue receiving mannitol for dehydration therapy, aiming to alleviate nerve edema and alleviate symptoms.

On the third day post-surgery, the dressing change revealed no signs of redness or swelling in the incision area. Following disinfection, the drainage tube was extracted, and the dressing was replaced. A lumbar X-ray reexamination exhibited proper and stable positioning of the lumbar fixation screws (Figure 4, 5). With several days of observation, notable improvements in symptoms were observed, thus enabling a smooth discharge of the patient.

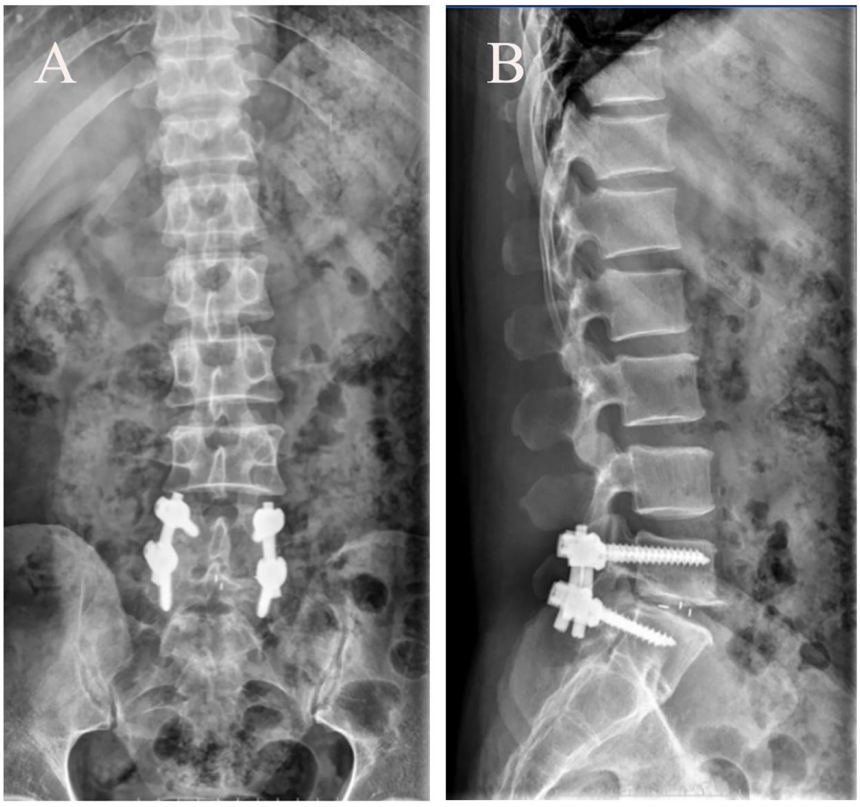

Figure 4: Postoperative X-ray of the patient (anteroposterior and lateral view)

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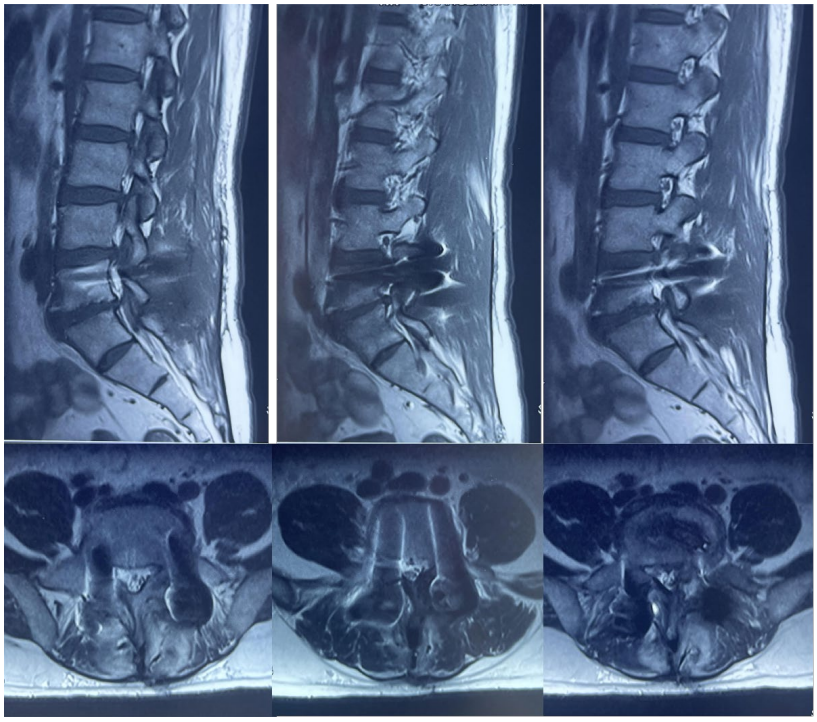

Figure 5: Postoperative MR Plain scan of the patient

3. Discussion

Recurrent lumbar disc herniation (RLDH) occurs when a patient experiences the reoccurrence of lumbar disc herniation on the same side or opposite side after a pain-free period lasting more than 6 months following their initial operation [7]. The reported rate of recurrence after lumbar discectomy ranges from 1% to 21% [8]. Numerous studies have investigated the risk factors associated with RLDH, which encompass a broad range of factors. Prominent risk factors frequently mentioned include patient age at the time of surgery, gender, the extent of lumbar disc material removed, the learning curve of the spine surgeon, the patient's body mass index, and the duration of the recovery period. Additionally, there exist several other contributing factors [9].

After the revision surgery of this case, the recurrence factors of iatrogenic percutaneous transforaminal endoscopic discectomy were summarized as follows: incomplete removal [10]of nucleus pulposus, destruction of annulus fibrosus, and long learning curve.

Incomplete removal of the nucleus pulposus refers to the situation where the surgical field during the operation is not clear due to incomplete hemostasis and other factors, resulting in the removal of only a part of the protruding nucleus pulposus into the spinal canal. However, the base of the nucleus pulposus at the herniated disc is not completely eliminated, leaving a small amount of nucleus pulposus still present inside the spinal canal. As a result, fragments of nucleus pulposus are prone to appearing in the spinal canal, eventually leading to stimulation of the nerve root or spinal cord by the residual nucleus pulposus sheet and causing recurrence [11]. McGirt et al. [12]conducted a meta-analysis on patients wo underwent Subtotal discectomy (SD) and Limited discectomy (LD). The results revealed that after surgery, the incidence of back pain and radiculopathy was similar in both groups, but the incidence of SD was 2.5 times higher at 2 years or more (mean 11.6% for LD and 27.8% for SD). Conversely, recurrent disc herniation was more common in the LD group (mean, 7% vs. 3.5%).

The intervertebral disc consists of two main components, namely the central nucleus pulposus and the peripheral annulus fibrosus. When the annulus fibrosus is damaged, the original rupture in its diameter enlarges, resulting in increased range of motion between the upper and lower parts. Additionally, the disc experiences uneven force distribution, aggravated by poor blood supply to the annulus fibrosus [13]. Consequently, it becomes challenging to repair the damaged annulus fibrosus, leading to the re-emergence of the protruding residual nucleus pulposus after percutaneous endoscopic lumbar discectomy (PELD). This scenario increases the risk of recurrence [14].

The learning curve refers to the process of continuous learning and achieving proficiency in a specific

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technology. This process is typically divided into two periods: a rapid rise period and a plateau period. The learning curve provides a means to assess the level of difficulty involved in mastering a technology. If the curve is long, it indicates that the technology is difficult to master [15]. PELD surgery is a procedure that requires precise hand-eye coordination and is performed within a highly limited surgical field. Furthermore, the learning curve for this technology is steep, heavily relying on the surgeon's experience. Consequently, if the surgeon lacks technical skills and surgical experience, the recurrence of the original segment intervertebral disc herniation may occur [16,17].

The Body Mass Index (BMI) is a widely used measure of body health that assesses the degree of obesity. An increased BMI can have an impact on the mechanical characteristics and structure of the intervertebral disc, particularly in cases of degeneration and surgery [18]. 0In this study, the patient had a BMI of 24.5, which falls within the overweight range. The investigation of the impact of early ambulation after Percutaneous Endoscopic Lumbar Discectomy (PELD) on postoperative outcomes revealed that premature loading of the lumbar disc due to early ambulation can lead to PELD recurrence. Previous literature indicates that recurrence of the condition is also associated with incorrect rehabilitation exercises and engaging in high-intensity labor [19]. Carragee et al. [20] found no adverse effects on prognosis when patients returned to work within an average of 1.2 weeks after surgery and completed all work within 2.2 weeks.

Acknowledgement

Foundation Project: Changzhi Key Laboratory of Biomechanical Research and Application of Spinal Degenerative Diseases (2022sy008)

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