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PERCUTANEOUS ENDOSCOPIC LUMBAR DISCECTOMY: INDICATIONS AND COMPLICATIONS

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Abstract: In the technique of percutaneous endoscopic lumbar discectomy (PELD), access to the disc is achieved through Kambin's triangle, formed by the exiting nerve root (hypotenuse), the superior endplate of the caudal vertebra (base), and the superior articular process of the caudal segment (height).
The PELD procedure involves removing the nucleus pulposus using forceps within the annulus fibrosus, thus being considered an "inside-out" technique, which complicates the removal of a migrated disc herniation [1,2,3].

During the PELD technique, foraminoplasty is performed using sequential trephines, followed by the insertion of an endoscope into the spinal canal to remove herniated material. Thus, PELD is regarded as an "outside-in" technology, providing significant advantages for treating highly migrated disc herniations and lumbar spinal stenosis [4,5,6,7].
Regarding the L5/S1 segment, puncture through the foraminal opening can be technically challenging due to the high iliac crest, large L5 transverse process, and concealed location of the herniated material. In such cases, the interlaminar approach may be a more preferable option [8,9].

Key words: endoscope, herniation, discectomy, indications, complications.

Introduction

Lumbar disc herniation (LDH) is becoming an increasingly common problem due to an aging population and high levels of physical activity [12,13]. Symptomatic LDH is subject to surgical treatment if it does not respond to conservative therapy.
PELD offers several advantages over open surgery:

1. Minimal trauma and blood loss.
   The incision for PELD is approximately 10 mm, sufficient for the insertion of the working cannula. Reported blood loss ranges from 5 to 51 ml, significantly less than with microendoscopic discectomy (MED) and open discectomy [14,15]. Due to minimal trauma, patients usually have a short hospital stay and quickly return to work postoperatively.

2. Anesthesia safety.
   PELD can be performed under local or epidural anesthesia, making it particularly safe for elderly patients with compromised general health. Additionally, immediate patient feedback allows timely detection and prevention of nerve root injury [19–22].

3. Preservation of spinal stability.
   Unlike posterior open surgery, the PELD working cannula minimally damages bony structures, preserving spinal stability and reducing the risk of secondary degenerative diseases.

Anatomical Considerations:

The size of the foraminal opening decreases, while the interlaminar space increases from L1 to L5 [23]. In these conditions:

- PETD (Percutaneous Transforaminal Endoscopic Discectomy) is suitable for disc herniations at L3/4 or higher levels.
- PEID (Percutaneous Endoscopic Interlaminar Discectomy) is preferable at L4/5 and L5/S1 levels.

Recurrent Lumbar Disc Herniation:

Recurrent lumbar disc herniation is typically defined as re-protrusion of the disc at the same segment within 6 months after the primary surgery [33]. Recurrence rates range from 2% to 18%, depending on the chosen surgical method [34–36].

Risk factors for recurrent lumbar herniation include:

- Male gender,
- Age > 50 years,
- Smoking,
- History of spinal trauma,
- Central disc herniation.

Scar tissue formation after the primary surgery complicates open reintervention, increasing the risk of dural tears and nerve damage. Moreover, repeated resection of posterior lumbar structures leads to spinal instability and secondary degenerative diseases.

Revision surgery using PELD allows avoiding scar tissue and prevents complications such as bleeding, dural tears, and nerve injury, while significantly reducing operative time.

Intervertebral Infection:

The incidence of intervertebral infection after spinal surgery is 0.1% to 0.4%, with most cases caused by bacterial infection. In a study of 209 LDH cases treated with PETD, Gu et al. [46] identified 1 case of infection successfully treated with intravenous antibiotics for 2 weeks, with an incidence rate of 0.47%.

While PELD minimizes the risk of intervertebral infection, the risk still exists. Pyogenic spondylodiscitis is a serious complication that can lead to significant dysfunction of spinal nerves.

Early diagnosis includes:

- Erythrocyte Sedimentation Rate (ESR),
- C-reactive Protein (CRP).

MRI is less effective for early diagnosis. The most accurate method is needle biopsy of the disc under fluoroscopic guidance, allowing pathogen identification.

Treatment depends on symptom severity:

- Mild cases: Antibiotics and bed rest with spinal stabilization.
- Severe cases: Irrigation and drainage of the intervertebral space.
- If conservative therapy fails: Open debridement with arthrodesis.

Advantages and Disadvantages of PELD:

PELD has significant advantages over traditional open surgery, including:

- Shorter operative time,
- Less blood loss,
- Minimal soft tissue damage,

- Faster recovery and return to work.

However, there are also disadvantages:

1. High surgeon skill requirements:
    - Insufficient experience, especially with fewer than 200 procedures, increases the risk of complications and reintervention.
    - A steep learning curve for novice surgeons.
2. Anesthesia challenges:
    - While local anesthesia reduces the risk of nerve damage, it can cause significant intraoperative pain, which may be difficult to tolerate.
    - In rare cases, severe pain may provoke serious cardiovascular complications.
3. Radiation exposure:
    - Frequent fluoroscopy for accurate puncture increases radiation exposure for both surgeons and patients.

PETD and PEID: Indications and Complications

PETD (Percutaneous Transforaminal Endoscopic Discectomy) is indicated for:

- Herniations at L4/5 and higher levels,
- Lateral stenosis and foraminal stenosis.

Disadvantages of PETD:

- Difficulty with highly migrated herniations, potentially leading to incomplete fragment resection.
- Incorrect puncture may injure lumbar arteries and nerve roots, increasing the risk of hematoma and dysesthesia.

PEID (Percutaneous Endoscopic Interlaminar Discectomy) is effective for:

- L5/S1 herniations,
- Central stenosis,
- Highly migrated herniations due to the wide interlaminar space at L5/S1.

Disadvantages of PEID:

- Nerve traction may lead to dural tears, occurring more frequently than with PETD [60].
- Local anesthesia is ineffective, requiring general anesthesia, which increases risks for elderly patients.

Surgical Stage Recommendations:

1. Preoperative:
    - Collect detailed history,
    - Evaluate positive symptoms and imaging results,
    - Plan the puncture trajectory to avoid complications.
2. Intraoperative:
    - Accurately differentiate anatomical structures under endoscopy,
    - Manipulate carefully without nerve root traction,

- Monitor nerve function and immediately halt the procedure if damage occurs.

3. Postoperative:
    - If pain persists or worsens, suspect incomplete decompression.
    - MRI helps clarify the diagnosis and guide appropriate therapy.
    - Dizziness and headache may indicate cerebrospinal fluid leakage. Treatment includes:
        - Horizontal positioning,
        - Adequate fluid infusion,
        - Compression dressing at the incision site.
    - Functional exercises are important for spinal stabilization and LDH recurrence prevention.

Results: Advancements in PELD have introduced new methods that enhance efficiency and safety:

1. Isocentric navigation ensures precise targeting during challenging L5/S1 punctures, increasing patient satisfaction to 90.91%.
2. Graduated cannula system for foraminotomy protects the nerve root from injury, with a treatment success rate of 92.7%.

Conclusion:

PELD is widely recognized for its high clinical safety and efficacy. Advantages: Minimal trauma, fast recovery, local anesthesia. Disadvantages: Learning curve, radiation exposure, anesthesia challenges with PEID.

PELD is a promising and effective spinal surgery technique, and further advancements and new technologies will continue to improve its accessibility and safety.

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