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Review Article

Unilateral Biportal Endoscopy, Recommendations for Extraforaminal Approach in Lumbar Spine

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Abstract

Unilateral Biportal Endoscopy (UBE) is a minimally invasive surgical technique that has gained attention in spinal surgery for its advantages in reducing tissue damage, promoting faster recovery, and grateful visualization. The extraforaminal approach using UBE specifically targets spinal conditions that affect the nerve roots and surrounding structures in the lumbar region, particularly in cases of lateral disc herniation or foraminal stenosis.

The procedure involves two small incisions, one for the endoscope, providing real-time visualization, and the other for surgical instruments. The extraforaminal approach is advantageous in addressing pathologies located outside the traditional foraminal space, allowing for more direct access to the affected nerve root and disc material. This approach avoids the need for extensive retraction of the neural structures, minimizing the risk of nerve damage, bleeding, and muscle disruption, which are common concerns in traditional open surgery.

UBE's extraforaminal approach offers several benefits over conventional techniques, including improved visualization through high-definition endoscopic cameras, the ability to perform decompressions and disc removals with minimal muscle and bone disruption, and a quicker recovery time for patients. Additionally, the use of this technique reduces hospital stay durations and post-operative complications, such as infection and excessive scar tissue formation.

This technique is particularly beneficial in patients with degenerative disc disease, herniated discs, and foraminal stenosis, where traditional surgical approaches may carry higher risks or longer recovery periods. As advancements in endoscopic technology continue, the extraforaminal UBE approach holds promise for revolutionizing spinal surgery, making it less invasive, more effective, and safer for patients.

Keywords : unilateral biportal endoscopy, extraforaminal approach, spine surgery, minimal invasive, disc herniation, decompression, stenosis

History:

Unilateral Biportal Endoscopy (UBE) is a minimally invasive spinal surgical technique that combines the use of two portals, one for the endoscope and the other for instruments to perform spinal procedures with minimal muscle disruption.

This approach was first described in the early 2000s by Dr. S. K. Lee in Korea, who aimed to reduce tissue damage, improve visualization, and provide better access to spinal structures while preserving the benefits of minimally invasive spine surgery (MISS).

Since its introduction, UBE has gained popularity due to its safety profile, improved patient outcomes, and its ability to be applied in various spinal pathologies, including lumbar disc herniations, spinal stenosis, and degenerative diseases. During the last years UBE is use in all the vertebral spine levels and for different types of pathologies. It's also a possibility to approach pathologies located outside the canal, in foraminal disc herniation, extraforaminal disc herniation, foraminal stenosis.

Advantages:

- Reduced muscle dissection and trauma compared to traditional open surgery.
- Shorter recovery times and less postoperative pain.
- Better visualization of the surgical area, with direct access to the spinal canal and foramen.
- High rang of movements with the endoscope and the different materials.
- Increased precision with smaller incisions. Better cosmetic results.

- Preservation of bone and ligamentous structures.

General Recommendations:

- UBE is recommended in cases where minimal soft tissue dissection is desired.
- Ideal for procedures like lumbar discectomy, decompression, and foraminotomy.
- In association with minimal invasive fusion techniques, when necessary.
- Recommended for patients with degenerative disc disease, foraminal stenosis, and all the types of discs herniations.

Extraforaminal Approach Indications:

The extraforaminal approach in spinal surgery is used to target pathologies located outside the conventional foraminal area but still in close proximity to nerve roots. This approach is most often used in:

- Extraforaminal disc herniations: particularly those that are lateral to the foramen and cannot be accessed with traditional approaches. Is a uncommon type of disc herniation that occur outside the intervertebral foramen where nerve roots emerge. Represent approximately 1-12% of all lumbar disc herniations.[8,9]
- Spinal stenosis: wthen there is a need to decompress the nerve root that lies outside the neural foramen.
- Foraminal or extraforaminal tumors: for precise resection or biopsy.
- Degenerative lumbar conditions : such as facet joint hypertrophy or foraminal stenosis.

Recommendations in UBE extraforaminal approach:

- Best utilized in patients with extraforaminal disc herniations or lateral recess stenosis where other approaches, such as traditional posterior or transforaminal routes, might be inadequate.
- Endoscopic techniques may be beneficial due to their minimal invasiveness. Less muscle destruction.
- The extraforaminal approach can be done under local anesthesia, in our center we do all the procedures under general anesthesia. This approach provide a quicker recovery compared to traditional open surgery.

Complications:

While the extraforaminal approach is effective, there are several complications and considerations:

1. Nerve root injury: due to the proximity to the nerve root, there is an increased risk of direct trauma. Important to take in account the 3D knowledge of Kambin triangle.
2. Infection: as with all spinal surgeries, infections are a concern, is significantly lower than in open surgery (0-1.4% vs 0.7-12%) because endoscopic surgery is performed under continuous irrigation with physiologic saline.[10]
3. Dural tears: The risk of inadvertent dural puncture is higher in this approach due to the anatomical complexities. Incidental durotomy is a complication of UBE surgery, ranging in incidence from 0.9% to 13.2%.[11]
4. Incomplete decompression:Achieving adequate decompression can be more difficult in extraforaminal areas.[12]
5. Blood vessel injury: The presence of vascular structures in the extraforaminal space can pose challenges.
6. Respect the anatomical landmarks are associated with less complications rates, like in all the surgical procedures.

Particular Issues:

• Anatomical challenges: the extraforaminal area is complex due to the proximity of the neurovascular bundle and the nerve roots. Achieving optimal access without damaging critical structures requires careful planning and experience.

• Learning curve: the technique requires advanced skill and familiarity with spinal anatomy, especially for surgeons who are less experienced with minimally invasive techniques.

• Field of view: endoscopic tools may offer a excellent view compared to traditional open approaches, making it more easy to address large or complex lesions.

UBE extraforaminal approach:

Performing unilateral biportal endoscopic surgery via the extraforaminal approach requires careful planning and understanding of the specific spinal anatomy. This technique is often employed for addressing pathologies such as extraforaminal disc herniations, lateral recess stenosis, and foraminal stenosis, particularly when the lesion is outside the foramen or laterally positioned. The procedure can be performed through small incisions and offers advantages like minimal soft tissue disruption, faster recovery, and reduced postoperative pain.

Here's a step-by-step guide to performing UBE in the extraforaminal approach:

1. Preoperative Planning and Imaging

• Indications: confirm the diagnosis of extraforaminal disc herniation, lateral disc bulging with compression nerve root, or foraminal stenosis. Typically using MRI or CT scans. Accurate preoperative imaging is crucial to assess the position and size of the pathology, as well as to map out critical anatomical structures (e.g., nerve roots, vascular structures).

• Patient Positioning: the patient, under general anesthesia, is positioned in a prone position on a specialized spinal table, if available, with the target side elevated to provide access to the lateral and extraforaminal regions. Fluoroscopy, CT, MRI, Neuronavigation systems may be used to verify the target level.

2. Incision Placement and Portal Setup

• First Portal (Endoscope Portal): a small incision (typically 1 cm) is made laterally, just outside the midline, over the site of pathology (usually in the extraforaminal zone). This portal is used for the insertion of the endoscope.

• Second Portal (Instrument Portal): another incision (also about 1 cm) is made 2-3 centimeters away , along the same horizontal plane. This portal allows the insertion of surgical instruments such as forceps, pituitary rongeur, or shavers.
Both incisions are made under fluoroscopic or neuronavigation guidance, to ensure optimal positioning, targeting the extraforaminal region. (Figure 1).

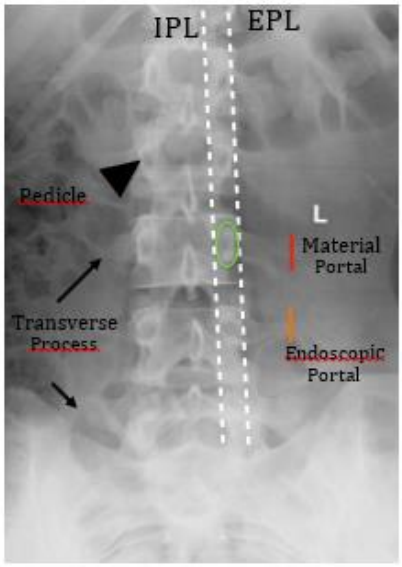

Figure 1: Skin incisions for UBE extraforaminal approach. Routine portal skin incisions for a left-sided approach. Paraspinal skin incisions for the left-sided, red for material portal, orange represent the endoscopic portal. The portals, are illustrated on the x-ray anteroposterior (AP) view. The portals are made at the junction of the lateral margin of the transverse process (TP) and the points 1 cm above and 1 cm below the target disc space, 2-3 cm between the two portals.

IPL- internal pedicle line; EPL- external pedicle line.

Head arrow and green circle for pedicle.

Black arrows for right superior and inferior transverse process.

3. Tissue Dissection and Access to the Foramen

• Muscle Dissection: The paraspinal muscles are gently retracted using specialized retractors or cannulas, minimizing tissue disruption. The goal is to access the extraforaminal space without cutting major muscle groups or ligaments.

1. Ligament and Bone Removal: If necessary, the ligamentum flavum or small bone spurs may be removed to access the extraforaminal space. Care must be taken not to damage the nerve root or blood vessels. In some cases, part of the facet joint may be resected to create a clear path to the lesion.

4. Image-guided surgery

• Fluoroscopy or Neuronavigation Imaging: in our center we fused both, at the beginning of the procedure, during and after decompression, fluoroscopy or further endoscopic visualization is performed to ensure complete removal of the herniated disc material and adequate decompression of the nerve root (Figure 2).

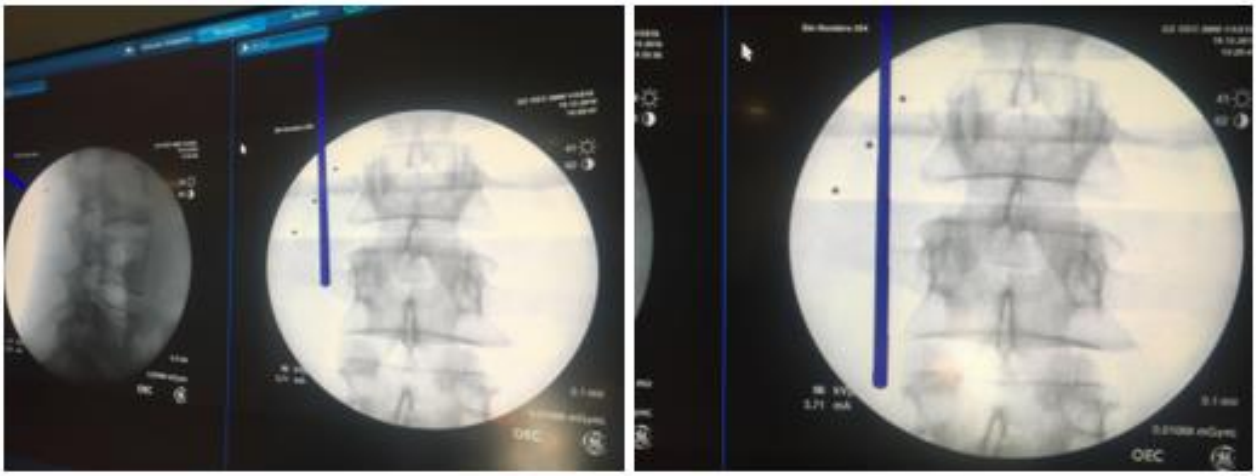

Figure 2: fluoroscopy and neuronavigation fused. Identify the landmarks, superior transverse process (left image), inferior transverse process (right image**).**

5. Endoscopic Visualization and Decompression

• Endoscope Insertion: the endoscope is introduced through the first portal, allowing the surgeon to visualize the target area on a monitor. The small size of the endoscope offers high magnification and excellent visualization of the extraforaminal structures, including nerve roots, herniated discs, and stenotic foraminal regions.

• Decompression: Using instruments inserted through the second portal, the surgeon can resect herniated disc material, decompress the nerve root, and remove any osteophytes or soft tissue obstructing the nerve root exit. Endoscopic tools like a pituitary rongeur, high-speed burrs, or shavers may be used for tissue removal (Figure 3 and 4).

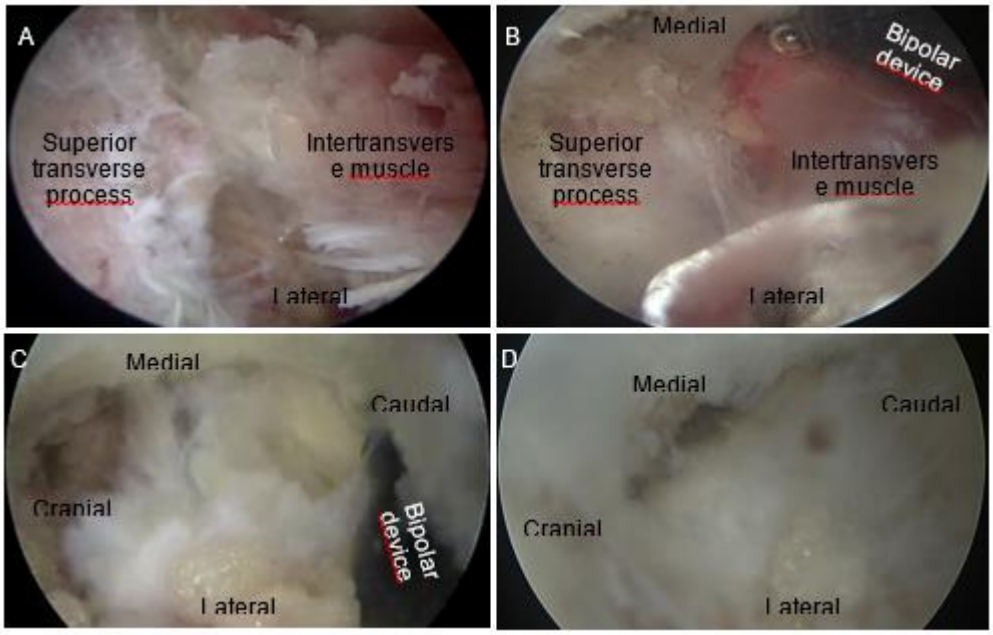

Figure 3: A, B, C.D endoscopical view of a left extraforaminal approach. Identification of the anatomical landmark

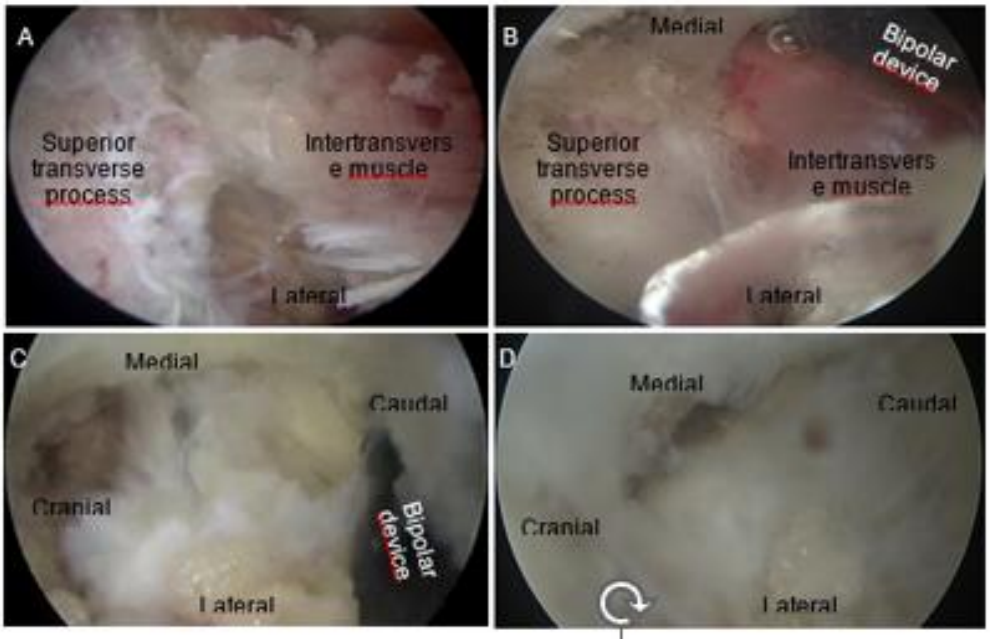

Figure 4: A, B, C. D endoscopical view of a left extraforaminal approach. B and D exposure of nerve root.

- Extraforaminal Disc Herniation: If there is an extraforaminal disc herniation, it is carefully mobilized and excised. The endoscope provides direct access to the lateral disc bulge that traditional methods might miss (Figure 5).

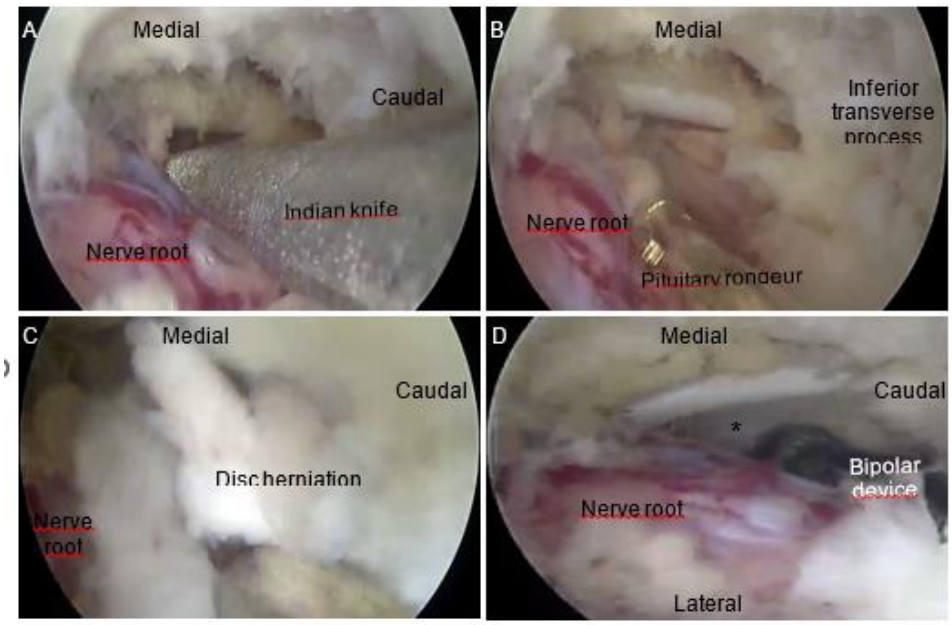

Figure 5: A, B,C,D endoscopical view of a left extraforaminal approach. Anatomical landmarks and nerve root exposure. B and C - pituitary rongeur for the discectomy. D- free nerve root after discectomy.

* access to the disc level.

5. Confirming Decompression

Inspection for Complications: the surgeon inspects for any dural tears, blood vessel injury, or unintended damage to surrounding

- structures. Control hemostasis it's important during all the surgery but specially in this moment, before finish the surgery.

6. Closure

- Suture: the small incisions are closed with sutures or adhesive strips. Since the incisions are minimal, there is little need for extensive suturing.

- Drainage: we recommend a drainage during 24h after the surgery.
- Postoperative Care: the patient is monitored for any immediate complications such as bleeding, nerve damage, or infection.

Postoperative Care and Considerations:

• Pain Management: most patients experience significantly less postoperative pain compared to traditional open surgery due to the smaller incisions and minimal tissue dissection.

• Early Mobilization: patients are often encouraged to begin mobilization and physiotherapy within 24–48 hours post-surgery.

- Imaging during Follow-up: MRI or CT scans are used at follow-up visits to assess for any residual disc herniation or signs of instability.

Complications Specific to Extraforaminal UBE Approach:

- Nerve Root Injury: due to the proximity of the nerve roots to the extraforaminal area, injury during dissection is possible. Proper anatomical understanding and careful tissue handling are key to minimizing this risk.
- Infection: although rare with minimally invasive techniques, infection remains a concern, particularly if proper sterile techniques are not followed.
- Dural Tears: as with any spinal procedure, there is a risk of accidental dural puncture, which can result in cerebrospinal fluid leaks. Increase infections risk.
- Incomplete Decompression: in some cases, especially if the disc herniation is large or lateral, full decompression may be difficult to achieve with an endoscopic approach, requiring a conversion to an open surgery.

Recommendations for Success:

• Team or surgeon experience: UBE and extraforaminal approaches require advanced knowledge of spinal anatomy, the landmarks especially the lateral and extraforaminal structures. Surgeons should have extensive experience with minimally invasive spinal techniques to optimize outcomes.

• Use of navigation systems: fluoroscopy or 3D navigation systems can enhance precision during portal placement, particularly for accessing difficult extraforaminal areas.

• Patient selection: ideal candidates are those with localized, extraforaminal disc herniations or stenotic lesions without significant facet joint degeneration or instability.

Conclusions:

UBE and the extraforaminal approach represent significant advancements in spinal surgery, offering reduced recovery times and minimizing soft tissue damage. Performing UBE extraforaminal approach is a powerful tool for minimally invasive spinal surgery. It provides excellent access to lateral and extraforaminal pathologies while minimizing the risks associated with traditional open surgeries.

However, it requires careful attention to detail, advanced technical skills, and thorough knowledge of spinal anatomy to achieve optimal results and avoid complications.

Their implementation should be tailored to specific patient conditions and performed by experienced spinal surgeons to avoid complications and achieve the best outcomes.

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