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ILLUSTRATIVE SURGICAL VIDEO

Unilateral biportal endoscopic spine surgery: A game changer in spine care

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Unilateral Biportal Endoscopic spine surgery is a minimally invasive technique using two portals for visualization and instrumentation. It offers enhanced precision, reduced tissue disruption, and faster recovery. This paper reviews its applications, advantages, and evolving role in spine care, including recent advancements in robotics and augmented reality.

Keywords: spine endoscopy, UBE, unilateral biportal spine endoscopy, MISS, minimal access spine surgery

Introduction

Unilateral Biportal Endoscopic (UBE) spine surgery has recently emerged as a state-of-the-art, minimally invasive spinal surgery technique that can be safely used to address various spinal pathologies.

UBE surgery involves creating *two portals* on the *same side* of the midline. One of the portals is used as a *visualization portal* (for introducing the endoscope) & another as a *working portal* (for introducing the instruments), thereby enhancing the visualization, maneuverability, & precision in comparison to single-port or microscopic spine surgeries. With a better understanding of the etiopathogenesis of degenerative processes & biomechanics of the spine, many concepts in spine surgery have changed. In the early days of endoscopic spine surgery, surgeons primarily focused on & treated disc herniations instead of treating spinal stenosis & selective discectomies.

The UBE technique, described in South Korea in the early 2010s, represented a paradigm shift by allowing surgeons to use standard arthroscopic instruments via two independent portals. UBE surgery combines the advantages of traditional open surgery and fully endoscopic techniques, minimizing tissue disruption while maintaining excellent clinical outcomes. As spinal disorders such as lumbar disc herniation and stenosis remain significant causes of disability worldwide, UBE is being performed globally with expanding indications & experiencing rapid advancement (1).

Historical background

The evolution of spine surgery has been marked by a consistent drive toward minimally invasive techniques to minimize the iatrogenic collateral damage to the surrounding structures like muscles, ligaments, facet joints, & nerve roots (2). Utilizing minimally invasive techniques also helped in maintaining stability & helped in faster post-operative recovery of the patients. Early open surgeries in the 20th century, though effective, were associated with extensive tissue damage, prolonged recovery, and significant postoperative morbidity. The introduction of endoscopic spine surgery in the 1990s revolutionized the field, offering a less invasive alternative.

In 1996, De Antoni et al. published the first technical note in which two separate ports were used: one for the insertion of an endoscope & another for instruments (3). In 2013 and 2015, Soliman published surgical results for lumbar disc herniation and spinal stenosis using UBE techniques with independent portals, which closely resemble the current method (4). The term "biportal" was first used in 2016, and "UBE" was introduced in an article published in South Korea (5). UBE was initially used for discectomy in the lumbar region, and later, it was successfully applied for laminectomy to treat central lumbar canal stenosis or lateral recess stenosis (6).

Usually, lumbar discectomy is considered the first generation of UBE. Procedures such as lumbar laminotomy, paraspinal approach, and contralateral approach can also be done using UBE, which is considered a second-generation UBE. Nowadays, lumbar interbody fusion also can be achieved using UBE with clinically similar outcomes as the open fusion procedure. UBE-assisted lumbar interbody fusion marks the third generation of UBE (7) (**Table 1**).

UBE surgery in the cervical and thoracic regions is a recent development that is continuously evolving. While the use of newer technologies like robotics, neuro-navigation & augmented reality remains less common in UBE, their use is expected to significantly improve efficiency, paving the way for the fourth generation of UBE (8) (**Figure 1**).

Indications

With the above-mentioned generational advances in UBE, indications for the biportal endoscopic approach are similar to those for minimally invasive microscopic surgery using a tubular retractor system. It can also be utilized in the central, lateral recess, foraminal, and extraforaminal stenoses in the lumbosacral caused by lumbar stenosis (9).

UBE spine surgery is primarily indicated for:

1. Degenerative spine conditions: disc herniation in the thoracic and lumbosacral spine.
2. Multi-level spinal canal stenosis and spondylolisthesis from the cervical to the lumbosacral area (10).
3. Spinal instability: For decompression and fusion procedures.
4. Spinal infections and tumors: In selected cases requiring minimally invasive biopsy or resection.
5. Recurrent disc herniations: Following failed conventional surgery.
6. Cauda Equina Syndrome (11).

While UBE has broad applicability, careful patient selection is critical to optimize outcomes.

Principles & technique

Although there are minor variations in the technique of UBE in the cervical, thoracic, & lumbosacral regions, the fundamental principles remain the same.

Conventional knee arthroscopy utilizes the naturally existing joint cavity, & laparoscopy uses CO_2 infusion to create a working space for surgeons to use the instruments. In the spine, however, there is no anatomical working space. Therefore, an artificial working space is created below the multifidus muscle by mechanical retraction of the multifidus from its attachment with the lamina. This space is called "Son's space;" it is an important anatomical landmark in UBE surgery (12). Just like arthroscopic joint surgery, UBE is also a fluid medium surgery, which utilizes irrigating saline as the working medium.

UBE is performed with the understanding of the following eight basic principles (13):

1. *Unilateral Biportal:* In UBE, the surgeon utilizes a traditional pathway to access the spine as in open surgery, and having two independent portals offers better maneuverability as compared to uniportal/monoportal endoscopic spine surgery.
2. *Fluid-Medium*: As mentioned earlier, UBE uses saline as the working medium. By controlling the outflow of the saline, hydrostatic pressure in the working field can be changed. Which, in turn, can stop the small bleeders & give a clear view of the surgical field. Therefore, having a continuous saline irrigation flow is critical for better visualization & safe surgery.
3. *Triangulation:* Tips of the Endoscope & the surgical instruments need to be positioned close together in UBE. This triangular positioning can be achieved using fluoroscopic guidance & tactile feel (**Figure 2**), the so-called "Chopstick maneuver."
4. *Semi-tubular system:* A small portion of the circle in the working portal in UBE is covered by the retractor, & the other portion is exposed without any covering. Having this semi-tubular retraction offers a comparatively wider working area (**Figure 3**). Once the triangulation is completed & continuous saline irrigation is evident via a well-formed working tract, the semi-tubular retractor also can be withdrawn, offering a further increase in the working area.
5. *One-hand surgery:* In UBE, the non-dominant hand controls the endoscope, while the dominant hand operates independently. That's why it is referred to as one-hand surgery.
6. *Lens inside the body:* Unlike microscopic surgery, the endoscope can be directly introduced into the body with better visualization of "dead spaces."
7. *A dynamic lens:* Unlike an operating microscope, the lens of the endoscope can be positioned dynamically to change the field of view.
8. *Pivot movement:* This is a universal principle in minimally invasive surgeries. During the UBE surgery, if we want to move the tip of the instrument inside the body of the patient upwards, we need to move the part of the instrument which lies outside the body of the patient in a downward direction. So,

TABLE 1 | Generations of UBE.

Generation	Lumbar	Thoracic	Cervical
First	Lumbar interlaminar discectomy	Paraspinal approach for discectomy	Posterior cervical foraminotomy and discectomy
Second	Lumbar laminotomy or laminectomy	Thoracic laminotomy	Posterior cervical laminectomy
	Paraspinal approach	Removal Ossification of ligamentum flavum	Posterior cervical extradural cyst removal
	Contralateral approach		
Third	Lumbar interbody fusion	Thoracic interbody fusion	Cervical laminoplasty
	Lumbar fusion extension		Posterior cervical instrumentation
Fourth	Use of Robotics, navigation & Augmented reality		

FIGURE 1 | Fourth generation of UBE being performed using augmented reality headset & navigation.

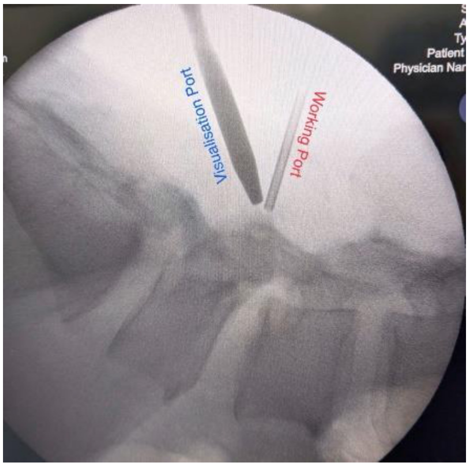

FIGURE 2 | Triangulation.

the instrument movements are pivoted at the skin level.

Technique

The midline is marked on the skin using a true anteroposterior view on the C-arm. Later on, the desired level is marked on the lateral view. The initial target point on the C-arm lateral view is the junction of the spinous process and the lamina. "Namaste Sign," as the author likes to describe it (**Figure 4**).

The author prefers to place the incisions more medial, near the left midline, compared to as described in standard literature (**Figure 5**), as it makes conversion to open procedure easier & with better cosmetic results.

Two surgical portals are created on the same side of the spine; one is for the endoscope and the other is for the instruments.

1. Visualization port: For introducing an endoscope to provide real-time imaging.
2. Working port: For insertion of instruments, such as drills, punches, or graspers.

The procedure begins with precise localization of the target spinal level under fluoroscopy. Sequential dilation and trocar placement are used to establish the portals. A triangular formation is made by positioning the endoscope and surgical instruments close together as described earlier (**Video 1**).

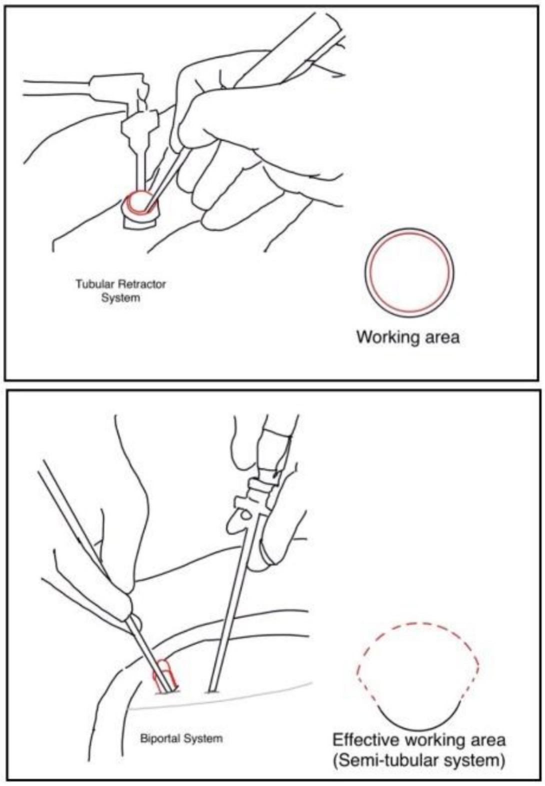

FIGURE 3 | Semi-tubular system in UBE provides larger effective working area compared to conventional tubular retractor systems.

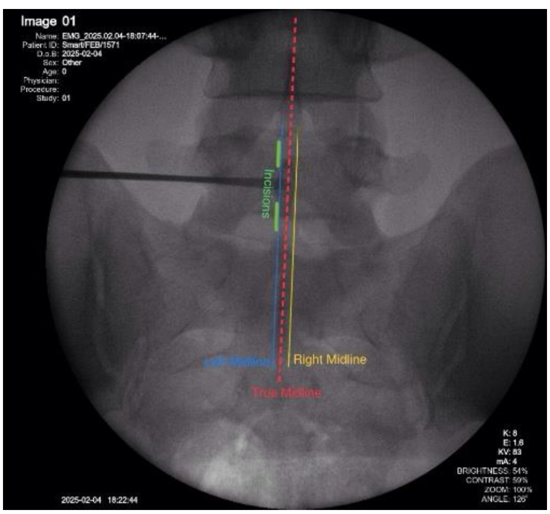

FIGURE 4 | "Namaste sign" showing junction of spinous process & lamina.

After localization & triangulation, the ipsilateral spino-laminar junction is identified and drilled to expose the ligamentum flavum & ipsilateral facet joint. Under endoscopic view these landmarks are appropriated with climbing up a mountain (exposure of the lamina), base camp (ipsilateral facet), & jumping off the cliff (drilling the facet & entering into the inter-laminar space) (**Figures 5** and **6**).

FIGURE 5 | Placement of incisions more medially makes conversion to an open procedure more convenient & with better cosmetic results.

VIDEO 1 | 0:01-History and clinical findings; 0:23-Gait; 1:13-Summit/Namaste sign; 2:18-Post positioning; 2:42-under the lamina; 4:45-Discectomy; 6:18-freeing bilateral nerve roots; 6:57-postoperative CT spine.
https://youtu.be/onBMn31C0IA

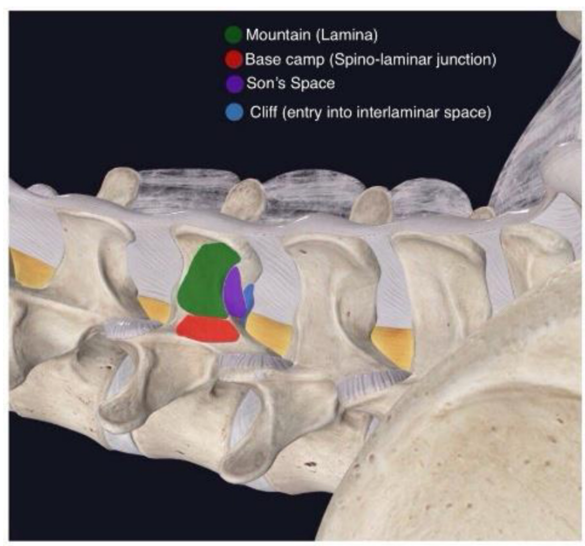

FIGURE 6 | Endoscopic view & landmarks in UBE.

The surgeon performs decompression, discectomy, or fusion under continuous endoscopic guidance. Unlike fully endoscopic techniques, UBE allows the use of conventional spine instruments, offering familiarity and versatility.

Advantages and disadvantages

Advantages

- **Minimally invasive:** Reduced muscle damage and faster recovery compared to open surgery.
- **Improved visualization:** High-definition imaging and better access to target anatomy along with visualization of blind spots.
- **Versatility:** Allows the use of standard instruments and techniques for complex cases.
- **Reduced complications:** Lower infection rates and less postoperative pain.
- **Maneuverability:** Unlike uniportal endoscopy, the endoscope and the instruments of the working portal move independently.
- **Less initial setting cost:** conventional open surgical instruments, such as drills, rongeurs, and punches, can be used through a working portal, making the initial setting-up cost less.

Disadvantages

- **Fluid-related complications:** the factitious space in UBE (Son's space) is not fully enclosed from all sides and is very close to the epidural space without any separating structure. Therefore, the saline pressure needs to be carefully controlled to avoid any inadvertent injury to adjacent neural structures. The optimal hydrostatic pressure should be 30–50 mmHg.
- **Learning curve:** Steep initial learning curve requiring technical expertise.
- **Extended operative time:** Initially longer due to the dual-portal setup.
- **Limited applicability:** Challenging in cases with severe deformity or extensive pathology.

Recent advances

Technological advancements have further enhanced the scope of UBE. Innovations such as high-definition 4K endoscopes, robotic assistance, and navigation systems have improved precision and outcomes. Additionally, expanded indications now include cervical spine surgeries and multilevel decompressions. Research into the integration of augmented reality (**Figure 1**) and artificial intelligence promises to further refine preoperative planning and intraoperative decision-making.

Conclusion

Unilateral Biportal Endoscopic spine surgery represents a significant leap forward in minimally invasive spinal care. By combining the benefits of traditional open and endoscopic techniques, UBE offers a versatile, effective, and patient-friendly alternative for managing spinal disorders. Despite its challenges, ongoing advancements and training initiative continue to expand its adoption worldwide, promising a brighter future for spine surgery.

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