

Breaking Barriers in Spine Surgery: Unilateral Biportal Endoscopy as a Trailblazer from Decompression to Fusion

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Learning Point of the Article:

This article highlights the evolving role of unilateral biportal endoscopy (UBE) from a decompression technique to a comprehensive minimally invasive approach for fusion and advanced spinal procedures. It emphasizes that while UBE offers enhanced visualization, tissue preservation, and minimally invasive advantages, its success depends on proper training, patient selection, and evidence-based adoption. The future of UBE lies in balancing innovation with reproducibility, safety, and long-term clinical validation.

Abstract

Survival analysis is critical in orthopaedics for determining how long procedures such as joint replacements and spinal operations are successful. Traditional approaches do not account for the timing of events such as implant failure or problems, whereas survival analysis does, allowing surgeons to make informed judgments. Key approaches for assessing risk variables and implant lifetime include Kaplan-Meier curves, log-rank tests, and Cox regression. This approach improves the evaluation of treatments across joint arthroplasty, fracture care, and spine surgery. Despite limitations such as data shortages and model assumptions, combining survival analysis with emerging technologies such as electronic health records and artificial intelligence improves personalised patient care and long-term outcome prediction, eventually leading to better surgical treatment.

Keywords: survival analysis, Kaplan-Meier, orthopaedics, Cox regression

Introduction

Unilateral biportal endoscopy (UBE) has become a trending minimally invasive approach to spine surgery. Early work was started in East Asian centers such as South Korea. The technique has progressed from simple lumbar decompression procedures to other surgical procedures such as discectomy, bilateral decompression through unilateral approaches, interbody fusion, and even some cervical and thoracic spine surgeries. The ever-expanding indication tells us a growing interest in surgical approaches that minimize tissue disruption while preserving or

enhancing clinical outcomes.[1]

Spine surgery has evolved over the years toward approaches that limit tissue damage while still achieving adequate neural decompression and maintaining stability. UBE achieves this using two separate portals, one for viewing and the other for instrumentation, allowing endoscopic visualization alongside the familiarity of standard surgical tools (Fig. 1). This dual-portal setup helps overcome some of the ergonomic challenges of uniportal and tubular techniques while preserving the principles of minimally invasive surgery.[2]

Continuous saline irrigation provides a clear operative field,

Author's Photo Gallery



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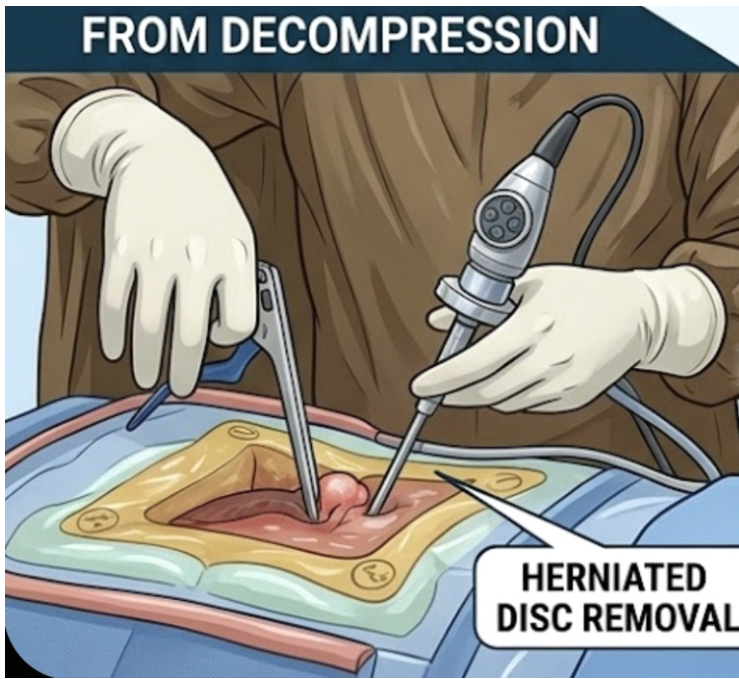


Figure 1: Unilateral biportal endoscopy, a right-handed surgeon has an instrument on right hand and the endoscope on left hand.

along with endoscopic visualization, which eases access to contralateral and anatomically concealed regions. In addition, the preservation of posterior musculoligamentous structures may contribute to reduced post-operative pain and faster recovery. Early studies have illustrated promising outcomes in terms of blood loss, hospital stay, and functional recovery, particularly in lumbar decompression procedures.[2,3] These factors have led to the increasing use of UBE across a range of spinal procedures.

However, the potential of UBE is beyond decompression only. Fusion procedures have a critical role in spine surgery, requiring precise endplate preparation, adequate disc clearance, accurate cage placement, and stable fixation. The application of UBE to transforaminal lumbar interbody fusion marks an important step in this direction (Fig. 2). Preliminary studies suggest that UBE-assisted fusion can achieve satisfactory clinical and radiological outcomes, with the added benefits of reduced perioperative morbidity compared to traditional open approaches.[4,5]

It is this evolution toward comprehensive minimally invasive spine surgery that UBE may be considered a “trailblazer.” Rather than serving as a temporary or transitional technique, UBE is leading to a meaningful shift in surgical practice,

comparable to the move from open to laparoscopic surgery. By combining endoscopic visualization with the familiarity and flexibility of conventional instruments, it has the potential to influence how spinal procedures are approached.[2]

Despite its advantages, UBE is not without limitations. Continuous saline irrigation, while essential for maintaining a clear operative field, can increase epidural pressure and, if not carefully managed, may lead to fluid extravasation or post-operative neurological symptoms.[6]

Equally important is the risk of overextension of its indications. With growing interest in minimally invasive techniques, there is a tendency to apply UBE in situations where conventional approaches may still be more appropriate. In such settings, issues such as incomplete decompression, excessive facet removal, or suboptimal implant positioning can arise, particularly during the early phase of the learning curve. These concerns underscore the need for careful case selection and structured training to ensure safe and effective use of the technique.

Recent advances in intraoperative guidance are further expanding the capabilities of UBE. Conventional two-dimensional (2D) endoscopic visualization, although effective,

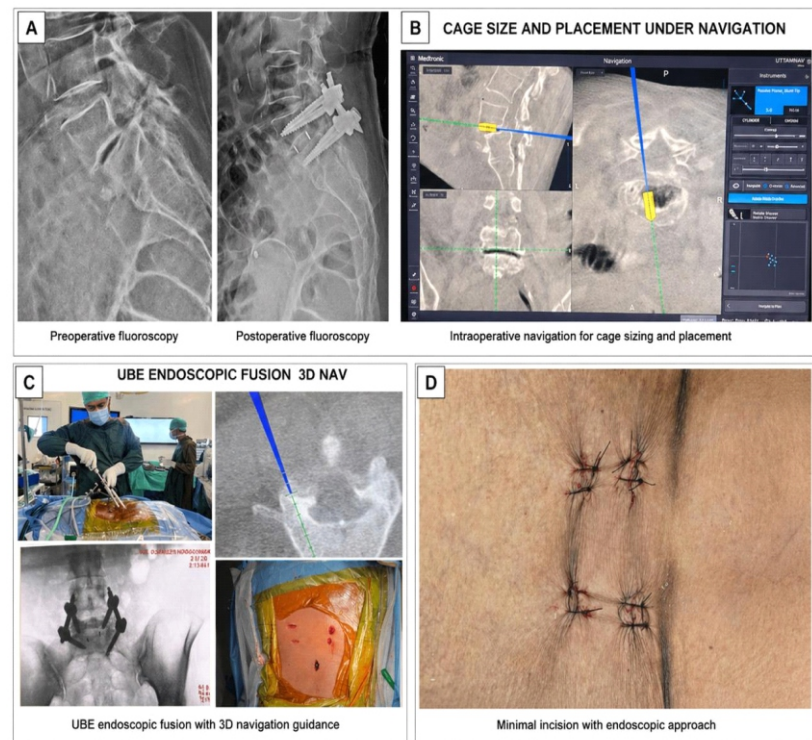


Figure 2: Well-prepared endplate with bleeding bone and cage position is visualized.

can limit depth perception and spatial orientation during complex decompression, revision surgery, and instrumentation. The introduction of three-dimensional (3D) navigation systems has addressed some of these limitations by providing real-time anatomical guidance and improved accuracy. Navigation-assisted UBE has been shown to enhance intraoperative precision, facilitate targeted decompression, and improve safety, particularly in anatomically challenging regions.[7]

In addition, 3D navigation-guided UBE techniques have demonstrated the ability to preserve facet integrity while achieving adequate decompression, with improved visualization of foraminal pathology and more accurate localization of disc fragments. The integration of robotic-assisted platforms with navigation further builds on this concept by enhancing the accuracy of pedicle screw placement, reducing radiation exposure, and improving procedural reproducibility. While these technologies are still evolving, they represent an important step toward greater precision and standardization in minimally invasive spine surgery.[8,9]

Despite its growing appeal, the expansion of UBE has outpaced the development of robust supporting evidence. Much of the current literature is retrospective and single-center experiences, often from high-volume centers with considerable expertise. While these reports offer useful early insights, they are subject to selection bias and have limited generalizability.[6] Comparative data against established minimally invasive and open techniques remain limited, and long-term outcomes, particularly regarding fusion rates, recurrence, and revision surgery, are not yet well reported.

The learning curve of UBE should not be underestimated. Despite being familiar in concept to surgeons with open or microscopic experience, it requires skill in endoscopy, fluid control, and bimanual handling. Early experience may be associated with longer operative times and complications such as dural tears, incomplete decompression, epidural hematoma, or excessive facet resection, and results from

specialized centers may not be readily reproducible in general practice.[10-12]

A measured approach is necessary when extending the indications of UBE. The technical feasibility of performing increasingly complex procedures using UBE should not be equated with clinical superiority. Careful patient selection and adherence to established surgical principles remain essential.[13]

At the same time, it would be premature to dismiss UBE as a transient trend. The evolution of spine surgery has historically been characterized by incremental advances rather than abrupt paradigm shifts. Its ability to combine familiar surgical ergonomics with enhanced visualization offers a unique platform for further innovation.

Looking ahead, the role of endoscopic techniques in spine surgery is likely to extend beyond conventional decompression and fusion. Emerging applications, such as endoscopic rhizotomy for chronic pain syndromes, point toward a broader therapeutic scope, particularly where direct visualization may enhance the precision of treatment.[14] However, definitive progress will depend not only on technological advancement but also on careful validation, appropriate patient selection, and structured training.

The future of UBE will ultimately be determined by the strength of the evidence supporting its use. Prospective multicenter studies, standardized outcome reporting, and long-term follow-up are essential to define its role alongside established techniques and to ensure consistent, reproducible results.

In this context, UBE represents both an opportunity and a responsibility. While it offers the potential to reduce surgical morbidity and expand the reach of minimally invasive spine surgery, its continued evolution must remain grounded in rigorous scientific evaluation rather than enthusiasm alone. Its position as a trailblazer will depend not only on innovation, but on evidence, reproducibility, and sustained clinical benefit.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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