



ENDOSCOPIC SPINE SURGERY: REVIEW ARTICLE

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Abstract

Background: Endoscopic spine surgery has emerged as an effective treatment option for cases of lumbar disc prolapse and lumbar canal stenosis, offering reduced postoperative pain and faster recovery.

Objectives: Highlight the different endoscopic spine surgery approaches and their indications and advantages.

Methods: We have searched literatures in PubMed, google scholar and science direct from 1994 to 2024.

Conclusion: Endoscopic spine surgery is safe and effective for treating lumbosacral radiculopathy due to lumbar disc prolapse and lumbar canal stenosis, offering significant pain relief and functional recovery.

Keywords: Endoscopic spine surgery; lumbar disc prolapse; lumbar canal stenosis.

Introduction:

The lumbar spine stands between the last thoracic vertebra (T12) and the first sacral vertebra (S1). The spinal cord in this region has protection from five durable vertebrae (L1-L5) that allow for the dispersion of axial forces. The spinal cord runs through the center of the vertebral column and terminates in the conus medullaris at the level of the L1-L2 vertebrae. The cauda equina, Latin for horse's tail, is a bundle of spinal nerve roots that begin at the termination of the spinal cord and descend through the remainder of the canal. The lumbar spine is comprised of bone, cartilage, ligaments, nerves, and muscle. Each of these components plays an integral role in the form and function of the lumbar spine (Waxenbaum *et al.*, 2017).

Low back pain is one of the most common musculoskeletal complaints in clinical practice. It is the leading cause of disability in the developed world and accounts for billions of dollars in healthcare costs annually (Alexander and Varacallo, 2023).



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Lumbosacral radiculopathy is the clinical term used to describe a constellation of symptoms occurring secondary to mechanical and/or inflammatory events affecting at least one of the lumbosacral nerve roots. Patients can present with radiating pain, numbness, weakness, and gait abnormalities. Depending on the nerve root(s) affected, patients can present with these symptoms in predictable patterns affecting the corresponding dermatome or myotome (**Alexander and Varacallo, 2023**).

Lesions of the intervertebral discs and degenerative disease of the spine are the most common causes of lumbosacral radiculopathy. However, any process that causes irritation of the spinal nerves can cause radicular symptoms. The differential diagnosis for lumbosacral radiculopathy should include (but is not limited to) the following: Degenerative conditions of the spine (most common causes), Trauma, Benign or malignant tumors, Infection, Vascular conditions (Hemangioblastoma, arteriovenous malformations) (**Alexander and Varacallo, 2017**).

Herniated intervertebral disc is one of the causes of low back pain. The majority of such symptoms improve with conservative treatments that include rest, medications, and physical therapy. In case of failure, many minimally invasive disc techniques have emerged as alternative to surgical treatments, to avoid their potential complications and possibly their suboptimal results (**Ezeldin et al., 2021**).

Endoscopic Spine Surgery:

Endoscopic spine surgery differs from other minimally invasive techniques because of the unique technical characteristics of the spinal working endoscope. The use of the spinal endoscope furthers the principles of minimally invasive spinal techniques by permitting the surgeon to visualize spinal contents in an expanded-angle field of view. This expanded view facilitates surgical treatment with minimal surgical dissection. The endoscope permits access to all regions of a spinal segment including the subarticular, far-lateral, foraminal and extraforaminal zones (**Yue and Long, 2015**).

Endoscopic spine techniques:

The three most commonly utilized techniques include full endoscopy, microendoscopy, and the Unilateral biportal endoscopy: **Full endoscopy** typically involves a single working channel, which houses the endoscope and one surgical instrument. The working channel allows for the utilization of one instrument at a time. The small working channel dictates that the camera used for visualization and the tool being used can only be moved in concert. **Microendoscopy** involves a single working channel, but the size is large enough to allow for multiple instruments to be used concurrently, and independent of the endoscope. The increased working channel size creates the potential to use a broader range of tools, and space to implant devices, such as interbody cages and bone graft. Unilateral **Biportal endoscopy** utilizes two working ports ‘skin entry incisions’ one for the endoscope and another for instruments. The main advantages of this approach are the independence of scope and instrument control, as well as a greater degree of freedom for positioning of the instruments (**Simpson et al., 2022b**).

Surgical approaches for endoscopic spine surgery:

The two most commonly utilized approaches for endoscopic surgery in the lumbar spine are the interlaminar approach and the extraforaminal (or transforaminal) approach. In the

interlaminar approach, a paramedian incision is used to access the interlaminar space, where the surgeon has direct access to the central canal and lateral recesses. This approach has the broadest application, as the majority of spinal disorders involve neural compression in the central and/or lateral recess zones. In the extraforaminal approach, a far lateral incision is used to allow instruments to access the extraforaminal and lateral foraminal zones in the Kambin's triangle. This approach provides direct access to the foramen and is most effective for isolated unilateral foraminal conditions or neural compression in the lateral recess (**Simpson et al., 2022b**).

Indications of Endoscopic spine surgery:

Lumbar spinal diseases are usually suitable for Endoscopic spine surgery with different approaches. Endoscopic lumbar discectomy has been a standard Minimally invasive spine surgery for all herniation types. At the L5-S1 level, the transforaminal approach can be restrictive by the high-iliac crest and narrowed foraminal area that results from a large L5 transverse process. (**Chen, Wei, et al., 2020**).

The interlaminar window is wider at the caudal level of the lumbar spine, making the interlaminar endoscopic approach an alternative at the L5-S1 level (**Choi et al., 2013**).

Table 1: Indications for lumbar endoscopic spinal surgery (**Chen et al., 2023**).

Herniated intervertebral disc
Central
Paramedian
Foraminal
Extraforaminal
Migrated disc
Lumbar spinal stenosis
Lateral recess stenosis
Central canal stenosis
Ossification of ligamentum flavum
Foraminal stenosis
Infective spondylodiscitis
Pyogenic discitis
Epidural abscess
Revision surgery
Recurrent disc herniation
Cage displacement
Bone cement leakage into canal or foramen
Spondylolisthesis (\leq grade 2)

The endoscopic burr and bone reamer have brought a new era for treating lumbar spinal stenosis using endoscopic spine surgery. Through an interlaminar approach, endoscopic surgeons can unilaterally decompress the thecal sac and traversing roots in cases of central canal or lateral recess stenosis. Complex pathologies, such as combined herniated intervertebral disc and spinal stenosis, can also be treated by endoscopic surgery (**Chen *et al.*, 2021**).

Advantages of Endoscopic Spine Surgery:

Endoscopic approaches are a great option because of their small incision size and minimal muscle dissection while still providing successful clinical outcomes. Several randomized controlled trials have demonstrated the clinical success of these approaches. A randomized clinical trial compared endoscopic discectomy to open microdiscectomy for patients with at least six weeks of radiating leg pain. The study showed that patients randomized to endoscopic discectomy had a significantly lower post-operative VAS score for leg pain compared to open microdiscectomy. There was also less blood loss, shorter hospital stays, and less back pain in the endoscopic discectomy group (**Ahn, Keum and Shin, 2020**).

There are several reports claiming that muscle splitting during discectomy operations is associated closely with postoperative low back pain. Endoscopic spinal surgery has been proven to be less invasive compared to a conventional microdiscectomy procedure. It has been shown that, as a muscle injury indicator, creatine phosphokinase (CPK) levels are significantly lower in full-endoscopic disc surgery than conventional microdiscectomy. (**Pan, Zhang and Yin, 2014**).

Endoscopic spine surgery does not require extensive tissue dissection and provides an advantage in obese patients. A study of 41 patients with a body mass index $> 30 \text{ kg/m}^2$ who underwent endoscopic lumbar surgeries showed that they were able to achieve significant improvements in pain and disability without high amounts of blood loss or postoperative complications (**Hudak and Perry, 2015**).

The mean operative time was shorter in endoscopic discectomy patients compared to those who underwent open microdiscectomy in obese patients with a BMI $> 30 \text{ kg/m}^2$ (**Bansal *et al.*, 2023**).

Endoscopic spine surgery has been shown to have a significantly lower risk of surgical site infections. A retrospective multicenter cohort study compared 1277 non instrumented full endoscopic spine surgery cases compared to non-endoscopic NSQIP (National Surgical Quality Improvement Program) cohort patients. In the matched data, the surgical site infections rates for non-endoscopic and endoscopic patients which was a 16-times reduction. The rate of infection with traditional microdiscectomies is low, but as full endoscopic surgical techniques are applied, the reduction in surgical site infections can have a larger effect (**Mahan *et al.*, 2023**).

Disadvantages of Endoscopic Spine Surgery:

The main disadvantages of the procedure are the steep learning curve and possible complications. Dural tears are complication for both conventional microdiscectomy and endoscopic discectomy procedures. Another possible complication for the transforaminal procedures is adjacent abdominal structure injury due to mal positioning of the endoscopic canula and in order to avoid intraabdominal injury, preoperative abdominal CT should be ordered to calculate the precise entry point during transforaminal procedures (**Aydin and Bolat, 2019**).

Postoperative paresthesia is another common complication for transforaminal procedures. This complication is probably because of the limited movement of the canula in the large vertebral foramen causing root irritation (Sencer *et al.*, 2014).

The transforaminal surgeries examined in some study took longer, required more time for fluoroscopy and puncture. The transforaminal approach is often inappropriate for patients with L5-S1 lesions, as the intervertebral space may be blocked by the iliac crest and the L5 transverse process (He *et al.*, 2016).

Compared with open surgery, endoscopic surgery has some obvious advantages, such as minimal invasion, less blood loss, and lower cost. Before endoscopic spinal surgery, careful analysis of imaging data must be undertaken to determine the range and degree of decompression (Yadav *et al.*, 2016).

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