OLSZAK, Joanna, ZALEWA, Karolina, BARTOSZEK, Lidia, ORŁOWSKA, Dominika, KAPŁAN, Wojciech, POLESZCZUK, Mikołaj, POLESZCZUK, Karol, MILEWSKA, Alicja and CZUBA, Anna. Complications after endoscopic spine surgery - risk factors and preventive strategies. Journal of Education, Health and Sport. 2025;77:56694. eISSN 2391-8306.
https://doi.org/10.12775/JEHS.2025.77.56694
https://apcz.umk.pl/JEHS/article/view/56694

The journal has had 40 points in Minister of Science and Higher Education of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences).
Punkty Ministerialne 40 punktów. Załącznik do komunikatu Ministra Nauki i Szkolnictwa Wyższego z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).
The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 06.12.2024. Revised: 29.12.2024. Accepted: 01.01.2025. Published: 02.01.2025.

Complications after endoscopic spine surgery - risk factors and preventive strategies

Joanna Olszak[1], Karolina Zalewa[1], Lidia Bartoszek[2], Dominika Orłowska[3], WojciechKapłan[1], Anna Czuba[4], Mikołaj Poleszczuk[5], Karol Poleszczuk[6], Alicja Milewska[6]

[1]Independent Public Hospital No. 4 in Lublin, Jaczewskiego street 8, 20-954 Lublin, Poland
[2]National Medical Institute of the Ministry of the Interior and Administration, Wołoska street 137, 02-507 Warsaw, Poland
[3] Trauma Surgery Hospital of St. Anna, Barska street 16/20, 02-315 Warsaw
[4] Stefan Żeromski Specialist Hospital SP ZOZ in Krakow
[5] Medical University of Lublin
[6] Kazimierz Pułaski University of Radom

Joanna Olszak
ORCID: 0009-0004-0211-1449
E-mail: asia.olszak663@gmail.com

Karolina Zalewa
ORCID: 0009-0004-0610-6866
E-mail: zalewa.karolina@gmail.com

Wojciech Kapłan
ORCID: 0000-0003-2270-0318
E-mail: wojtek.kaplan@gmail.com

Dominika Orłowska
ORCID: 0009-0001-9104-0459
E-mail: dominikarachwal98@gmail.com

Lidia Bartoszek
ORCID: 0009-0000-1656-7325
E-mail: lidka.bartosz@gmail.com

Anna Czuba
ORCID: 0009-0006-4497-0457
E-mail: anna.czuba@vp.pl

Karol Poleszczuk
ORCID: 0009-0002-4042-5612
E-mail: kpoleszczuk02@gmail.com

Mikołaj Poleszczuk
ORCID: 0009-0000-7282-615X
E-mail: poleszczuk.mikolaj@gmail.com

Alicja Milewska
ORCID: 0009-0005-4854-8555
E-mail: ali.milewska@gmail.com

ABSTRCT

Introduction and Purpose

Endoscopic spine surgery (EOS) is a minimally invasive alternative to traditional surgery, with less tissue trauma and shorter hospital stay. Despite these advantages, these procedures are associated with the risk of complications. The aim of this article is to analyze the most common complications, identify risk factors, and discuss preventive strategies that can minimize the risk of their occurrence.

Materials and Methods

A comprehensive literature review was conducted using the PubMed database, focusing on articles published up to the end of 2024. The search included the keywords “endoscopic”, “spine surgery”, “complications”, and “risk factors” in different combinations. Relevant studies were selected based on criteria such as complications after endoscopic spine procedures and risk factors that affect them, as well as methods for their prevention.

Results

The literature review indicates that the most common complications after EOS are dura tears, nerve injury, infection, bleeding, and adhesions. Risk factors include both patient-related aspects and surgical technique. Patient factors include age, comorbidities, and anatomical abnormalities of the spine. Procedural factors include operator inexperience, selection of an inappropriate surgical approach, and technical limitations of endoscopic equipment.

Conclusions

Prevention of complications after EOS requires a comprehensive approach that includes both careful patient qualification and optimization of surgical technique. Regular operator training can significantly improve patient outcomes. Strict control of risk factors and individualization of the surgical approach are also key. These measures can not only reduce the risk of complications but also improve the efficiency and safety of endoscopic spine surgery.

Keywords: endoscopic, spine surgery, complications, risk factors

Introduction

Microscopic decompression is one of the most common procedures used to treat spinal conditions. The procedure reduces blood loss, post-operative pain and length of hospitalization, and promotes a quick return of patients to daily activities. However, despite its many advantages, it has some limitations, such as the need for partial damage to the spinal muscles and limited intraoperative visibility. In response to these challenges, endoscopic techniques, both uniportal (UPFE) and bi-portal (BESS), have been developed. Endoscopic decompression approaches minimize damage to surrounding tissues while providing excellent visualization of the pathology site. In the uniportal system, a single portal is used for both optics and labor, while the dual-portal system separates the channels for imaging and instruments, increasing the precision of the procedure. Patients undergoing endoscopic procedures often experience less lower back pain after surgery, shorter hospitalization time and less blood loss, resulting in a faster return to normal function.[1] Full endoscopic technique in spine surgery provides clinical results comparable to microsurgical technique, while offering the benefit of less surgical trauma. With modern surgical devices and the choice of interlaminar or posterior-lateral access, herniated lumbar discs can be successfully removed if the appropriate criteria are met. This procedure is a safe and effective alternative to microsurgery. [2] Endoscopic approaches to spine surgery can be used at all levels of the spine, and numerous clinical studies confirm their effectiveness and positive results.[3] The

remarkable development of endoscopic techniques and surgical instruments has led to results comparable to traditional open surgery. The FELD (full-endoscopic lumbar discectomy) technique offers a number of advantages over microdiscectomy (MD), such as minimal damage to the spinal muscles, less postoperative pain, preservation of bone structures, faster recovery and shorter hospitalization time. With these advantages, FELD is increasingly becoming the preferred method for treating spinal disorders.[4] The complication rate is comparable or lower compared to traditional open and microscopic techniques. Clinical results are promising, with about 80% of patients achieving high satisfaction and significant improvement in pain and disability after surgery.[5]

Most Common Complications

Complications of endoscopic spine surgery can be divided into perioperative and late complications. The former include transient neurological deficits, dura tears, and dysesthesia,

which are common with discectomy and decompression. Late complications, such as implant failure, occur mainly with endoscopic interbody fusion, often due to migration or overloading of the implant.[6] Complications also vary depending on where the surgery is performed.
Cervical spine surgery often involves dura mater damage, which can lead to serious complications if not properly diagnosed and treated. Other complications include temporary dysesthesia, neck pain, and nerve damage, including to the retrobulbar laryngeal nerve, which can cause swallowing problems or voice changes. In the thoracic segment, complications include similar problems such as dura rupture, which is relatively common, and transient paresthesias. Intercostal neuralgia is a characteristic complication of endoscopic surgery in this area. Although hematomas are less common, their presence can cause serious neurological symptoms, especially when large vessels are involved. In the lumbar region, the most common complication is dura mater damage, which can occur as a result of difficult surgical access or technical complications. It has also been reported the formation of epidural hematomas has also been reported, which can cause pressure on nerve structures. Other common complications include persistent postoperative pain, surgical site infections, incomplete decompression and, less commonly, bone fractures. All endoscopic procedures carry the risk of incomplete resection of disc fragments, which may lead to recurrence of symptoms. Postoperative headache or other neurological symptoms, such as seizures, may

result from the use of high water pressure during surgery, which increases cerebrospinal fluid and intracranial pressure. It is noteworthy that the risk of complications increases with more complex procedures, such as bilateral decompression or surgery for spinal stenosis, which are more technically demanding.[7] In summary, studies indicate that the most common complication is dura tear, which occurs in 2% of cases, followed by epidural hematoma, which occurs in 1% of cases. [8] Another study also listed postoperative headache among the most common complications.[9] Although other complications are less common, each requires prompt recognition and appropriate management to avoid long-term consequences for the patient. Nerve damage is a rare complication that may result in neurological deficits such as motor weakness or ponytail syndrome. To minimize the risk, intraoperative neuromonitoring and caution in nerve root manipulation are recommended, as well as the use of techniques that minimize the risk of thermal damage, such as controlled radiofrequency ablation.[10] Complications following procedures performed by experienced chiropractors are rare. One study found that the overall complication rate after unilateral biportal endoscopic surgery for lumbar spinal stenosis was 8.1%. Dura tears remain a major complication, occurring in 4.5% of cases. Other complications include incomplete decompression (2.0%), transient paralysis (2.6%), and symptomatic postoperative epidural hematoma, which occurred in only 1.1% of cases.[11]

Table 1: Types of complications

Complication type	Description	Preventive strategies
Dural tear	A puncture of the dura mater of the spinal cord that can lead to cerebrospinal fluid leakage	Accurate preoperative imaging, caution when inserting instruments.
Epidural hematoma	A collection of blood in the epidural space that can compress neural structures	Use of intraoperative monitoring, control of pressure during surgery
Incomplete decompression	Inadequate removal of pathological disc fragments	Thorough removal of pathological changes,

	or compression of neural structures	monitoring of surgical results
Postoperative headache	A headache resulting from the use of high cerebrospinal fluid pressure	Adequate control of CSF pressure during the procedure
Nerve damage	Damage to nerve roots leading to neurological deficits (e.g. motor weakness)	Neuromonitoring during the procedure, caution when manipulating nerves

Risk Factors

A review of the literature on total endoscopic lumbar decompression shows that there are specific contraindications to this type of procedure. The endoscopic procedure is not recommended for pure back pain not associated with neurogenic symptoms or spinal instability or deformity requiring stabilization. In addition, transforaminal decompression is contraindicated in cases of central spinal canal stenosis or complex intervertebral foraminal stenosis.[12] The supraspinal scarring that occurs with revision discectomy increases the risk of nerve root damage and dura tear. In addition, excessive removal of posterior structures such as intervertebral joints may lead to segmental instability, further compromising the outcome.[13] Older age, advanced disc degeneration at the level of surgery, and the presence of degenerative changes at multiple levels of the spine significantly increase the risk of postoperative complications. [14] The advantages of endoscopic surgery include better visualization, panoramic imaging, and the ability to work precisely in hard-to-reach areas.
However, endoscopic have their limitations, such as proximal blind spots, difficulty manipulating instruments through a narrow corridor, disorientation, frequent lens fogging, loss of depth perception, and difficulty achieving hemostasis. This can lead to complications and increased operative time, especially during the learning curve.[15] Dura fractures during endoscopic spine surgery can have several causes. First, novice surgeons may make mistakes due to lack of experience, and second, endoscopic surgery does not require retraction of anatomical structures, which increases the risk of damage. The long operating time, especially in patients with complex conditions, also increases this risk. Injection of saline can cause

undulation of the dura, and the use of high-speed drills can stretch the fibrous bands of the dura, leading to tears. Risk factors for postoperative hematoma include age (>70 years), female gender, use of anticoagulants, use of an infusion pump, and procedures that require work on the bone, such as laminectomy. Postoperative dysesthesia results from damage to the dorsal root ganglion (DRG), which is susceptible to disc herniation and mechanical damage from instruments.[7] Obesity is associated with an increased risk of complications in spine surgery and more difficult surgical access, but one study found that obesity was not a risk factor for increased perioperative complications in biportal spine endoscopy, and the outcomes of obese patients did not differ from those with a normal BMI.[16]

Table 2: Risk factors for complications

Risk factor	Description	Impact on outcome	Preventive strategies
Complexity of procedure (e.g. bilateral decompression)	Procedures requiring greater precision, e.g. decompression at multiple levels of the spine	Higher risk of complications such as hematomas, dural laceration	Careful operative planning
Surgeon experience	Level of experience and skill of the surgeon	Lower risk of complications in experienced surgeons	Training of surgeons, improvement of surgical techniques
Location of surgery (e.g. cervical, lumbar)	Different levels of the spine are associated with different types of risks	Increased risk of complications specific to the location (e.g. laryngeal nerve in the cervical spine)	Selection of appropriate access technique, caution when manipulating structures
Comorbidities (e.g. osteoporosis)	Conditions such as osteoporosis may increase the risk of bone fractures	Increased risk of damage to bone structures	Assessment of health status before the procedure

Prevention Strategies

Prevention of complications is difficult due to the challenging learning curve and individual patient characteristics. The most common include nucleus pulposus fragment omission, nerve root damage, dura rupture, damage to visceral structures, burning root pain, postoperative dysesthesia, and surgical site infection. Avoiding these complications requires extensive

surgeon experience and careful surgical planning.[17] Young surgeons are advised to attend live workshops, watch videos of procedures, visit hospitals, observe experienced endoscopic surgeons, select cases appropriately, work with a multidisciplinary team, practice on models, and workshop on cadavers.[15] If the dura is torn, a thin layer of TachoSil should be applied to prevent complications. However, too much TachoSil can lead to pressure on the spinal cord and nerve roots. Gelatin-Thrombin Sealer (GTMS) is widely used to reduce the risk of postoperative epidural hematoma, especially in biportal endoscopic spine surgery. Its use improves clinical outcomes and reduces the incidence of this complication. In addition, insertion of a postoperative Hemovac drain into the epidural space helps to drain excess irrigation fluid, and neck or head pain can be relieved with rest and conservative treatment.
Precise needle insertion technique into a safe avascular area is critical to avoid vessel damage, as is careful assessment for potential bleeding when removing the endoscope. To reduce the risk of dysesthesia, foraminoplasty should be considered to expand the safe zone without irritating the nerve root. In turn, to avoid postoperative headache, avoid high-pressure water infusion by improving fluid drainage through a fascial incision in the working portal.[7]

Summary

Endoscopic spine surgery is becoming an increasingly popular treatment option, offering numerous advantages over traditional surgery, including less tissue trauma and faster return to activity. [18] Studies also suggest that endoscopic surgery offers faster pain relief and a shorter hospital stay.[19] As a result, endoscopic procedures such as microscopic decompression and endoscopic lumbar discectomy are being widely used. However, endoscopic spine surgery is associated with the risk of complications such as dura mater damage, epidural hematoma, incomplete decompression, and transient dysesthesia. Although other complications such as nerve damage, infection, or implant problems are less common, each requires prompt intervention. Proper diagnosis, surgical planning, and surgeon experience are key to minimizing risk. Studies show that the results of endoscopic spine surgery are promising, with low rates of complications and the need for revision surgery. However, patients with disc herniation, spinal canal stenosis, or herniation associated with degenerative canal stenosis can be challenging, especially in the early stages of learning the technique. In such cases, it is worth considering traditional open surgery or other minimally

invasive methods that may be more appropriate.[20] Despite these risks, endoscopic spine surgery remains a promising treatment option, providing patients with rapid recovery and high satisfaction. With advances in technology, the risk of complications continues to decrease and outcomes continue to improve.

Conceptualization: Joanna Olszak, Dominika Orłowska, Karolina Zalewa
Methodology: Joanna Olszak, Lidia Bartoszek, Anna Czuba
Software: Karolina Zalewa, Karol Poleszczuk
Check: Alicja Milewska, Anna Czuba, Mikołaj Poleszczuk
Formal analysis: Lidia Bartoszek, Wojciech Kapłan
Investigation: Dominika Orłowska, Joanna Olszak Resources: Joanna Olszak, Karolina Zalewa
Data curation: Karol Poleszczuk, Mikołaj Poleszczuk, Lidia Bartoszek
Writing -rough preparation: Dominika Orłowska, Joanna Olszak, Karolina Zalewa Writing - review and editing: Wojciech Kapłan, Lidia Bartoszek, Karol Poleszczuk Supervision: Joanna Olszak, Karolina Zalewa
Project administration: Joanna Olszak, Lidia Bartoszek, Alicja Milewska

All authors have read and agreed with the published version of the manuscript.
Founding Statement:The study did not receive funding.
Institutional Review Board Statement: Not applicable.
Informed Consent Statement:Not applicable.
Data Availability Statement:Not applicable.
Conflict of Interest Statement: The authors declare no conflicts of interest.
Acknowledgments: Not applicable.

Acknowledgments: Not applicable.

References:

1.Roberto J. Perez-Roman MD, Wendy Gaztanaga BS, Victor M. Lu MD, and Michael Y. Wang MD Endoscopic decompression for the treatment of lumbar spinal stenosis: an updated

systematic review and meta-analysis https://doi.org/10.3171/2021.8.SPINE21890 Journal of Neurosurgery: Spine Volume 36: Issue 4 549–557

2.Sebastian Ruetten, MD, PhD,Martin Komp, MD, PhD, Harry Merk, MD, and Georgios Godolias, MD Full-Endoscopic Interlaminar and Transforaminal Lumbar Discectomy Versus Conventional Microsurgical Technique SPINE Volume 33, Number 9, pp 931–939

3.Daniel J Burkett, Nathaniel Brooks A Critical Review of Endoscopic Spine Surgery Neurosurg Clin N Am. 2025 Jan;36(1): 21-30.doi: 10.1016/j.nec.2024.08.002. Epub 2024 Sep 10.

4.Chao-Chun Yang, Chien-Min Chen, Martin Hsiu-Chu Lin, Wei-Chao Huang, Ming- Hsueh Lee, Jin-Sung Kim, Kuo-Tai Chen Complications of Full-Endoscopic Lumbar Discectomy versus Open Lumbar Microdiscectomy: A Systematic Review and Meta-Analysis World Neurosurg. 2022 Dec: 168:333-348.doi: 10.1016/j.wneu.2022.06.023

5.Don Y Park, Alexander Upfill-Brown, Nora Curtin, Christopher D Hamad, Akash Shah, Brian Kwon, Yong H Kim, Dong Hwa Heo, Cheol Woong Park, William L Sheppard Clinical outcomes and complications after biportal endoscopic spine surgery: a comprehensive systematic review and meta-analysis of 3673 cases Eur Spine J. 2023 Aug;32(8): 2637-2646.doi: 10.1007/s00586-023-07701-9. Epub 2023Apr 20.

6.Domenico Compagnone, Filippo Mandelli, Matteo Ponzo, Francesco Langella, Riccardo Cecchinato, Marco Damilano, Andrea Redaelli, Giuseppe Maria Peretti, Daniele Vanni, Pedro Berjano Complications in endoscopic spine surgery: a systematic review Eur Spine J. 2024 Feb;33(2): 401-408.doi: 10.1007/s00586-023-07891-2. Epub 2023 Aug 16.

7.Chang Il Ju, Seung Myung Lee Complications and Management of Endoscopic Spinal Surgery https://doi.org/10.14245/ns.2346226.113 Neurospine 2023;20(1):56-77.

8.Jiachang Liang, Lirong Lian, Shaotian Liang, Haibo Zhao, Gao Shu, Jiwei Chao, Chao Yuan, Mingyu Zhai Efficacy and Complications of Unilateral Biportal Endoscopic Spinal

Surgery for Lumbar Spinal Stenosis: A Meta-Analysis and Systematic Review World Neurosurg. 2022 Mar: 159:e91-e102.doi: 10.1016/j.wneu.2021.12.005. Epub 2021 Dec 7.

9.Bin Wang, Peng He, Xiowei Liu, Zhengfang Wu, Bin Xu Complications of Unilateral Biportal Endoscopic Spinal Surgery for Lumbar Spinal Stenosis: A Systematic Review of the Literature and Meta-analysis of Single-arm Studies Orthop Surg. 2023 Jan;15(1) :3-15.doi: 10.1111/os.13437. Epub 2022 Nov 17.

10.Kai-Uwe Lewandrowski , Albert E Telfeian , Stefan Hellinger, Jorge Felipe Ramírez León, Paulo Sérgio Teixeira de Carvalho, Max R F Ramos, Hyeun Sung Kim Daniel W Hanson Nimar Salari, Anthony Yeung Difficulties, Challenges, and the Learning Curve of Avoiding Complications in Lumbar Endoscopic Spine Surgery Int J Spine Surg. 2021 Dec;15(suppl 3): S21-S37. doi: 10.14444/8161.

11.Zhaoyuan Chen, Huaqiang Zhou, Xuhua Wang, Zhenxing Liu, Wuyang Liu, Jiaquan Luo Complications of Unilateral Biportal Endoscopic Spinal Surgery for Lumbar SpinalStenosis: A Meta-Analysis and Systematic ReviewWorld Neurosurg. 2023 Feb : 170:e371-e379.doi: 10.1016/j.wneu.2022.11.019. Epub 2022 Nov 8.

12.Chang-Il Ju, Pius Kim, Sang-Woo Ha, Seok-Won Kim, Seung-Myung Lee Contraindications and Complications of Full Endoscopic Lumbar Decompression for Lumbar Spinal Stenosis: A Systematic Review World Neurosurg. 2022 Dec: 168: 398-410.doi: 10.1016/j.wneu.2022.07.066.

13.Yan Wang, Houchen Liu, Antao Lin, Hao Zhang, Xuexiao Ma Surgical Strategy and Outcomes of Full Endoscopic Lumbar Discectomy for Recurrent Lumbar Disk Herniation Following a Previous Full Endoscopic Lumbar Discectomy Orthop Surg. 2023 Oct;15(10):2602-2611. doi: 10.1111/os.13844. Epub 2023 Aug 3.

14.Ning Fan, Shuo Yuan, Peng Du, Qichao Wu, Tianyi Wang, Aobo Wang, Jian Li, Xiaochuan Kong, Wenyi Zhu Lei Zang Complications and risk factors of percutaneous endoscopic transforaminal discectomy in the treatment of lumbar spinal stenosis BMC Musculoskeletal Disorders volume 22, Article number: 1041 (2021)

15.Yad Ram Yadav, Angelo Lucano, Shailendra Ratre, Vijay Singh Parihar Practical Aspects and Avoidance of Complications in Microendoscopic Spine Surgeries: A Review J

Neurol Surg A Cent Eur Neurosurg. 2019 Jul;80(4) 291-301.doi: 10.1055/s-0039-1677825. Epub 2019 Apr 9

16.Thomas E Olson, Alexander Upfill-Brown, Babapelumi Adejuyigbe , Nitin Bhatia , Yu-Po Lee, Sohaib Hashmi, Hao-Hua Wu, Hansen Bow, Cheol Wung Park, Dong Hwa Heo, Don Young Park Does obesity and varying body mass index affect the clinical outcomes and safety of biportal endoscopic lumbar decompression? A comparative cohort study Acta Neurochir (Wien). 2024 Jun 3;166(1):246.doi: 10.1007/s00701-024-06110-1.

17..Chuanli Zhou, Guoqing Zhang, Ripul R Panchal, Xianfeng Ren, Hongfei Xiang, Ma Xuexiao , Xiaoliang Chen, Gu Tongtong , Wang Hong, Alana D Dixson Unique Complications of Percutaneous Endoscopic Lumbar Discectomy and Percutaneous Endoscopic Interlaminar Discectomy Pain Physician. 2018 Mar;21(2): E105-E112.

18.Dong Hwa Heo, Dong Chan Lee, Hyeun Sung Kim, Choon Keun Park, Hungtae Chung Clinical Results and Complications of Endoscopic Lumbar Interbody Fusion for Lumbar Degenerative Disease: A Meta-Analysis World Neurosurg 2021 Jan:145:396-404. doi: 10.1016/j.wneu.2020.10.033. Epub 2020 Oct 13.

19.Qian Wang, Shuai Chang, Jun-Feng Dong, Xu Fang, Yang Chen, Can Zhuo
Comparing the efficacy and complications of unilateral biportal endoscopic fusion versus minimally invasive fusion for lumbar degenerative diseases: a systematic review and mate-analysis Eur Spine J.2023 Apr;32(4): 1345-1357.doi: 10.1007/s00586-023-07588-6. Epub 2023 Mar 3.

20.Daniel B Scherman, Daniel Madani, Shanu Gambhir, Marcus Ling Zhixing , Yingda Li Predictors of Clinical Failure after Endoscopic Lumbar Spine Surgery During the Initial Learning Curve World Neurosurg. 2024 Feb: 182:e506-e516.doi: 10.1016/j.wneu.2023.11.137.Epub 2023 Dec 5.