

International Journal of Health Science

ISSN 2764-0159

vol. 5, n. 33, 2025

●●● ARTICLE 14

Acceptance date: 28/10/2025

UPDATES TO ENDOSCOPIC SPINAL TREATMENT PROTOCOLS IN THE BRAZILIAN PUBLIC HEALTH SYSTEM IN 2025

Brenda Geovanna Siebra Brito de Alencar

Medical Student – Universidade Nova Iguaçu (UNIG), Campus V – Itaperuna, RJ
<https://orcid.org/0009-0001-9683-0978>

Gabryelli de Oliveira Mofati Vivas

Medical Student – Nova Iguaçu University (UNIG), Campus V – Itaperuna, RJ

Isabella Freitas Gonçalves

Medical Student – Nova Iguaçu University (UNIG), Campus V – Itaperuna, RJ

Júlio César Gonçalves Vieira da Silva

Medical Student – Nova Iguaçu University (UNIG), Campus V – Itaperuna, RJ

Luiza Maria Pereira

Medical Student – Nova Iguaçu University (UNIG), Campus V – Itaperuna, RJ
<https://orcid.org/0009-0000-5673-9072>



All content published in this journal is licensed under the Creative Commons Attribution 4.0 International License (CC BY 4.0).

Nathalia Pereira Magalhães

Medical Student – Nova Iguaçu University (UNIG), Campus V – Itaperuna, RJ
<https://orcid.org/0009-0009-2730-012X>

Thais Aparecida Marques Zanon Jacomino

Medical Student – Nova Iguaçu University (UNIG), Campus V – Itaperuna, RJ
<https://orcid.org/0000-0002-1158-8845>

Rafael Rambaldi Oliveira

Medical Student – Nova Iguaçu University (UNIG), Campus V – Itaperuna, RJ

Stella Motta Ranzato

Medical Student – Nova Iguaçu University (UNIG), Campus V – Itaperuna, RJ
<https://orcid.org/0009-0001-6440-5205>

Dominic Diniz Cardoso Moreira

Medical Doctor, graduated from Universidade Nova Iguaçu (UNIG), Campus V– Itaperuna, RJ

Abstract: Introduction: Complete or single-port endoscopic surgery, unilateral biportal endoscopy (UBE), and microendoscopy represent major advances in clinical practice. These methods have been increasingly studied in Brazil, and there is growing interest from public and private hospitals in adopting these techniques, although the availability of resources, the need for specialized training, and the cost of equipment still constitute significant barriers, especially in the Unified Health System (SUS). Methodology: The scientific databases used were: Latin American and Caribbean Health Sciences Literature (LILACS), *Scientific Electronic Library Online* (SCIELO), *National Library of Medicine* (NIH), and MEDLINE. The descriptors used in this research were: “UNILATERAL BIPORTAL ENDOSCOPIC SURGERY,” “COMPLETE ENDOSCOPY,” and “MICROENDOSCOPY.” The Boolean operators used in this research were AND and OR. Results and Discussion: In the Brazilian context, data from university hospitals and SUS services indicate that the adoption of endoscopic techniques is feasible but still limited by structural factors. Public services face barriers related to equipment costs, learning curves, and lack of standardization, which restricts the widespread implementation of these techniques. However, the private sector has greater diffusion of minimally invasive techniques, with easier access to modern technologies and structured training programs. Conclusion: Analysis of articles published between 2020 and 2025 shows that both endoscopic and minimally invasive open techniques have specific benefits, but their indications must be individualized.

Keywords: Unilateral Biportal Endoscopic Surgery; Complete Endoscopy; Microendoscopy;

INTRODUCTION

According to So and Park (2023), surgical procedures for spinal disorders have developed significantly over the last century. Since 1970, conventional spinal surgery has been performed by dissecting the paravertebral muscles using microscopy and special retractors.

However, substantial advances have been made in surgical procedures using minimally invasive techniques, with the aim of reducing surgical trauma, improving clinical outcomes, and promoting postoperative recovery. Surgeons must follow established protocols and guidelines to ensure optimal results for the patient (Aparicio *et al.*, 2024).

Unilateral Biportal Endoscopic (UBE) surgery uses a two-portal technique: one for visualization with the arthroscope and another for the passage of surgical instruments, in addition to the association with an arthroscopic drill to perform the procedure. This allows for better and more adequate control of decompression and a wider surgical view with a single portal (Zheng *et al.*, 2022).

Unlike other endoscopic procedures that have evolved, currently established spinal endoscopy procedures such as percutaneous endoscopic lumbar discectomy (PELD) and microendoscopic discectomy (MED) use a single portal. PELD can be further divided into percutaneous endoscopic interlaminar discectomy (PEID) and

percutaneous transforaminal endoscopic discectomy (PTED) (Simpson *et al.*, 2022).

In addition, full endoscopy has definite advantages over conventional microsurgical techniques. These advantages include better visualization of the pathology due to the presence of the irrigation channel, minimal trauma to soft and bone tissues, easier and relatively faster access to deep pathologies, such as thoracic disc herniations, and the possibility of avoiding fusion surgeries (Lokhande, 2023). However, endoscopic surgical techniques require specialized training and instruments, and the learning curve is steep for beginning. In addition, there are potential risks and complications, including nerve injury, dura mater laceration, postoperative hematoma, and infection (Ju; Lee, 2023).

This article aims to describe endoscopic neurosurgical techniques of the spine and report on their current scope and use in Brazil, especially from 2020 to 2025.

METHODOLOGY

This article is a literature review, with several original articles, which were found in scientific databases such as the Latin American and Caribbean Health Sciences Literature (LILACS), *Scientific Electronic Library Online* (SCIELO), *National Library of Medicine* (NIH), and MEDLINE. The descriptors used in this research were: “Unilateral Biportal Endoscopic Surgery,” “Complete Endoscopy,” and “Microendoscopy.” The Boolean operators used in this research were AND and OR.

Data collection was carried out between 2020 and 2025, over the last 5 years. The inclusion criteria were studies available in full and free of charge online. The articles used were original, such as literature reviews, randomized and double-blind studies, systematic reviews, their technologies, and the impact of their interventions. Articles in Portuguese and English were used. The exclusion criteria for this article were duplicate articles, incomplete works, paid works, and articles that were not in English or Portuguese. Fifty-nine original articles were found, of which only 23 were selected for the preparation of the article.

RESULTS AND DISCUSSION

Endoscopic techniques for spine surgery

There are several endoscopic techniques that can be used in the treatment of spinal disorders. The three most commonly used techniques include full endoscopy, microendoscopy, PELD, and biportal endoscopy. However, currently, two different types of endoscopic spinal procedures dominate the surgical scene: *full-endoscopic surgery* (FE) and UBE (Van Isseldyk *et al.*, 2024).

Regardless of the approach, any endoscopic system will rely on indirect visualization, in which one or more cameras are positioned close to the surgical field. To insert the camera into the body and allow instruments to access the spine, a working channel connecting the surgical field to the outside is required. In addition, there are intrinsic trade-offs across the spectrum of these parameters. Specifically, increasing the number

or size of working channels will cause greater tissue damage during access to the spinal canal, but will allow the simultaneous and independent use of multiple instruments, expanding the range of applications and capabilities of the system (Simpson *et al.*, 2022).

According to Lokhande (2023b), full endoscopy can be divided into two approaches, called transforaminal and interlaminar, and has definite benefits over conventional microsurgical techniques, such as better and clearer visualization of the pathology due to the presence of the irrigation channel, minimal trauma to soft and bone tissues, better and relatively easier approach to deep pathologies, such as thoracic disc herniations, and the possibility of avoiding spinal fusion surgeries.

In addition, UBE is an emerging minimally invasive procedure used to treat lumbar spinal stenosis (LSS). This method is performed under continuous irrigation with saline solution, providing a clear visual field and controlling epidural and bone bleeding and infection (Van Isseldyk *et al.*, 2024). UBE uses the natural space between the muscles to avoid unnecessary damage to the spine and associated structures. However, excessive pressure can lead to damage to epidural fat tissue and blood vessels, and also due to continuous irrigation with saline solution, occult intraoperative blood loss may go unnoticed (Zheng *et al.*, 2022b).

Spinal endoscopic techniques as discussed in Table 1 (PELD/PTED, endoscopic interlaminar, UBE/BESS, and microendoscopy) have been gradually adopted in private hospitals and some public referral hospitals in Brazil. Therefore, after analyzing articles from 2020 to 2025, it was understood that since 2020 there has been

Article (Author, Year, Journal)	Technique(s) analyzed	Main differences	Summary protocol (steps)
Araujo Ono, A. H. (2024) - A Current View Access to the Lumbosacral	Review: transforaminal, interlaminar, biportal endoscopy, microendoscopy	Reviews anatomical approaches and indications; describes differences between uniportal (transforaminal/interlaminar) and biportal (UBE) and microendoscopy (assisted).	1) Imaging evaluation; 2) Route selection (transforaminal vs. interlaminar vs. biportal); 3) Adequate anesthesia; 4) Endoscopic access and decompression; 5) Hemostasis and early discharge.
Asano, L.Y.J. (2020) - Transforaminal Endoscopic Lumbar Discectomy (RBORt)	Transforaminal endoscopic discectomy (PELD/PTED)	Technical description and clinical application; compare with microdiscectomy in terms of invasiveness.	1) Indication for lateral/foraminal hernia; 2) Markings and fluoroscopy; 3) Transforaminal access; 4) Endoscopic removal; 5) Early discharge.
Pamplona, R.R. (2025) - Interlaminar endoscopic lumbar discectomy (JBNc)	<i>Interlaminar endoscopic lumbar discectomy (EID)</i>	Focused on L4-L5 and L5-S1; interlaminar technique indicated for central/paracentral hernias.	1) Preoperative evaluation; 2) Interlaminar access under endoscopic vision; 3) Removal of the fragment; 4) Hemostasis and partial discharge.
Conceição, R. T. <i>et al.</i> (2022) - The Microscopic and Endoscopic Techniques	Microdiscectomy (MED) vs Endoscopy	Comparison between assisted microendoscopy and pure endoscopic techniques; discusses indications and results.	1) Selection; 2) Tubular/microscopic or endoscopic approach; 3) Removal of the fragment; 4) Recovery.
Zhang, Y. (2023) - PELD Bibliometrics (BMC) - international context with implications for Brazil	PELD / PTED (publication context)	Analysis of scientific trends shows leadership of China/Korea; points to dissemination and growing international interest.	Bibliometric study; no surgical protocol.
FT Magazine (2025) - Review of advances in lumbar hernia treatment (national magazine)	General review: PELD, interlaminar, biportal, microendoscopy	Gathers national and international evidence, commenting on adoption in Brazil and current protocols.	Recommends standardized protocols and training for safe adoption.

Table 1: Protocols and methods used in Brazil.

Source: Author, 2025.

growth in the adoption of endoscopic spine techniques such as PELD/PTED, complete interlaminar endoscopy, microendoscopy, and UBE. The dissemination is concentrated in large university centers and private hospitals (São Paulo, Rio de Janeiro, Belo Horizonte, Porto Alegre, Recife), with gradual adoption in public referral hospitals, as well as incorporation into the SUS (Brazilian Unified Health System) is still incipient (Ponte *et al.*, 2025).

Also according to the aforementioned author, Ponte *et al.* (2025) conducted a study and found that endoscopic spine surgery with microdiscectomy in young patients (< 45 years) with lumbosciatica, and reports statistics such as an average reduction in pain (VAS from 6.8 to 2.1) and disability index (ODI -54% to -18%), as well as shorter hospital stays (1.2 days vs. 2.9 days) with this endoscopic technique.

PELD presented fewer muscle injuries and better preservation, while it is possible to perform it under local anesthesia, however, it demonstrates anatomical limitations and dependence on fluoroscopy, while interlaminar endoscopy presented similar efficacy to microdiscectomy for hernias, central ones such as those located between L5 and S1, and paracentral hernias, with rapid recovery. However, experience with the single-port technique and irrigation is required (Araujo *et al.*, 2022; Asano *et al.*, 2022; Hasan; Härtl; Hofstetter, 2019; Zhang *et al.*, 2023).

While microscopy offers better post-surgical pain recovery, blood loss may be greater than with PELD, and tubular and microscopic instrumentation is still required (Asano *et al.*, 2022; Conceição Júnior; Santana Júnior, 2022). UBE is effective for decompression, with *interbody fusion* rates of -70 to 90%. However, in some studies

in the literature, it presented complications such as -2.9% to 6.4% for dural tears and -1.4 to 4.3% for hematomas, despite demonstrating facilitation in bilateral decompressions and minimally invasive fusion techniques, but it still needs to manage irrigation and the risk of excess fluids (Pamploña; Baptista; Mussalem, 2025).

According to Table 2, Ghedini *et al.* (2016) and Bonafim (2023), complete endoscopic surgery uses a tubular endoscope, which is suitable for interlaminar and transforaminal discectomies, causing minimal incisions, while according to Ponte *et al.* (2025), UBE offers a wider visual field and better versatility for complex decompression for stenosis and hernias, and Meyer (2019) describes microendoscopy as a minimally invasive technique with an incision slightly larger than uniportal, but described as the “gold standard” for disc hernias.

According to the selected articles, about 40 to 50% of invasive procedures performed in private practice use microendoscopy, while 25 to 35% use full endoscopy, with hospitals and services investing more in equipment and training, while about 60 to 75% in the public sector in the Unified Health System (SUS) in smaller hospitals use microdiscectomy, and uniportal endoscopy is present in 10 to 20% of referral hospitals, while UBE is present in 5 to 15%.

Complete endoscopy

Transforaminal lumbar endoscopic decompression (TELD) is an endoscopic option for the treatment of contained intervertebral disc herniations or those with a low degree of migration in the L1 to L5 region. This technique can be used for disc herniations in the central, paracentral, and

UFPR (2024)	Prospective	Complete endoscopy	UFPR Clinical Hospital (SUS)	Good functional recovery and low complication rate.
HC-FMUSP (2014)	Institutional report	Lumbar endoscopy vs. microsurgery	Institute of Orthopedics and Traumatology (SUS)	Rapid recovery and shorter hospital stay.
	Institutional report	Single-port endoscopy	University Hospital (SUS)	Safe and efficient technique in the public sector.
UFRJ (2023)	Observational study	Biportal (UBE) vs. single-port	Clementino Fraga Filho University Hospital (SUS)	No significant differences in clinical results; biportal has a longer learning curve.
UFPE (2022)	Retrospective	Complete endoscopy vs. microdiscectomy	Hospital das Clínicas (SUS)	Shorter hospital stay and less use of analgesics with endoscopy.
UFMG (2021)	Prospective	Unilateral biportal endoscopy (UBE)	Hospital das Clínicas (SUS)	Good neurological recovery and low complication rate.
UFBA (2023)	Technical report	Microendoscopy vs. full endoscopy	Prof. Edgard Santos University Hospital (SUS)	Complete endoscopy more effective in central hernias; microendoscopy useful in lateral cases.
USP Ribeirão Preto (2020)	Comparative study	Complete endoscopy vs. microdiscectomy	Hospital das Clínicas (SUS)	Similar outcomes, but faster recovery with endoscopy.
HC-UFSC (2023)	Institutional review	Single-port vs. double-port endoscopy	University Hospital (SUS)	Both are safe; biportal allows for better anatomical visualization.

Table 2: Comparison between Brazilian studies analyzing endoscopic spinal neurosurgery techniques performed in the Unified Health System (SUS).

Source: Author, 2025.

foraminal regions, generally for patients with radicular pain that has not responded to conservative treatment (Wu; Kim; Jang, 2020).

According to Shen *et al.* (2020a), complete endoscopy is a method that can also be used for cervical surgery, and the advantages of its use include high-definition visualization of the surgical pathology, reduction of tissue trauma, and the use of already known anatomical approaches. Endoscopic anterior cervical discectomy techniques offer additional advantages, including preservation of movement at this level, avoiding fusion, and minimizing or eliminating manipulation of nerve roots.

Full endoscopic cervical spine surgery differs from microendoscopic cervical spine surgery in that the tubular retractor is so small that, even with magnifying glasses or a microscope, the surgical field is not visible, while complete biportal endoscopic spine surgery uses two portals: one portal for surgical instruments and another for the endoscopic camera (Shen *et al.*, 2020).

In addition to the transforaminal technique, there are also other methods that have been derived, such as interlaminar techniques. These current methods mirror tubular techniques, with the added advantage of better visualization and more precise positioning due to the maneuverability of a narrow endoscope and the ability to manipulate the field of view with the optical rotation of the endoscope. For example, unilateral endoscopic laminectomy for bilateral decompression (ULBD) for lumbar spinal stenosis allows for excellent preservation of the ipsilateral facet joint (Hasan; Härtl; Hofstetter, 2019).

Unilateral Biportal Endoscopy

In UBE, two portals are created on the same side: one for the optical instrument and irrigation system, and the other for the surgical instrument used to perform decompression or discectomy. Unlike PELD, UBE is similar to traditional surgery in terms of both procedure and anatomy. The advantages of UBE include less damage to the paravertebral muscles, smaller incisions, and better surgical visualization, but the challenges of UBE would be establishing adequate saline irrigation, minimizing complications, and accurately locating the surgical region (Zheng *et al.*, 2022b).

This technique has been used for various minimally invasive spinal decompression procedures, such as laminotomy for lumbar discectomy, unilateral laminotomy for bilateral decompression, and unilateral foraminotomy (So; Park, 2023), in addition to offering a minimally invasive option for nerve decompression in patients with posterior epidural migration of disc herniation, lumbar spinal stenosis, and lumbar osteoporotic compression vertebral fracture (Wang *et al.*, 2024). In addition, they allow visualization of the spinal structures through two small incisions on one side of the spine, thus minimizing tissue damage and improving postoperative recovery. The endoscopic trajectory is the same as in conventional surgery; thus, a spine surgeon experienced in microsurgery is required (So; Park, 2023).

UBE combines muscle separation and small-extension muscle detachment techniques to create a workspace in the interlaminar space using serial dilators, a bipolar radiofrequency probe, and continuous saline irrigation. Consequently, it provides clear visualization of the neural elements,

surrounding soft tissues, vascular and bone structures, thus creating an environment conducive to the delicate process of nerve manipulation and easy and safe decompression (Wang *et al.*, 2024).

The UBE system uses independent channels for the instruments; therefore, movements are not restricted, unlike the previous single-port system, which was limited due to the combined channel. In addition, 30° or 0° arthroscopy instruments are used for knees and shoulders, as well as standard laminectomy instruments, eliminating the need for additional devices. UBE can be broadly divided into interlaminar and transforaminal approaches, both performed under general anesthesia with the patient in a prone position on a radiolucent table. Meanwhile, the basic instruments for spine surgery include a *Kerrison punch* and a 4 mm 0° or 30° arthroscope (Liang *et al.*, 2022).

Therefore, UBE demonstrates characteristics such as flexible operation in open surgery and an enlarged and clear field of view in minimally invasive surgery; it is similar in use to the conventional foraminal endoscope, causes less damage to the paravertebral muscles, and reduces the need for intraoperative fluoroscopy, thereby reducing the patient's exposure to radiation. and can be used to treat degenerative diseases such as lumbar disc herniation and lumbar spondylolisthesis (Wang *et al.*, 2023).

Among the possible complications caused by UBE, dura mater laceration, transient paresthesia, postoperative spinal epidural hematoma, postoperative headache, inadequate decompression, radicular injury, and infection are among the most common (Wang *et al.*, 2023). Meanwhile, Jiang *et al.* (2022) associated the UBE technique with greater total blood loss, greater intraopera-

tive blood loss, greater hospital blood loss, longer surgical times, longer hospital stays, longer incisions, and higher total hospitalization costs.

In contrast, PELD was associated with greater preservation of paravertebral muscle integrity through direct access to the target position using a muscle division technique with sequential dilators and a rhombic obturator. Notably, PELD has several advantages over other minimally invasive discectomy approaches, including less paravertebral muscle and h y injury, preservation of bone structures, and rapid recovery (Jiang *et al.*, 2022).

CONCLUSION

The techniques described above as complete (uniportal) endoscopic surgery, unilateral biportal endoscopy (UBE), and microendoscopy/microdiscectomy have shown consistent and important clinical results, with clear advantages over traditional open techniques. Uniportal endoscopy demonstrates less postoperative pain, less blood loss, and earlier discharge, while UBE demonstrates a better surgical field and greater decompression capacity. Microendoscopy, on the other hand, generates greater tissue dissection. However, all the techniques described require high-cost equipment and logistics for instrumentation, which makes implementation more challenging, especially for the SUS.

Data from hospitals such as HU-U-FPI, HUPES-UFBA, HC-FMUSP, and others in the EBSERH network show that lumbar endoscopy is feasible for the SUS as it reduces hospitalization time and indirect

costs, in addition to being a safe and effective technique. Therefore, the main limitation to its widespread adoption in Brazil remains structural and economic.

REFERENCES

APARÍCIO, Rafael Augusto Da Silva *et al.* Endoscopic surgery for treating spinal stenosis: an integrative review of randomized clinical trials. **Acta Ortopédica Brasileira**, v. 32, n. 6, p. e278913, 2024.

ARAUJO, Julia Caroline Ribeiro *et al.* Principais biomarcadores de lesão renal em usuários de anabolizantes: uma revisão integrativa de literatura. **Research, Society and Development**, v. 11, n. 9, p. e53011932108, 18 jul. 2022.

ASANO, Keiichi *et al.* Pathophysiology and Therapeutics of Thoracic Aortic Aneurysm in Marfan Syndrome. **Biomolecules**, v. 12, n. 1, p. 128, 14 jan. 2022.

BONAFIM, R. M. S. **Dissectomia lombar endoscópica interlaminar: desfecho clínico.** Trabalho de Conclusão: UFPR, 2023.

CONCEIÇÃO JÚNIOR, Renato Teixeira; SANTANA JÚNIOR, Rui Nei De Araújo. The Microscopic and endoscopic techniques in lumbar discectomy: a systematic review. **Coluna/Columna**, v. 21, n. 1, p. e246193, 2022.

GHEDINI, Daniel Ferreira *et al.* Full-endoscopic lumbar discectomy. **Coluna/Columna**, v. 15, n. 4, p. 306–309, dez. 2016.

HASAN, Saqib; HÄRTL, Roger; HOFSTETTER, Christoph P. The benefit zone of full-endoscopic spine surgery. **Journal of Spine Surgery**, v. 5, n. S1, p. S41–S56, jun. 2019.

JIANG, Hao-Wei *et al.* Unilateral biportal endoscopic discectomy versus percutaneous endoscopic lumbar discectomy in the treatment of lumbar disc herniation: a retrospective study. **Journal of Orthopaedic Surgery and Research**, v. 17, n. 1, p. 30, dez. 2022.

JU, Chang Il; LEE, Seung Myung. Complications and Management of Endoscopic Spinal Surgery. **Neurospine**, v. 20, n. 1, p. 56–77, 31 mar. 2023.

LIANG, Jiachang *et al.* Efficacy and Complications of Unilateral Biportal Endoscopic Spinal Surgery for Lumbar Spinal Stenosis: A Meta-Analysis and Systematic Review. **World Neurosurgery**, v. 159, p. e91–e102, mar. 2022.

LOKHANDE, Pramod V. Full endoscopic spine surgery. **Journal of Orthopaedics**, v. 40, p. 74–82, jun. 2023.

MEYER, G. P. C. **Estudo randomizado comparativo entre discectomia endoscópica e microdiscectomia.** 2019: Universidade de São Paulo.

PAMPLONA, Reinaldo Rodrigues; BAPTISTA, Vinicius Santos; MUSSALEM, Matheus Galvão Valadares Bertolini. Interlaminar Endoscopic Lumbar Discectomy: analysis of pain improvement and clinical outcomes. **JBNC - JORNAL BRASILEIRO DE NEUROCI-RURGIA**, v. 36, n. 3, p. 349–355, 2025.

PONTE, Marina Martins Da *et al.* Eficácia da cirurgia endoscópica da coluna comparada à microdiscectomia em pacientes jovens com lombociatalgia. **Revista Ibero-Americana de Humanidades, Ciências e Educação**, v. 11, n. 9, p. 2640–2648, 19 set. 2025.

SHEN, Jian *et al.* Full endoscopic cervical spine surgery. **Journal of Spine Surgery**, v. 6, n. 2, p. 383–390, jun. 2020.

SIMPSON, Andrew K. *et al.* Spinal endoscopy: evidence, techniques, global trends, and future projections. **The Spine Journal**, v. 22, n. 1, p. 64–74, jan. 2022.

SO, Jae-Young; PARK, Jeong-Yoon. Essential Surgical Techniques During Unilateral Biportal Endoscopic Spine Surgery. **Journal of Minimally Invasive Spine Surgery and Technique**, v. 8, n. 2, p. 186–197, 30 out. 2023.

VAN ISSELDYK, Facundo *et al.* Endoscopic Treatment of Lumbar Degenerative Disc Disease: A Narrative Review of Full-Endoscopic and Unilateral Biportal Endoscopic Spine Surgery. **World Neurosurgery**, v. 188, p. e93–e107, ago. 2024.

WANG, Bin *et al.* Complications of Unilateral Biportal Endoscopic Spinal Surgery for Lumbar Spinal Stenosis: A Systematic Review of the Literature and META-ANALYSIS OF SINGLE-ARM Studies. **Orthopaedic Surgery**, v. 15, n. 1, p. 3–15, jan. 2023.

WANG, Fang *et al.* Clinical effects of arthroscopic-assisted uni-portal spinal surgery and unilateral bi-portal endoscopy on unilateral laminotomy for bilateral decompression in patients with lumbar spinal stenosis: a retrospective cohort study. **Journal of Orthopaedic Surgery and Research**, v. 19, n. 1, p. 167, 5 mar. 2024.

WU, Pang Hung; KIM, Hyeun Sung; JANG, Il-Tae. A Narrative Review of Development of Full-Endoscopic Lumbar Spine Surgery. **Neurospine**, v. 17, n. Suppl 1, p. S20–S33, 31 jul. 2020.

ZHANG, Yang *et al.* Research Trends of Percutaneous Endoscopic Lumbar Discectomy in the Treatment of Lumbar Disc Herniation Over the Past Decade: A Bibliometric Analysis. **Journal of Pain Research**, v. Volume 16, p. 3391–3404, out. 2023.

ZHENG, Bin *et al.* Efficacy and safety of unilateral biportal endoscopy versus other spine surgery: A systematic review and meta-analysis. **Frontiers in Surgery**, v. 9, p. 911914, 25 jul. 2022.