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COMPARISON OF OUTCOMES BETWEEN BIPORTAL AND UNIPORTAL TECHNIQUES FOR THE TREATMENT OF LUMBAR STENOSIS

COMPARAÇÃO DOS DESFECHOS ENTRE TÉCNICAS BIPORTAL E UNIPORTAL NO TRATAMENTO DA ESTENOSE LOMBAR

COMPARACIÓN DE RESULTADOS ENTRE TÉCNICAS BIPORTALES Y UNIPORTALES PARA EL TRATAMIENTO DE LA ESTENOSIS LUMBAR

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ABSTRACT

Minimally invasive surgery (MIS) has gained prominence in the treatment of lumbar spinal stenosis (LSS), especially with the advancement of uniportal (UE) and biportal (UBE) endoscopic techniques. Both seek to reduce surgical trauma without compromising decompression efficacy, although they have distinct characteristics that influence their choice. This study compared UE and UBE through a systematic review and meta-analysis. Databases such as PubMed, Google Scholar, Ovid, and BVS were analyzed. Data were organized in Excel and processed in R software (v4.2) with the meta package. Continuous variables were expressed as mean differences (MD) and categorical variables as odds ratios (OR). Heterogeneity was assessed by Cochran's Q and chi-square tests ($p < 0.05$). Random or fixed-effects models were applied depending on heterogeneity. Of the 164 studies initially identified, 15 were selected for full reading and 8 were included in the final analysis. There was no statistically significant difference between the techniques in the outcomes evaluated, except for the ODI score at the last follow-up, where UBE showed slightly lower values. However, this difference (MD = 0.54) was not clinically relevant. Both endoscopic techniques are effective and safe for lumbar decompression in cases of stenosis, with no statistical superiority between them. ***Level of Evidence III; Systematic Review.***

Keywords: Lumbar Region; Minimally Invasive Surgical Procedures; Stenosis; Systematic Review.

RESUMO

A cirurgia minimamente invasiva tem ganhado destaque no tratamento da estenose espinhal lombar, especialmente com o avanço das técnicas endoscópicas uniportal (UE) e biportal (UBE). Ambas buscam reduzir o trauma cirúrgico sem comprometer a eficácia da descompressão, embora apresentem características distintas que influenciam sua escolha. Este estudo comparou UE e UBE por meio de revisão sistemática e metanálise. Foram analisadas bases como PubMed, Google Scholar, Ovid e BVS. Os dados foram organizados no Excel e processados no software R (v4.2) com o pacote meta. Variáveis contínuas foram expressas como diferença média (MD) e categóricas como razão de chances (OR). A heterogeneidade foi avaliada pelos testes Q de Cochran e qui-quadrado ($p < 0,05$). Modelos de efeitos aleatórios ou fixos foram aplicados conforme a heterogeneidade. Dos 164 estudos inicialmente identificados, 15 foram selecionados para leitura completa e 8 incluídos na análise final. Não houve diferença estatística significativa entre as técnicas nos desfechos avaliados, exceto no escore ODI no último acompanhamento, onde a UBE apresentou valores ligeiramente menores. Contudo, essa diferença (MD = 0,54) não foi clinicamente relevante. Ambas as técnicas endoscópicas são eficazes e seguras para descompressão lombar em casos de estenose, sem superioridade estatística entre elas. ***Nível de Evidência III; Revisão Sistemática.***

Descritores: *Região Lombar; Procedimentos Cirúrgicos Minimamente Invasivos; Estenose; Revisão Sistemática.*

RESUMEN

La cirugía mínimamente invasiva ha cobrado relevancia en el tratamiento de la estenosis espinal lumbar, especialmente con el avance de las técnicas endoscópicas uniportales (UE) y biportales (UBE). Ambas buscan reducir el trauma quirúrgico sin comprometer la eficacia de la descompresión, aunque presentan características distintivas que influyen en su elección. Este estudio comparó la UE y la UBE mediante una revisión sistemática y un metaanálisis. Se analizaron bases de datos como PubMed, Google Scholar, Ovid y BVS. Los datos se organizaron en Excel y se procesaron en el software R (v4.2) con el paquete meta. Las variables continuas se expresaron como diferencias de medias (DM) y las variables categóricas como odds ratios (OR). La heterogeneidad se evaluó mediante las pruebas Q de Cochran y de

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chi-cuadrado (p < 0,05). Se aplicaron modelos de efectos aleatorios o fijos en función de la heterogeneidad. De los 164 estudios identificados inicialmente, 15 fueron seleccionados para su lectura completa y 8 se incluyeron en el análisis final. No se observaron diferencias estadísticamente significativas entre las técnicas en los resultados evaluados, excepto en la puntuación ODI en el último seguimiento, donde la UBE mostró valores ligeramente inferiores. Sin embargo, esta diferencia (DM = 0,54) no fue clínicamente relevante. Ambas técnicas endoscópicas son eficaces y seguras para la descompresión lumbar en casos de estenosis, sin superioridad estadística entre ellas. ***Nivel de Evidencia: III; Revisión Sistemática.***

Descriptores: *Región Lumbar; Procedimientos Quirúrgicos Mínimamente Invasivos; Estenosis; Revisión Sistemática.*

INTRODUCTION

Minimally invasive surgery (MIS) has gained prominence in the treatment of lumbar spinal stenosis (LSS), driven by the advancement of uniportal (UE) and biportal (UBE) endoscopic techniques. Both approaches seek to minimize surgical trauma without compromising the effectiveness of neural decompression, although they present specific features, with advantages and limitations, which can influence the choice of the most suitable method for each case[1-3].

Minimally invasive spinal surgery (MISS) through uniportal endoscopy has been widely recognized for presenting therapeutic results comparable to those of conventional surgical techniques. This approach offers significant benefits, such as reduced incision, reduced tissue trauma, accelerated recovery, early deambulation and better aesthetic outcome, with discrete scar. However, its main limitations are associated with a steep learning curve and higher costs[4-7].

In contrast, the biportal endoscopic technique offers a broad visual field, with greater anatomical similarity compared to traditional open approaches, which contributes to a smoother learning curve. The possibility of using conventional instruments, such as Kerrison rongeurs and larger drills, allows for broader maneuvers and effective bone resections, favoring the reduction of surgical time and, theoretically, decreasing the incidence of reoperations by reherniation or incomplete removal of disc fragments. In this scenario, the biportal approach has gained growing adherence in the treatment of lumbar canal stenosis. Among its main limitations are the potential increase in tissue damage and the risk, although low, of promoting instability in the operated segment[4,8-10].

Although the uniportal and biportal techniques are increasingly being employed in lumbar decompression in cases of stenosis, the comparative effects between them still require in-depth research[11,12]. Thus, the present study aimed to compare both approaches in the treatment of lumbar stenosis, through a systematic review followed by meta-analysis.

METHODOLOGY

Research and Recovery Strategy

The electronic databases, including PubMed, Google Scholar, Ovid and BVS, were systematically reviewed using the following search strategy: "(((uniportal endoscopy) OR (percutaneous endoscopy)) OR (full endoscopy)) AND (((UBE) OR (biportal endoscopic surgery)) OR (biportal endoscopy)):" - Filters: from -- to 2024". Only original articles were included in the review.

Selection and inclusion criteria

The study was conducted in two stages. The first consisted of an initial sorting of the titles and summaries, in which the authors sought to identify evidence that justified the inclusion of the articles in the next phase. The studies that generated doubts regarding the compliance with the inclusion criteria were referred to the second stage. In this, a comprehensive analysis of the texts of the selected articles was carried out.

The inclusion criteria adopted were:

- (i) comparative, retrospective or prospective studies;
- (ii) direct comparison between the biportal and uniportal techniques;
- (iii) presentation of the number of patients in each group, as well as average and standard deviation data (or information that would allow its inference) regarding at least one of the evaluated outcomes: surgical time, blood loss, complications, Oswestry incapacity index (ODI) and hospitalization time.

Studies that met at least one of the following criteria were excluded:

- (i) did not specifically address central lumbar canal stenosis;
- (ii) were written in a language other than English or Portuguese, and whose translation could not be carried out by means of specialized software;
- (iii) did not make the full text available for access and analysis.

Definition of analyzed outcomes

1. Surgery time: the duration of time between the first incision and the closure of the last surgical incision, measured in minutes.
2. Estimated blood loss: estimate of blood loss occurred during the procedure, measured in milliliters.
3. Complications: Any adverse event that has required medication or surgical treatment, or unexpected return to the hospital, described as counting.
4. ODI: Oswestry Incapacity Score, measured on a scale of 0-100%.
5. Admission time: time, in days, that the patient took to receive hospital discharge after the procedure.

Data extraction

The inclusion of continuous variables in the meta-analysis calculations was performed only when the articles presented the standard deviation or provided sufficient information for its estimation in each group analyzed.

In studies that contained two or more subgroups, the data were segmented proportionally, and each subgroup received a specific identification, plus a numeric suffix next to the article ID (e.g.: A-1, A-2), in order to ensure traceability and organization during analysis.

Quality Assessment

To evaluate the quality of the included articles two tools were used: for Randomized Clinical Trials, the Cochrane Foundation's RoB-Risk2 tool, and the Newcastle Ottawa (NOS) scale for prospective and retrospective cohort studies.

Statistical analysis

The data was planned with the help of the Excel program and analyzed in the R software (version 4.2) with the *meta* package. Results for continuous variables were presented as mean differences (MD) and for categorial variables such as Risk Rate (*Odds Ratio*). The heterogeneity between the studies was evaluated using the Cochran Q statistical test, and the heterogeneity between the studies included was evaluated using the qui-square test, with $p < 0.05$ indicating heterogeneity. In the presence of heterogeneity, the model of random effects was employed, and in other cases, the model of fixed effects. P values lower than 0.05 were considered significant.

RESULTS

Initially, 164 studies were identified through the search engine. After sorting the titles and summaries, 15 articles were considered eligible for the full text analysis stage. At the end of this stage, 8 studies met the inclusion criteria and were incorporated into the systematic review and meta-analysis.

All studies included in the analysis were cohort, prospective or retrospective. For this reason, the risk assessment of bias was

performed using the Newcastle-Ottawa scale (NOS), a widely recognized instrument for this type of delineation. The median of quality scores was 4 points, with a range between 4 and 9 (Table 1).

Complications Rate

For analysis of the outcome of complications, 7 articles were included, totaling 940 patients and 39 complications, of which 18 were in the UBE and 21 were in the uniportal. The main complications found were dural, nerve injury, transient weakness and infection. In order to enable a better mathematical analysis, we have chosen to evaluate the incidence of complications in a grouped manner, considering each reported event and without distinguishing them. No significant biases were detected between the studies (3%, p = 0.40) nor significant publication biases (p = 0.150). The analysis showed that there was no significant difference between the groups (OR = 0.8040 [95% CI = 0.4249; 1.5213], z = -0.67, p = 0.5025) (Figure 1).

The complications found in each study are described in Table 2.

Oswestry Disability Index (ODI)

In the post-operative evaluation of Oswestry 6 studies were included, totaling 863 patients. No significant biases were detected between the studies (0%, p = 0.78) nor significant publication biases (p = 0.403). The analysis demonstrated that there was a statistically significant numerical difference in ODI values between the groups in the last assessment, with 12 months. However, this difference is

Table 2. Table containing the complications described in each of the studies.

First author of the study (year)	UBE Complications (Quantity)	Complications Uniportal (Quantity)
Han G (2024)[13]	Dural Injury (1)	Dural Injury (1)
Wang F (2024)[14]	Nervous Injury (2) Dural Injury (1)	Infection (1) Nervous Injury (3) Dural Injury (2)
Heo D (2019)[15]	Dural Injury (1) Postoperative hematoma (1)	Dural Injury (1) Transient weakness (1) Postoperative hematoma (1)
He BL (2024)[6]	Transient weakness (1)	Dural Injury (2) Transient weakness (1)
Tang Z (2024)[16]	Transient weakness (1)	Dural Injury (2)
Wu PH (2023)[17]	--	Intraoperative complications (2) Insufficient Decompression (2)
Chang H (2023)[18]	Dural Injury (1) Nervous Injury (1) Transient dysesthesia (2) Motor Deficit (1) Reoperation (1)	Transient dysesthesia (2) Motor Deficit (1) Review (2)
Cheng J (2023)[19]	Dural Injury (2)	Postoperative weakness (1)

Table 1. Basic data and data on bias risk scores from studies included in the systematic review.

Title	First author	Year	Pathology	Operated Level	NOS
Comparison of effectiveness between unilateral biportal endoscopic and uniportal interlaminar endoscopic decompression in the treatment of lumbar spinal stenosis[13]	Han, G	2024	Central channel stenosis	Mixed	5
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[14]	Wang, F	2024	Channel Stenosis, Foraminal and Lateral Recess	Mixed	5
Comparative analysis of three types of minimally invasive decompressive surgery for lumbar central stenosis: biportal endoscopy, uniportal endoscopy, and microsurgery[15]	Heo, D	2019	Central stenosis	L4L5	4
Biportal versus uniportal endoscopic technique in Unilateral Laminectomy for Bilateral Decompression (ULBD) for lumbar spinal stenosis[6]	He, BL	2024	Central stenosis	Mixed	4
Comparative efficacy of unilateral biportal and percutaneous endoscopic techniques in unilateral laminectomy for bilateral decompression (ULBD) for lumbar spinal stenosis[16]	Tang, Z	2024	Central stenosis	Mixed	4
Ambulatory uniportal versus biportal endoscopic unilateral laminotomy with bilateral decompression for lumbar spinal stenosis—cohort study using a prospective registry[17]	Wu, PH	2023	Stenosis	Mixed	9
Comparison of full-endoscopic foraminoplasty and lumbar discectomy (FEFLD), unilateral biportal endoscopic (UBE) discectomy, and microdiscectomy (MD) for symptomatic lumbar disc herniation[18]	Chan, H	2023	Channel Stenosis, Foraminal and Lateral Recess	Mixed	6
A comparative study of unilateral biportal endoscopic decompression and percutaneous transforaminal endoscopic decompression for geriatric patients with lumbar lateral recess stenosis[19]	Cheng, J	2023	Lateral recessive stenosis	Mixed	6

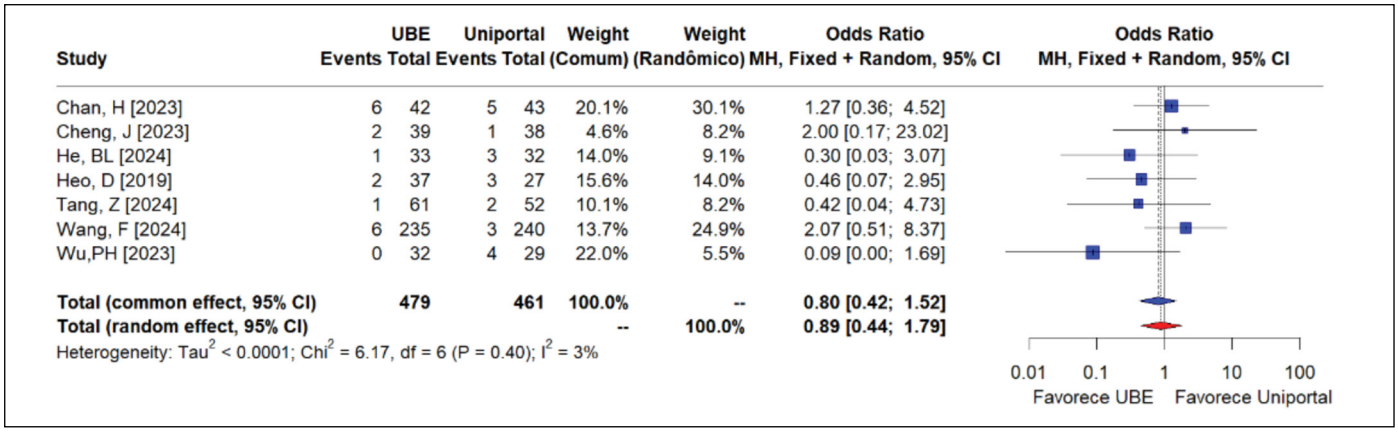

Figure 1. *Forest-plot* analyzing the chance rate of complications between the uniportal and the biportal technique.

not significant for clinical outcome, without affecting the outcome groups. (MD = -0.5434 [95% CI = -1.0397; -0.0471], z = -2.15, p = 0.00319) (Figure 2).

Operation Time

8 studies regarding the duration of surgery were included, totaling 992 patients. Significant biases were detected between the studies (98%, p = < 0.0001), but there were no significant publication biases (p = 0.3554). The analysis showed that there was no significant difference between the groups (MD = -6.2822 [95% CI = -30.7020; 18.1375], z = -0.50, p = 0.6141) (Figure 3).

Time of admission

When analyzing the hospitalization time, 7 studies were included in the analysis, totaling 928 patients. Significant heterogeneity was identified in the sample (I2 = 90%, p = < 0.0001), but without significant publication biases (p = 0.7323). Demonstrating the analysis, there was no significant reduction in hospitalization time between the techniques (MD = 0.7237 [95% CI = -0.0724; 1.5197] z = 1.78, p = 0.0748 (Figure 4).

Blood loss

Finally, when analyzing blood loss between the techniques, 4 studies were included in the analysis, totaling 726 patients. Significant heterogeneity was identified in the sample (I2 = 98%, p = < 0.0001), but without significant publication biases (p = 0.2332). The analysis showed that there was no significant reduction in the bleeding rate between the techniques (MD = 11.0661, 95% = [-3.0982; 25.2304], z = 1.53; p = 0.1257) (Figure 5).

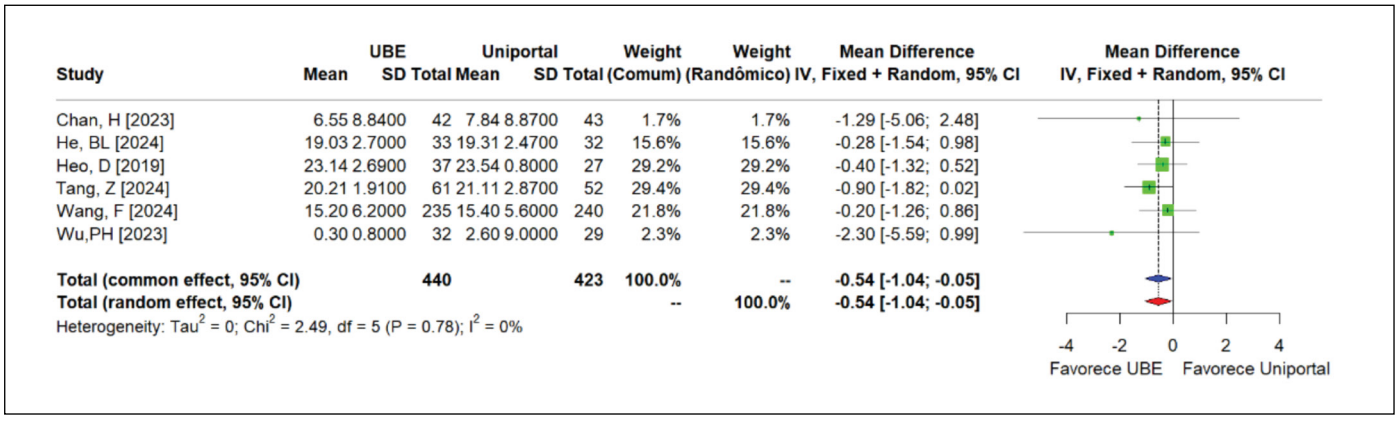

Figure 2. *Forest-plot* analyzing the difference in average ODI scores between the uniportal (UE) and biportal (UBE) techniques.

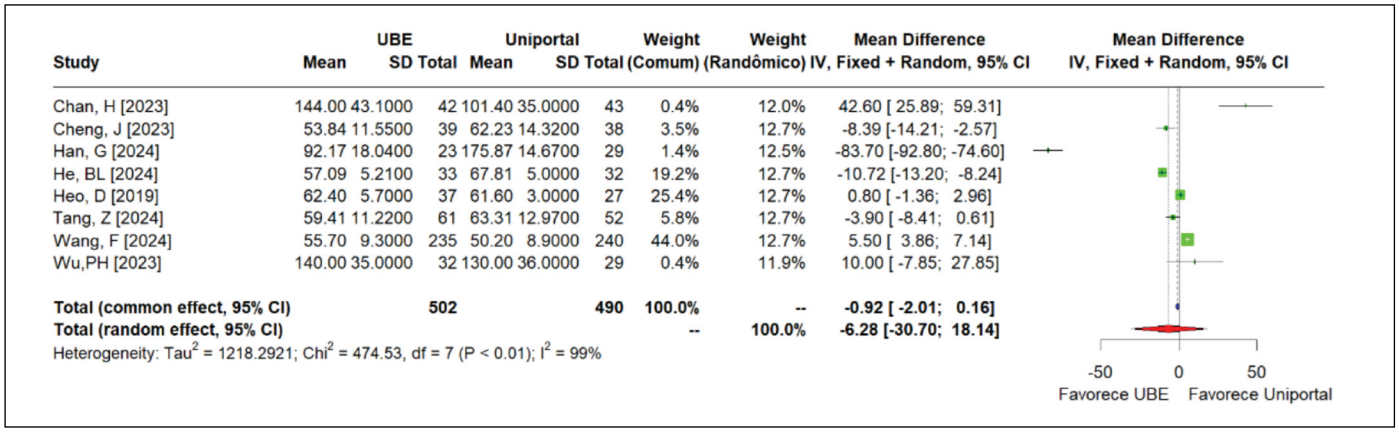

Figure 3. *Forest-plot* analyzing the difference in median surgical times between the uniportal and biportal techniques (UBE).

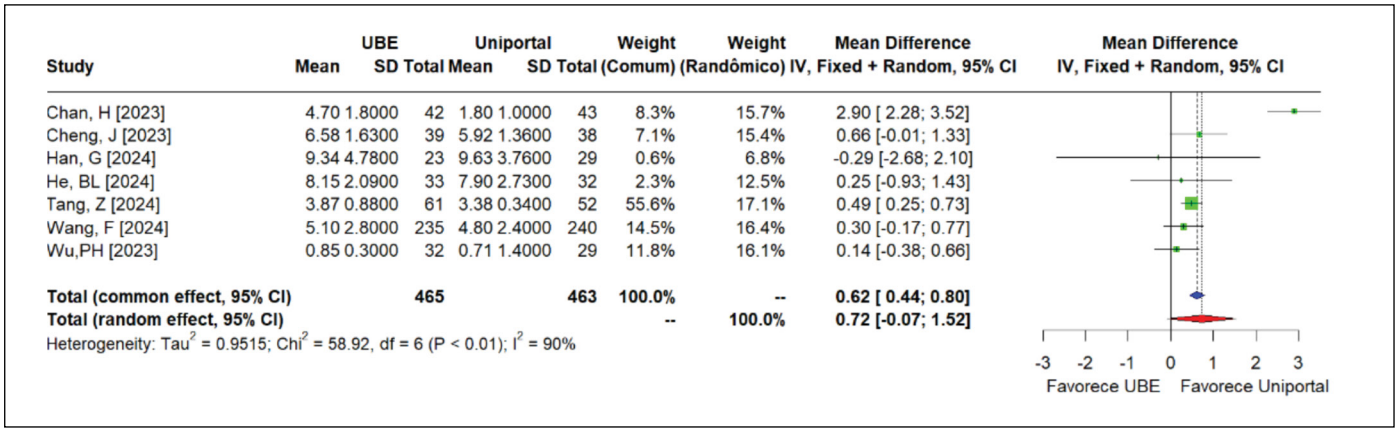

Figure 4. *Forest-plot* analyzing the difference between averages regarding the time of admission between the uniportal and biportal techniques (UBE).

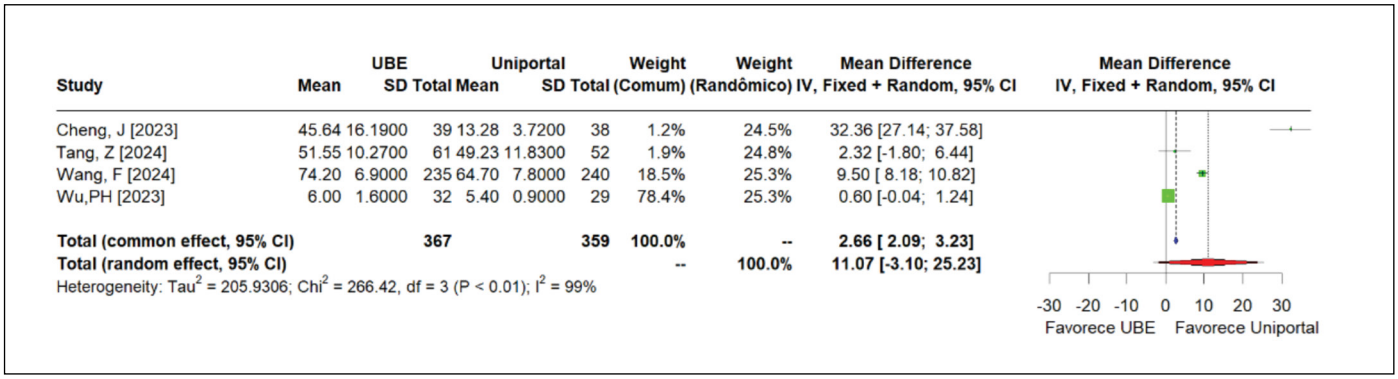

Figure 5. *Forest-plot* analyzing the difference between averages regarding blood loss between the uniportal and biportal techniques (UBE).

DISCUSSION

The present study investigates the impact of the use of biportal or uniportal technique for decompression of lumbar stenosis, demonstrating that both techniques are safe and present good results as well as almost similar outcomes, with apparent discreet advantage for biportal technique when analyzed the numerical results of ODI, but without clinically significant impact. Other outcomes such as procedure time and hospitalization, complication rate and estimated bleeding were similar between the techniques.

Vantages and limitations of the uniportal technique

The evaluated studies indicate that uniportal endoscopy tends to be less invasive and presents potential for faster recovery. Some authors suggest that this approach may be associated with a lower rate of muscle injury, which may contribute to reduced postoperative pain and enable an earlier return to daily activities. Due to these characteristics, the uniportal technique can be especially advantageous in high-risk patients or in less complex cases of lumbar stenosis[5,12,20].

Despite the benefits associated with the uniportal approach, this technique presents some limitations for less experienced surgeons, especially in cases of greater complexity. The use of a single portal may restrict the intraoperative visual field, make it difficult to handle surgical instruments in difficult to access anatomical regions and cause a false impression of sufficient decompression. In addition, the learning curve for the mastery of the technique is considered steep, representing a significant challenge for surgeons with less experience in endoscopic procedures[3,5,21].

Vantages and limitations of the biportal technique

Biportal endoscopy employs two distinct portals: one for the endoscope and the other for the surgical instruments. This configuration provides greater operational flexibility and a broader visual field, favoring the accuracy and safety of the procedure. This approach facilitates the manipulation of the instruments and allows for more extensive decompressions, being especially useful in complex cases of lumbar stenosis. A notable example is the possibility of performing bilateral decompression ("*over the top*") in multiple levels, reducing surgical time[22,23].

Although biportal endoscopy is classified as a minimally invasive technique, it can present greater aggressiveness in terms of tissue dissection when compared to the uniportal approach. This feature can affect the recovery profile and the risk of complications in certain cases. In addition, the curve of learning the technique varies according to the surgeon's professional history. Surgeons with prior experience in open procedures tend to adapt more easily to the biportal approach, while those accustomed to the uniportal technique may face greater complexity in the transition[5,24,25].

Several studies indicate that the clinical results of the comparison between the techniques of biportal (UBE) and uniportal (UE) endoscopy are similar in most indicators, such as the analog visual scale (VAS) for pain and the incidence of postoperative complications. However, in our review, we observed a tendency of the UBE technique to present better numerical results in the Oswestry Disability Index (ODI) in the final evaluation. Despite this, no statistically significant differences in clinical outcomes were identified between the groups. In addition, some studies suggest a functional superiority of UBE in the first months of postoperative, with faster recovery. However, this benefit does not appear to last long-term, indicating that late results tend to match between techniques[26, 27].

A meta-analysis published in 2023 demonstrated that the technique of biportal endoscopy (UBE) presents superior results in the first weeks of the postoperative period, especially as regards the reduction of irradiated pain. However, after the three-month period, the differences between UBE and the uniportal technique (EU) became statistically insignificant, suggesting that the initial benefits of UBE do not necessarily persist over the long term, considering that both approaches are effective in treating lumbar stenosis[28].

Complementing this evidence, a systematic review conducted by Chen et al. (2024) pointed out that the biportal technique is associated with a significant reduction in surgical time compared to the uniportal approach. On the other hand, the EU technique demonstrated advantages in terms of hospitalization time and bleeding rate, indicating that each approach can offer specific benefits depending on the patient's clinical profile and the complexity of the case[29].

CONCLUSION

The present study demonstrates that both endoscopic techniques for lumbar decompression in cases of central canal stenosis are effective and safe. The biportal approach presented a discreet advantage in the numerical scores of the Oswestry Incapacity Index (ODI) in the first months after surgery; however, this difference was not statistically significant ($p = 0.54$), not having a relevant impact on the overall clinical outcomes of patients.

Although both techniques offer comparable levels of safety and efficiency, the choice between the uniportal and biportal approach should be guided by the surgeon's experience, the resources available at the surgical center and the individual clinical characteristics of each patient. The biportal technique can be especially advantageous in more complex cases due to its greater flexibility and enlarged visual field. On the other hand, the uniportal technique tends to be more suitable for less complex procedures, with the potential for less invasiveness and faster recovery.

Finally, the importance of structured documentation of results, outcomes and complications associated with each technique is highlighted. This practice is fundamental for future studies, with greater sampling and methodological rigor, to offer more accurate estimates of the differential impact between the uniportal and biportal approaches.

CONFLICT OF INTEREST

All authors declare no potential conflict of interest related to this article.

CONTRIBUTIONS OF THE AUTHORS

Each author contributed individually and significantly to the development of this article. FPAAP, LMAH, TQS, MPD: conceptualization, systematic review and writing of the original draft; TQS, ECQAB, MBSB: data curation, validation; SEL, JPMB: formal analysis, writing - review and editing.

DATA AVAILABILITY DECLARATION

The contents underlying the research are available in the manuscript.

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