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REVERSE FORAMINOPLASTY BY CONTRALATERAL ENDOSCOPIC ACCESS: EVALUATION OF OUTCOMES WITH A MINIMUM FOLLOW-UP OF TWO YEARS

FORAMINOPLASTIA REVERSA POR ACESSO ENDOSCÓPICO CONTRALATERAL: AVALIAÇÃO DOS DESFECHOS COM FOLLOW-UP MÍNIMO DE DOIS ANOS

FORAMINOPLASTIA INVERSA MEDIANTE ABORDAJE ENDOSCÓPICO CONTRALATERAL: EVALUACIÓN DE LOS RESULTADOS CON UN FOLLOW-UP MÍNIMO DE DOS AÑOS

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ABSTRACT

Objective: To evaluate the surgical and postoperative outcomes of patients undergoing reverse foraminoplasty via a contralateral endoscopic approach for the treatment of central canal or lateral recess stenosis associated with foraminal stenosis, with a minimum follow-up of two years. Methods: This retrospective, quantitative, and descriptive study was conducted at Porto Dias Hospital, Belém–PA, and approved by the Research Ethics Committee. Thirteen patients who met the inclusion criteria were enrolled. Primary outcomes included pain reduction, assessed by the Visual Analogue Scale (VAS), and functional improvement, measured by the Oswestry Disability Index (ODI). Data normality was tested using the Shapiro–Wilk test, and paired t-tests were used to compare outcomes over time (significance level $p < 0.05$). Results: The mean patient age was 57.3 ± 13.54 years. The average operative time per level treated was 58.4 minutes (range: 22–117 min). There was a mean ODI reduction of 33.6 points over the follow-up period ($p < 0.001$). Local pain (VAS) decreased from 6.8 to 1.8, and radicular pain from 7.9 to 1.6 after two years ($p < 0.001$ for both). One complication was reported (dural tear; 7.69%). Conclusions: Reverse foraminoplasty performed via a contralateral endoscopic approach was safe and effective, providing sustained pain relief, significant functional improvement, and a low complication rate over a two-year follow-up. ***Level of Evidence III; Retrospective Comparative Study.***

Keywords: Endoscopic Surgical Procedure; Spinal Stenosis; Spinal Cord Diseases; Minimally Invasive Surgical Procedures.

RESUMO

Objetivo: Avaliar os desfechos cirúrgicos e pós-operatórios de pacientes submetidos a foraminoplastia reversa por acesso endoscópico contralateral para tratamento de estenose central do canal vertebral ou do recesso lateral associada a estenose foraminal. Métodos: Estudo retrospectivo, quantitativo descritivo, realizado no Hospital Porto Dias, Belém–PA, aprovado pelo Comitê de Ética em Pesquisa. Foram incluídos 13 pacientes que atenderam aos critérios de inclusão, com seguimento mínimo de dois anos. Os desfechos primários incluíram a redução da dor, avaliada pela Escala Visual Analógica (EVA), e a melhora funcional, medida pelo Índice de Incapacidade de Oswestry (ODI). A análise estatística utilizou o teste de Shapiro-Wilk para verificar a normalidade dos dados e o teste t pareado para comparações entre tempos (nível de significância $p < 0,05$). Resultados: A idade média dos pacientes foi de 57,3 ± 13,54 anos. O tempo cirúrgico médio por nível tratado foi de 58,4 minutos (variação: 22–117 min). O ODI apresentou redução média de 33,6 pontos ao longo do seguimento ($p < 0,001$). A dor (EVA) local reduziu de 6,8 para 1,8, e a dor irradiada de 7,9 para 1,6 após dois anos ($p < 0,001$ para ambos). Houve uma complicação (lesão dural; 7,69%). Conclusão: A foraminoplastia reversa por acesso endoscópico contralateral mostrou-se segura e eficaz, com alívio sustentado da dor, melhora funcional e baixa taxa de complicações. ***Nível de Evidencia III; Estudo Retrospectivo Comparativo.***

Descritores: *Procedimentos Cirúrgicos Endoscópicos; Estenose Espinal; Doenças da Medula Espinal; Procedimentos Cirúrgicos Minimamente Invasivos.*

RESUMEN

Objetivo: Evaluar los resultados quirúrgicos y posoperatorios de pacientes sometidos a foraminoplastia reversa mediante abordaje endoscópico contralateral para el tratamiento de estenosis central del canal vertebral o del receso lateral, asociada a estenosis foraminal. Métodos: Estudio retrospectivo, cuantitativo y descriptivo, realizado en el Hospital Porto Dias, Belém–PA, aprobado por el Comité de Ética en Investigación. Se incluyeron 13 pacientes que cumplieron con los criterios de inclusión, con un seguimiento mínimo de dos años. Los desenlaces primarios incluyeron la reducción del dolor, evaluada mediante la Escala Visual Análoga (EVA), y la mejoría funcional, medida

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por el Índice de Discapacidad de Oswestry (ODI). El análisis estadístico empleó la prueba de Shapiro-Wilk para verificar la normalidad de los datos y la prueba t pareada para las comparaciones temporales (nivel de significancia p < 0,05). Resultados: La edad media de los pacientes fue de 57,3 ± 13,54 años. El tiempo quirúrgico promedio por nivel tratado fue de 58,4 minutos (rango: 22–117 min). El ODI mostró una reducción media de 33,6 puntos durante el seguimiento (p < 0,001). El dolor local (EVA) disminuyó de 6,8 a 1,8, y el dolor irradiado de 7,9 a 1,6 después de dos años (p < 0,001 para ambos). Se registró una complicación (lesión dural; 7,69%). Conclusión: La foraminoplastia reversa mediante abordaje endoscópico contralateral demostró ser segura y eficaz, con alivio sostenido del dolor, mejoría funcional y baja tasa de complicaciones. ***Nivel de Evidencia III; Estudio Retrospectivo Comparativo.***

Descriptores: *Procedimientos Quirúrgicos Endoscópicos; Estenosis Espinal; Enfermedades de la Médula Espinal; Procedimientos Quirúrgicos Mínimamente Invasivos.*

INTRODUCTION

Spinal canal stenosis and lumbar disc herniation are among the most prevalent degenerative diseases of the lumbar spine, responsible for a significant portion of chronic pain cases and functional limitation in adults and the elderly.[1-3] The increase in life expectancy has contributed to the rise in the incidence of these conditions, as the aging population is directly related to the degenerative process of the intervertebral disc and adjacent spinal structures.[4-6]

Spinal canal stenosis is characterized by the narrowing of the spinal canal, compromising the passage of neural structures and leading to compression of the nerve roots. Clinically, it manifests as neurogenic claudication, weakness, and pain radiating to the lower limbs, severely impairing the mobility and quality of life of patients.[7-9]

The initial management of these conditions is predominantly conservative, including analgesia, physiotherapy, and image-guided infiltrations. However, in cases refractory to clinical treatment, surgical intervention becomes necessary.[10-12] The conventional surgical approach, performed via open surgery, is associated with greater tissue trauma, higher risk of bleeding, prolonged recovery, and higher rates of complications such as infection and segmental instability.[13-15]

In recent years, minimally invasive spine surgery has gained prominence as an effective and safe alternative for the treatment of these pathologies.[16] The endoscopic technique allows for neural decompression through percutaneous portals, preserving the integrity of ligamentous and muscular structures, resulting in shorter recovery time, lower complication rates, and early hospital discharge.[17-20]

However, cases that combine spinal canal stenosis, lateral recess stenosis, foraminal stenosis, and disc herniation often require a hybrid strategy, combining transforaminal and interlaminar techniques for more comprehensive decompression.[6,7,21] Reverse foraminoplasty aims to resolve foraminal stenosis, combined with central canal stenosis and lateral recess stenosis, with or without disc herniation, performing a single access route.[1,2,12]

In light of this, the present study aims to analyze the surgical and postoperative outcomes of patients undergoing reverse foraminoplasty via contralateral endoscopic access for the treatment of central spinal canal stenosis or lateral recess stenosis associated with foraminal stenosis, with a minimum follow-up of 2 years.

METHOD

This is a retrospective, quantitative, descriptive, and unicentric study conducted at Porto Dias Hospital in the city of Belém, Pará. The protocol was approved by the Research Ethics Committee under number CAAE: 86427825.7.0000.0235, number 7.460.284, following the guidelines of Resolution No. 466/2012 of the National Health Council.

Patients with central spinal canal stenosis or lateral recess stenosis, concomitant with foraminal stenosis, refractory to conservative treatment for at least 3 months, with compatible clinical presentation and confirmation by imaging studies, were included, undergoing endoscopic reverse foraminoplasty with a minimum follow-up of 2 years. Cases of severe cauda equina syndrome, peripheral neuropathies, spondylolisthesis with dynamic instability, as well as patients who refused participation or lost follow-up, were excluded.

In total, 33 patients underwent the endoscopic reverse foraminoplasty technique during the evaluated period. However, only 13 were included in the final analysis for meeting all eligibility criteria established in this protocol.

Data were obtained through electronic medical record review and clinical interviews. The analyzed variables included demographic data, surgical time, number of treated levels, as well as clinical and functional scores. The primary outcomes were pain reduction and functional improvement, assessed through the Visual Analog Scale (VAS) for local and radiating pain, and the Oswestry Disability Index (ODI) for function.

Data were expressed as mean ± standard deviation (SD) or median (minimum–maximum), according to distribution. To assess the normality of continuous variables, the Shapiro-Wilk test was applied. Comparisons between different follow-up moments (preoperative, 1 month, 3 months, 6 months, and 2 years/last follow-up) were performed using the paired t-test when the distribution was normal, and non-parametric distributions. The significance level adopted was $p < 0.05$. All analyses were conducted using BioEstat 4.6 software

Surgical Technique

All procedures were performed under general anesthesia. Patients were positioned in a prone position, with arms extended, semi-flexion of the hips, knees, and ankles, placing a cushion under the anterior superior iliac spines and the ankles. A radiolucent table and intraoperative fluoroscopy were used to guide the positioning of the instruments.

Access and Positioning

The entry point was determined in the interlaminar space, approximately 0.5 – 1cm from the midline, contralateral to the area of foraminal stenosis, based on preoperative imaging studies including X-ray, CT scan, and MRI. The planning of the surgical trajectory aimed to access the intervertebral foramen safely, avoiding neural and vascular structures.

To create the entry point, the endoscope dilator was used as a guide, under fluoroscopic visualization. The spinolaminar crest and the spinous process were located, identifying the interlaminar space. Thus, the dilator was positioned closer to the lateral edge of the interlaminar space. Once this point was found, a mark was made on the patient's skin with a surgical marker pen.

Dilation and Introduction of the Working Channel

After confirming the correct position, a 7mm incision was made with a scalpel blade on the skin, subcutaneous tissue, and muscle fascia, allowing for the progressive introduction of the dilator. The working cannula, with a diameter of 7 mm, was positioned at the lower edge of the lamina of the upper vertebra, under fluoroscopic guidance. A continuous flow of 0.9% saline was set up, and the surgery was performed under endoscopic visual control.

Foraminoplasty and Neural Decompression

An endoscope with a 25° angle was introduced through the working channel, allowing direct visualization of the laminae, ipsilateral facet, and adjacent structures. A 3.5 mm cutting drill was used to perform a hemi-laminectomy and subsequently pass *over the top*, below the base of the spinous process, in a "joystick" maneuver, creating a pathway to reach the lateral recess and contralateral foramen, with the contralateral yellow ligament still intact to protect the dural sac. When visualizing the facet, there is a need to remove

the contralateral yellow ligament to expose the superior and inferior articular processes, initiating foraminal decompression. (Figure 1)

On the contralateral side, foraminal enlargement was performed with the aid of a drill with a cutting bit, smoothing the inferior articular process (IAP) and superior articular process (SAP) until the visibility of the emerging nerve root. This process is complemented with Kerrison and forceps, decompressing the stenosed foramen.

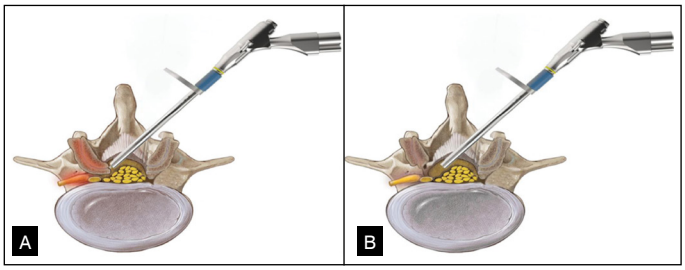
Additional Resection in Cases of Central Stenosis, Lateral Recess Stenosis, and Disc Herniation

In cases where foraminal stenosis was associated with central stenosis and/or lateral recess stenosis, the hemi-laminectomy was extended, aiming to disconnect the yellow ligament. Additionally, there was an enlargement of the bone debridement at the lateral edge of the ipsilateral facet. With the yellow ligament detached, total removal was performed.

In cases where there was an associated disc herniation, after extensive decompression, medial retraction of the dural sac was performed, with protection of the cannula, addressing the disc herniation. (Figure 2)

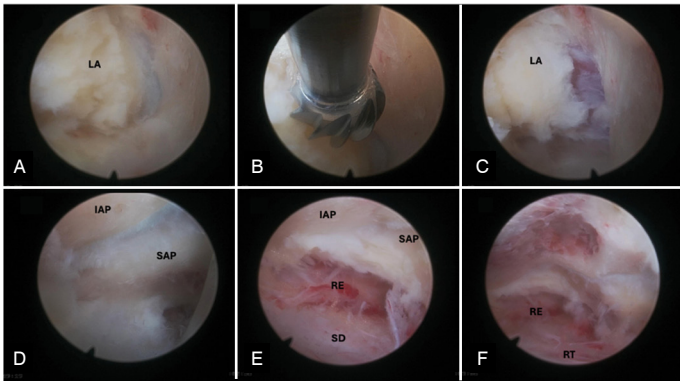
Confirmation of Decompression and Post-Operative

The release of the nerve root and complete removal of compression were confirmed endoscopically. In the immediate postoperative period, all patients were instructed to ambulate. Hospital discharge was allowed the morning after the procedure, depending on the clinical evolution of the patient. All patients were instructed to use an abdominal elastic band for a postoperative period of 30 days. (Figure 3)



Source: Author.

Figure 1. (A) Positioning of the endoscope on the contralateral facet to initiate reverse foraminoplasty, decompressing the stenosed foramen. (B) Final aspect of reverse foraminoplasty, highlighting increased foraminal amplitude and free emerging root.



Source: Research Protocol.

Figure 2. Intraoperative sequence of Endoscopic Reverse Foraminoplasty. (A), (B), and (C) Progressive disinsertion of the yellow ligament (LA) from the ipsilateral lamina with the aid of a cutting bit; (D) Contralateral aspect before foraminoplasty; (E) Decompression of the contralateral foramen, highlighting the superior articular process (SAP), inferior articular process (IAP), free emerging root (RE), and dural sac (SD); (F) Final image of the surgery, with completed reverse foraminoplasty and absence of residual foraminal compression, highlighting the emerging root (RE) and transiting root (RT).

Source: Research Protocol.

Figure 3. Lumbar tomography demonstrating foraminal decompression by Endoscopic Reverse Foraminoplasty. (A) and (C) Preoperative sagittal and axial cuts with foraminal stenosis. B and D: Postoperative sagittal and axial cuts showing the wide foraminoplasty, with satisfactory resection of the SAP.

RESULTS

In total, 13 patients underwent reverse foraminoplasty, with an average age of 57.3 ± 13.54 years, ranging from 33 to 76 years. The gender distribution showed a slight predominance of females (53.8% women and 46.2% men). Most patients were over 60 years old (53.8%), with 71.4% of them, although elderly, economically active, and fully engaged in work activities. (Table 1)

Table 1. Demographic characteristics and diagnoses of patients undergoing endoscopic contralateral access reverse foraminoplasty.

N	Gender	Age	Profession	Diagnosis
1º	Man	48	Driver	Central stenosis, foraminal stenosis, and foraminal herniation L4-L5 and L5-S1 Right
2º	Man	44	Teacher	Foraminal stenosis and lateral recess stenosis L5-S1 Left
3º	Man	61	Promoter	Central and foraminal stenosis L4-L5 Left
4º	Woman	55	Teacher	Foraminal stenosis L5-S1 Left
5º	Woman	70	Retired	Lateral recess and foraminal stenosis L4-L5 and L5-S1 Left
6º	Woman	76	Retired	Central and foraminal stenosis L4-L5 and L5-S1 Left
7º	Woman	63	Housekeeper	Foraminal stenosis L4-L5 and L5-S1 Left
8º	Man	69	Mechanic	Central and foraminal stenosis L4-L5 Right
9º	Man	70	Mechanic	Central and foraminal stenosis L4-L5 Right
10º	Man	33	Analyst	Foraminal stenosis and calcified disc herniation L5-S1 Left
11º	Woman	68	Teacher	Central and foraminal stenosis L3-L4 and L4-L5 Right
12º	Woman	41	Electrician	Foraminal stenosis and disc herniation L5-S1 Right
13º	Woman	47	Electrician	Foraminal stenosis and disc herniation L3-L4 Right
13	Patients	53.7 ± 13.54 years		

The preoperative diagnoses involved, in all cases, lumbar foraminal stenosis, either isolated or associated with central stenosis, lateral recess stenosis, or disc herniations. The affected levels included exclusively lumbar segments — L3-L4, L4-L5, and L5-S1. In five patients, the intervention was performed at more than one level. Thus, the 13 patients totaled 18 surgical levels addressed.

The average surgical time per addressed level was 58.4 minutes, with a variation between 22 and 117 minutes. Procedures with shorter duration were observed in patients undergoing isolated decompression of the foramen and lateral recess, while longer times were recorded in cases that also required central decompression (Table 2). One surgical complication of dural injury was recorded, corresponding to 7.69% in the study.

The interlaminar *over the top* approach with contralateral entry was used in all cases for performing reverse foraminoplasty. The more complex procedures involved decompression of multiple levels (patients 1, 5, 6, 7, and 11), in which more than one vertebral segment was treated.

The functional assessment, based on the ODI, showed a statistically significant reduction over the follow-up period. The preoperative average was 45.19% (severe disability), with reductions to 27.01% in the first month (moderate disability), 18.67% at three months, 16.48% at six months, and 11.54% after two years or at the last follow-up (mild disability). The statistical analysis by paired t-test, preceded by the Shapiro-Wilk test, confirmed the normality of the distributions and the statistical significance of the reductions ($p < 0.001$ in all compared intervals), reinforcing the existence of sustained functional improvement in patients undergoing endoscopic reverse foraminoplasty. (Table 3)

The intensity of pain, measured by the VAS, also showed a clinically and statistically significant reduction during the follow-up. Local pain decreased from a preoperative average of 6.77 to 4.08 in the first month, 2.54 at three months, 2.38 at six months, and 1.85 after two years or at the last follow-up. Radiating pain started at 7.92, reducing to 3.54, 2.23, and 1.62, respectively, in the same periods. The normality of the differences was confirmed by the Shapiro-Wilk test, validating the use of the paired t-test, which revealed $p < 0.001$ in all analyses between the evaluated times. These results confirm that the technique provided a significant reduction in local and radiating pain, with maintenance of the beneficial effect over two years. (Table 4 and 5)

Table 2. Surgical time and approaches used in reverse foraminoplasty.

Surgery	Surgical treatment by operated level	Time
1st	Endoscopy IL over the top L4-L5 with RF to treat CS, FS, and DH	60
2nd	Endoscopy IL over the top L5-S1 with RF to treat CS, FS and DH	63
3rd	Endoscopy IL over the top L5-S1 with RF to treat LRS and FS	72
4th	Endoscopy IL over the top L4-L5 with RF to treat CS and FS	79
5th	Endoscopy IL over the top L5-S1 with RF to treat FS	71
6th	Endoscopy IL over the top L4-L5 with RF to treat LRS and FS	63
7th	Endoscopy IL over the top L5-S1 with RF to treat LRS and FS	66
8th	Endoscopy IL over the top L4-L5 with RF to treat CS and FS	40
9th	Endoscopy IL over the top L5-S1 with RF to treat CS and FS	45
10th	Endoscopy IL over the top L4-L5 with RF to treat FS	36
11th	Endoscopy IL over the top L5-S1 with RF to treat FS	39
12th	Endoscopy IL over the top L4-L5 with RF to treat CS and FS	67
13th	Endoscopy IL over the top L4-L5 with RF to treat CS and FS	70
14th	Endoscopy IL over the top L5-S1 with RF to treat FS and calcified DH	117
15th	Endoscopy IL over the top L3-L4 with RF to treat CS and FS	52
16th	Endoscopy IL over the top L4-L5 with RF to treat CS and FS	48
17th	Endoscopy IL over the top L5-S1 with RF to treat FS and DH	42
18th	Endoscopy IL over the top L3-L4 with RF to treat FS and DH	22

IL: Interlaminar; RF: reverse foraminoplasty; CS: central stenosis; FS: foraminal stenosis; DH: disc herniation; LRS: lateral recess stenosis.

Table 3. Evolution of the Oswestry Disability Index.

N	Oswestry Pre and Post-operative				
	Pre	1m[A]	3m[B]	6m[C]	+2y[D]
1st	52	46	50	56	51
2nd	28	24	12	0	4
3rd	38	16	14	6	4
4th	54	12	12	12	12
5th	75.5	51.1	40	42.2	0
6th	66.7	38	20	20	12
7th	16	24	3	3	3
8th	36	30	22	18	10
9th	52	16	24	24	32
10th	40	16	4	2	0
11th	54	46	26.7	21	14
12th	42	2	2	4	2
13th	33.3	30	13	6	6

Pre: pre-operative; 1m: 1 month; 3m: 3 months; 6m: 6 months; +2y: last follow-up. Paired t-test A: p value = 0.0015; B, C, and D: p value < 0.0001. Validation by the Shapiro-Wilk Test.

Table 4. Evolution of the visual analog scale of pain in the postoperative period.

N	Visual Analog Scale of Pain									
	Pre		1m[A]		3m[B]		6m[C]		+2y[D]	
	L	I	L	I	L	I	L	I	L	I
1st	9	9	7	3	5	7	8	7	7	7
2nd	7	7	4	3	2	1	2	0	2	0
3rd	8	8	5	2	5	2	2	2	1	1
4th	4	9	2	0	2	0	2	0	2	0
5th	9	9	7	7	0	0	3	6	0	0
6th	9	8	6	6	4	2	4	2	3	1
7th	7	8	0	3	0	0	0	0	0	0
8th	8	8	7	7	6	4	4	4	3	3
9th	8	9	3	3	4	4	4	4	5	5
10th	5	8	4	1	2	2	1	2	0	0
11th	5	8	3	5	0	3	0	3	0	2
12th	4	4	0	0	0	0	0	0	0	0
13th	5	8	5	6	3	4	1	2	1	2

Pre: pre-operative; 1m: 1 month; 3m: 3 months; 6m: 6 months; +2y: last follow-up; L: Location; I: Irradiated. **Radiated Pain: A** p-value = 0.0022**; B** p-value = 0.0037**; C** p-value = 0.00031**; D** p-value = 0.00015. **Local Pain: A** p-value = 0.001**; B** p-value <0.001**; C** p-value = 0.001**; D** p-value = 0.0015. Validation by the Shapiro-Wilk Test.

Table 5. Means of ODI and VAS pre and post-operative up to 2 years or last follow-up.

Time		VAS	
	ODI	Local	Irradiated
Pre	45.19	6.77	7.92
1 month	27.01	4.08	3.54
3 months	18.67	2.54	2.23
6 months	16.48	2.38	2.46
+2 years	11.54	1.85	1.62

DISCUSSION

Endoscopic contralateral reverse foraminoplasty has proven to be an effective approach for the treatment of lateral recess and foraminal stenosis, whether associated with disc herniation or not,[1,17,22] being a minimally invasive alternative that aims to preserve segmental stability and reduce surgical trauma.[1,18] This technique has been widely used to promote efficient decompression, symptomatic relief, and functional recovery of patients, combining the advantages of minimally invasive techniques while sparing additional surgical approaches. Thus, the complete surgical intervention is performed in a single time.

The results of this study demonstrated statistically significant improvement in pain and function over two years. The VAS showed an average reduction of 6.3 points for radiating pain (from 7.92 to 1.62) and 4.92 points for local pain (from 6.77 to 1.85). In the ODI, there was an average decrease of 33.65 points (from 45.19% to 11.54%), progressively reducing the patients' disability from severe to mild over the follow-up period. However, satisfactory levels of functional improvement were evident as early as the first 3 months postoperatively. This functional assessment demonstrated statistically significant results, aligning with the findings of Lin et al.[16] who reported similar reductions in patients undergoing the endoscopic technique for lumbar stenosis. Moreover, the average reduction values observed in this study are comparable to those described by Wang et al.[12] who evidenced sustained functional improvement in long-term follow-up.

The average surgical time was 58.4 minutes, ranging from 22 to 117 minutes. Similar to what was found by Li et al.[11] longer procedures were associated with more complex cases, but do not seem to determine a negative impact on functional recovery or postoperative pain control. Shorter procedures were associated with isolated decompressions of a single level. Additionally, the choice between different endoscopic approaches directly impacts the duration of the procedure.[1] Reverse foraminoplasty, involving a broader bone resection, naturally adds time to the procedure but provides an enhanced field of view and minimizes the need for additional pathways and conversion to open techniques.

Compared to open approaches, endoscopic foraminoplasty presents a lower risk of complications, such as epidural fibrosis and post-laminectomy syndrome, conditions associated with extensive manipulation of the paravertebral musculature and vertebral laminae, as demonstrated by Ahn.[5] The complication rate in this study was 7.69%, corresponding to one case of dural injury, a value that is within the range reported for endoscopic procedures, varying between 4% and 10% as described by Lin et al.[16] and Wang et al.[12] Strategies to minimize complications include enhancing the surgeon's learning curve, using improved visualization techniques, and careful patient selection. Moreover, the implementation of strict protocols for hemostasis control and handling of instruments can contribute to the reduction of adverse events. No cases of infection, facet instability, or compressive hematoma were reported. The data indicate a low incidence of complications and a safety profile consistent with the literature on minimally invasive spinal procedures.

A relevant aspect in the dissemination of reverse foraminoplasty is the learning curve, which can directly impact the efficacy and safety of the technique.[6] Studies, such as those by Pan et al.[4] demonstrate that mastering the approach requires performing 50 to 70 cases to achieve optimized surgical times and minimize complications.[6,7,16] Therefore, reverse foraminoplasty should be better utilized by surgeons with a higher learning curve.

The precise indication of the technique is essential to ensure good results. This technique should be better utilized as an exception technique when the patient presents conditions that hinder classic transforaminal access on the affected side, such as high iliac crest, megatransverse process, and apex of the concavity in degenerative scoliosis.[1,23-25] Patients with grade II or higher spondylolisthesis, dynamic segmental instability, and advanced deformities may not be the best candidates for this approach, requiring careful evaluation in case selection.[11,16,17]

CONCLUSION

Endoscopic contralateral foraminoplasty is an effective and safe technique for the treatment of spinal canal stenosis associated with foraminal stenosis, providing sustained functional improvement and significant pain reduction over at least two years of follow-up. The procedure presented an average surgical time consistent with the literature and a low complication rate.

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. JPCFS, MBSB, and BBC: participated in the study design, research conduct, data analysis, and critical review of the intellectual content, being the main responsible for the scientific execution of the work; DRS: contributed to the methodological structure, statistical analysis, manuscript preparation, and final writing; MTR: assisted in data curation, technical support, and preliminary content review.

DATA AVAILABILITY DECLARATION

The contents underlying the research are available in the manuscript.

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