

THORACIC-LUMBAR ARTHRODESIS VIA EXTREME LATERAL APPROACH: A RETROSPECTIVE STUDY

ARTRODESE COM ABORDAGEM EXTREMO LATERAL DA COLUNA TORACOLOMBAR: UM ESTUDO RETROSPECTIVO

ARTRODESIS POR ABORDAJE LATERAL EXTREMO DE LA COLUMNA TORÁCICO-LUMBAR: UN ESTUDIO RETROSPECTIVO

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ABSTRACT

Objective: To evaluate the epidemiological, clinical, and radiological data of patients treated with XLIF, including the impact on quality of life, pain parameters, and improvement of lumbar lordosis. **Methods:** Retrospective longitudinal study, in which medical records of patients who underwent XLIF between 2017 and 2020 at Hospital do Trabalhador/UFPR were reviewed. Demographic characteristics and radiological aspects, such as the Cobb angle, were recorded. Clinical characteristics using parameters such as pain by VAS and the disability index by ODI were evaluated before surgery and 12 months after. **Results:** Female patients predominated (66.7%), with a mean age of 59.1 years (35-82 years). The length of stay, in the median, was three days, and the time to return to daily activities was three months. Only four patients (8.9%) had complications. The questionnaire analysis showed a significant difference between all scales' pre and postoperative scores. The ODI showed an average reduction of 39.2%, and the median score of VAS in the postoperative period was half the preoperative period (reduction of 50%; $p < 0.001$). The lordosis angle increased by 26.3% in the postoperative period ($p < 0.001$). **Conclusion:** XLIF presents low complication rates, improves lumbar lordosis, and allows recovery from daily activities in a short period, in addition to performing a statistically significant improvement in quality of life and pain according to the VAS and ODI scales, being, therefore, a viable and effective treatment technique. **Level of Evidence II; Retrospective Study.**

Keywords: Spine; Arthrodesis; Minimally Invasive Surgical Procedures; Pain Measurement.

RESUMO

Objetivo: Avaliar o perfil epidemiológico dos pacientes tratados com a XLIF, dados clínicos e radiológicos, incluindo o impacto na qualidade de vida, parâmetros de dor e melhora da lordose lombar. **Métodos:** Estudo longitudinal retrospectivo, em que foram revisados prontuários de pacientes submetidos à XLIF entre 2017 e 2020 no Hospital do Trabalhador/UFPR. Foram registrados os aspectos demográficos, características clínicas através de parâmetros como dor pela EVA e o índice de incapacidade pelo ODI, aspectos radiológicos incluindo o ângulo de Cobb antes da cirurgia e 12 meses após. **Resultados:** Predominou o sexo feminino (66,7%), com média de idade de 59,1 anos (35-82 anos). O tempo de internação, em mediana, foi de 3 dias e o tempo de retorno às atividades diárias foi de 3 meses. Apenas quatro pacientes (8,9%) apresentaram complicações. A análise através de questionários demonstrou diferença significativa entre as pontuações pré e pós-operatórias em todas as escalas. No ODI, houve redução média na pontuação de 39,2% e na EVA, a pontuação mediana no pós-operatório foi a metade da pontuação no pré-operatório (redução de 50%; $p < 0,001$). O ângulo da lordose teve aumento de 26,3% no pós-operatório em relação ao valor basal ($p < 0,001$). **Conclusão:** A XLIF apresenta baixos índices de complicação, melhora da lordose lombar e permite a recuperação às atividades diárias em curto período de tempo, além de desempenhar melhora estatisticamente significativa na qualidade de vida e no quadro algico segundo as escalas EVA e ODI, sendo, portanto, uma técnica viável e eficaz de tratamento. **Nível de Evidência II; Estudo Retrospectivo.**

Descritores: Coluna Vertebral; Artrodese; Procedimentos Cirúrgicos Minimamente Invasivos; Medição da Dor.

RESUMEN

Objetivo: Evaluar los datos epidemiológicos, clínicos y radiológicos de los pacientes tratados con XLIF, incluyendo el impacto en la calidad de vida, los parámetros de dolor y la mejoría de la lordosis lumbar. **Métodos:** Estudio longitudinal retrospectivo, revisando las historias clínicas de los pacientes que se sometieron a XLIF entre 2017 y 2020 en el Hospital do Trabalhador/UFPR. Se registraron características demográficas y radiológicas, como el ángulo de Cobb. Se evaluaron las características clínicas mediante parámetros como el dolor por EVA y el índice de discapacidad por ODI antes de la cirugía y 12 meses después. **Resultados:** Predominó el sexo femenino (66,7%), con una edad media de 59,1 años (35-82 años). La duración de la estancia, en promedio, fue de 3 días y el tiempo para volver a las actividades diarias

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fue de 3 meses. Solo cuatro pacientes (8,9%) presentaron complicaciones. Los cuestionarios mostraron una diferencia significativa entre las puntuaciones pre y postoperatorias. El ODI mostró una reducción media del 39,2% y la puntuación media de la EVA en el postoperatorio fue la mitad de la puntuación en el preoperatorio ($p < 0,001$). El ángulo de lordosis aumentó un 26,3% en el postoperatorio ($p < 0,001$). Conclusiones: XLIF presenta bajas tasas de complicaciones, mejora la lordosis lumbar y permite la recuperación de las actividades diarias en un corto período de tiempo, con una mejora estadísticamente significativa en la calidad de vida y el dolor según EVA y ODI, siendo una técnica de tratamiento viable y eficaz. **Nivel de evidencia IV; Estudio Retrospectivo.**

Descriptores: Columna Vertebral; Artrodesis; Procedimientos Quirúrgicos Mínimamente Invasivos; Dimensión del Dolor.

INTRODUCTION

Thoracolumbar arthrodesis has been widely used for various spine diseases, including degenerative discopathy, trauma, infections, tumors, deformities, and instability.¹ This fusion between the vertebral bodies usually accompanies the introduction of a structural implant into the disc space, which can be an allograft or cage. This inter-somatic device promotes the replacement of the vertebral disc.²

When performed by traditional routes (anterior and posterior), it is associated with various complications, such as pseudarthrosis, displacement of the graft, direct damage to large vessels and the dural sac or nerve roots, chronic dysfunction of the paravertebral musculature, and post-surgical syndrome of the lumbar spine.^{3,4}

Since 2000, Pimenta⁵ has disseminated the *extreme lateral interbody fusion* (XLIF), which is a minimally invasive technique, using a lateral, retroperitoneal, small (3 to 4 cm incisions), transpsoas access, providing wide discectomy and fusion between vertebral bodies.⁶

There are many indications for the use of the XLIF technique, the main ones being degenerative conditions such as spondylolisthesis, degenerative discopathy, and herniated discs, and it is a good option for correcting deformities in the sagittal and coronal planes. In addition, limitations to posterior and/or anterior access to the spine also encourage using the technique, for example, in obese patients or in cases of pseudoarthrosis, where the spine has already been approached previously by other access routes.^{7,8}

The technique, however, has some restrictions and disadvantages and is not recommended for approaching the L5/S1 levels due to the obstruction of lateral access by the iliac crests. In addition, at more caudal levels, there is a more anterior course of the lumbar plexus and a more lateral course of the iliac vessels, determining the potential risk of injury to these structures.^{9,10} However, intraoperative monitoring of the technique helps with localization, minimizing the occurrence of potential injuries during surgical access.

XLIF has been developing every year, but Brazilian literature is still scarce. The growing experience with cases indicates that a minimally invasive extreme lateral approach could be a viable and effective treatment technique, improving patients' quality of life.

In the present study, we explored a series of patients undergoing XLIF to analyze the impact on quality of life and pain parameters after the procedure. In addition, the complications of the technique, the lordosis acquired with the procedure, and demographic data on the sample were also analyzed.

MATERIAL AND METHODS

This is a longitudinal, retrospective study in which the medical records of patients who underwent thoracolumbar arthrodesis via the extreme lateral route between 2017 and 2020 at a tertiary referral hospital for spinal care were reviewed, with approval from the research ethics committee under number 25235519.0.0000.5225.

Patients aged between 18 and 100 years who had been followed up on an outpatient basis and had complete medical records containing contact information, epidemiological data, and a surgery description were included. The inclusion criteria also included signing the Informed Consent Form and completing the evaluation questionnaires before the procedure and one year after the surgery. Patients who had undergone a different surgical technique, were not in the same age group, had incomplete data, or were lost to outpatient follow-up were excluded.

Medical records were reviewed to record demographic data,

assessing variables such as gender, age, underlying pathology, levels approached, reports of complications, and surgical technique. Clinical characteristics were assessed using parameters such as pain intensity using the Visual Analog Pain Scale (VAS) and the Oswestry Disability Index (ODI) before and one year after the procedure.

Radiographs of the thoracolumbar segment were taken before surgery and 12 months later, using anteroposterior and lateral views, with the patient in an orthostatic position, weight equally distributed on both feet, with the central ray perpendicular and directed towards the midpoint of the film, and a focus-film distance of 100 to 150 cm.

Radiological parameters for assessing lordosis and consolidation were analyzed through radiographic evaluation and measurement of the Cobb angle, formed between a line drawn parallel to the upper plateau of L1 and the upper plateau of S1, considering angles of 30° to 79° as normal variation.¹¹ Complications such as migration (lateral, anterior, and posterior) of the cage and subsidence were also evaluated radiographically. In some cases, CT scans with a slice thickness of 2 to 4 mm were used, as required by the medical records.

All surgeries were performed by a single spine surgeon with a total experience in the XLIF technique of 4 years before the start of the study. The surgical procedure was performed using a single minimally invasive lateral retroperitoneal approach (Figure 1) (a modification of Pimenta's original technique),⁵ with constant electromyographic monitoring (Neurovision JJB NuVasive®, RJ, Brazil) and 10-degree peek lordosis implants (polyetheretherketone) (CoRoent XLNuVasive®, RJ, Brazil). Subsequent supplementation was chosen in cases considered unstable.

In the statistical analysis for quantitative variables, normality was assessed using the Shapiro-Wilk test. Quantitative variables were represented by mean and standard deviation or median and interquartile range (first quartile; third quartile), and absolute and relative frequencies represented qualitative variables. All the analyses were carried out using SPSS software (version 21.0) and considered a 5% significance level.

The two moments (pre- and post-operative) were compared using the Student's t-test for paired samples or the Wilcoxon test. The association between the variables was assessed using Pearson's or Spearman's correlation coefficients.



Figure 1. Example of an incision for minimally invasive single lateral retroperitoneal access.

RESULTS

A total of 50 cases were reviewed, 45 of which met the eligibility criteria. Female patients were predominant (66.7%) with an average age of 59 (35-82). Most surgeries were performed in 2019 (60%), with foraminal stenosis being the most common underlying cause (66.7%), as shown in Table 1.

The median hospitalization time was three days (2-18 days), and the median time to return to daily activities, such as returning to work, was three months (0.25-10 months).

As shown in Table 2, the vertebral level most frequently approached was L3-4 (55.6%), and the entry route was preferably the left lateral (66.7%). The most commonly used technique was the *cage stand-alone*, i.e., without additional instrumentation (77.8%), with bilateral pedicle fixation being used in the others due to the instability of the approached segment. There was no injury to the anterior longitudinal ligament.

Only four patients studied (8.9%) had associated complications, of which one case (25%) was *subsidence*, another case (25%) lateral migration of the *cage*, and two cases (50%) of pleural opening in the thoracic approach.

Despite the known possibilities of radiculopathy, spinal cord injury,

Table 1. Demographic variables (N=45).

Variable Categories		Number of Patients	Proportion (%)
Sex	Female	30	66.7
	Male	15	33.3
Year of Surgery	2017	6	13.3
	2018	10	22.2
	2019	27	60.0
	2020	2	4.4
Basic pathology*	Adjacent level degeneration	6	13.3
	Foraminal stenosis	30	66.7
	Degenerative scoliosis	3	6.7
	Spondylolisthesis	6	13.3
	Pseudoarthrosis	2	4.4
Average			Standard Deviation
Age		59.1	11.5
Median			Quartile 1-3
Length of stay (days)		3	2 - 4
Time until return to daily activities (months)		3	3 - 3

*Multiple answers.

Table 2. Perioperative variables (n=45).

Variable	Number of Patients	Proportion (%)	
Levels covered*	L1-2	2	4.4
	L2-3	18	40.0
	L3-4	25	55.6
	L4-5	12	26.7
	T12-L1	2	4.4
	T6-7	1	2.2
	T7-8	1	2.2
Cage stand alone	Yes	35	77.8
	No	10	22.2
Rear fixing	Yes	10	22.2
	No	35	77.8
Entry	Right	15	33.3
	Left	30	66.7
Presence of complications**	4	8.9	

*Multiple answers; ** two cases of pleural opening (4.4%), one case of lateral migration of the *cage* (2.2%), and one case of *subsidence* (2.2%).

and cauda equina lesions, no neurological complications existed.

Questionnaires analysis showed a significant difference between pre-and post-operative scores on all the scales (Table 3). In the case of Oswestry, patients had an average reduction of 39.2% post-operatively compared to baseline levels (p<0.001). For the VAS test, the median postoperative score was half the preoperative score (50% reduction; p<0.001). In addition, the mean lordosis angle (Figure 2) increased by 26.3% postoperatively compared to baseline (p<0.001).

(A) Pre-operative X-rays and (B) 12 months after surgery showing an example of a case with increased lumbar lordosis.

Figure 3 shows that before surgery, 55.6% of patients had severe disability, and one year after surgery, moderate disability predominated (66.7%).

The pain level was intense in 71.1% of patients preoperatively, reducing to 8.9% 12 months after surgery. During this period, moderate pain was predominant (82.2%), as shown in Figure 4.

There was no statistically significant association between age, length of hospital stay, time since returning to work and improvement in Oswestry, VAS, and lordosis scores. However, more recent

Table 3. Clinical and radiological parameters (n=45).

Test	Preoperative	Post-surgery	Difference (%)	p-value
	Mean ± SD	Mean ± SD		
Oswestry (%)	62.0 ± 13.7	37.7 ± 14.9	-39.2%	<0.001
EVA (0-10)*	8.2 ± 1.3 (8)	4.2 ± 2.0 (4)	-50.0%	<0.001
Lordosis (°)	35.3 ± 17.2	44.6 ± 16.3	+26.3%	<0.001

*Due to asymmetry, the median was also described in brackets.

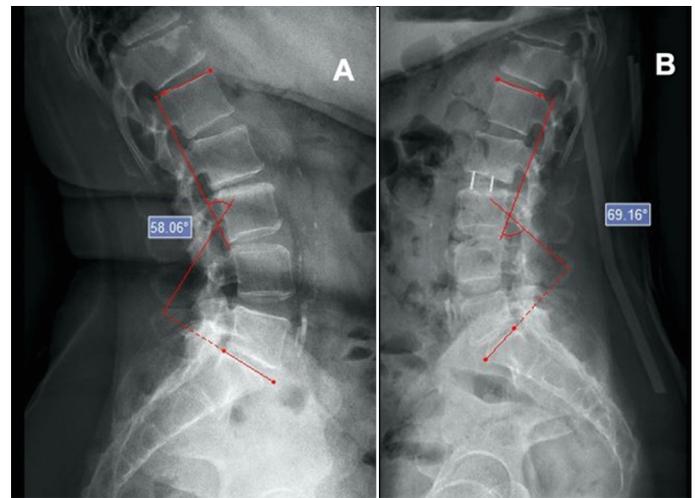


Figure 2. Demonstration of the increase in lumbar lordosis through the Cobb angle after surgery.

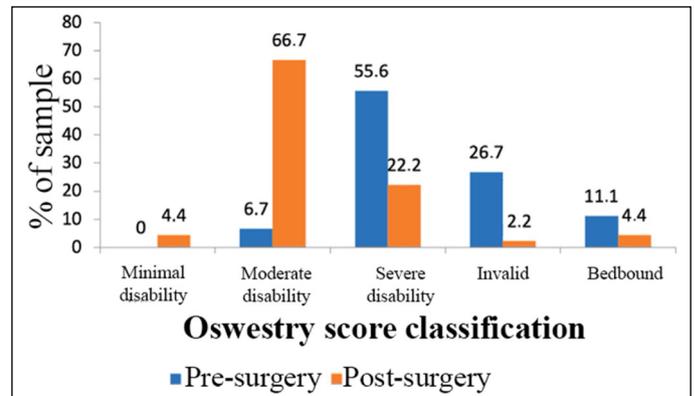


Figure 3. Evaluation of the degree of disability by Oswestry before and after surgery.

surgeries performed from 2019 onwards showed a better result on the Oswestry scale, with a greater reduction ($r_s = -0.359$; $p = 0.016$), as shown in Figure 5.

There was no statistically significant association between gain in lordosis and reduction in Oswestry and VAS scores, as shown in Table 4.

DISCUSSION

The choice of surgical technique must represent a reasonable compromise between the planned surgical intervention and the associated operative risks. As a result, minimally invasive techniques have been introduced to reduce perioperative complications and shorten hospital stays, directly impacting postoperative quality of life.

This study carried out a retrospective evaluation of patients undergoing XLIF, and there was a predominance of females in the sample studied, as in other studies in the literature.^{12,13}

Using the VAS, there was a 50% reduction in pain levels (from 8 points preoperatively to 4 points one year after surgery). This value is similar to the study by Klimov and Vasilenko,¹⁴ who obtained a reduction from 6 to 3 points using the same scale for a lateral surgical approach ($p < 0.0001$).

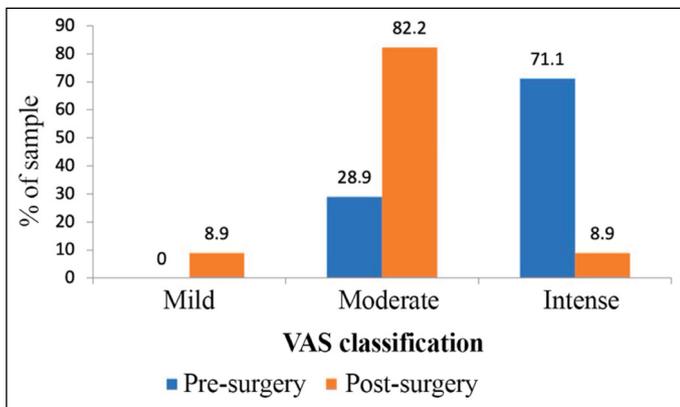


Figure 4. Assessment of pain levels using the visual analog scale (VAS) before and after surgery.

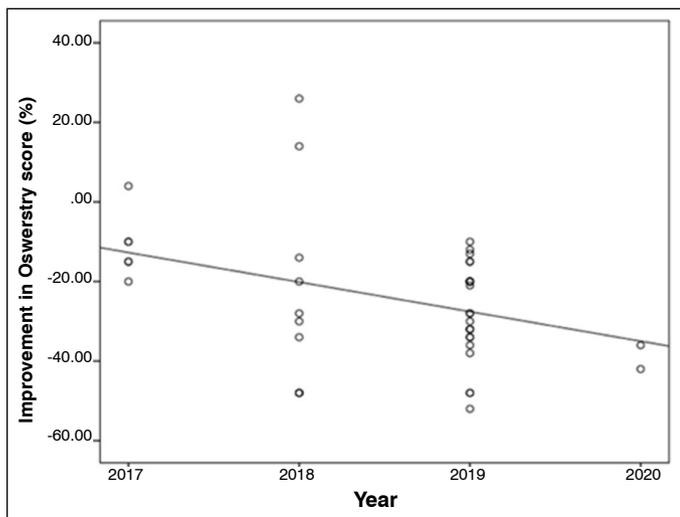


Figure 5. Association between the year the surgery was performed and the improvement, in %, of the Oswestry score 12 months after surgery ($r_s = -0.359$; $p = 0.016$).

Table 4. Association between clinical and radiological parameters.

Test	Gain in lordosis
Oswestry reduction (%)	$r = 0.001$ ($p = 0.997$)
EVA reduction (0-10)	$r_s = 0.000$ ($p = 0.998$)

Klimov and Vasilenko¹⁴ also evaluated functional adaptation according to the Oswestry Disability Index (ODI), observing an improvement from 47.8 ± 17.4 to 38.5 ± 14.5 (a reduction of 19.5%; $p < 0.0273$), which also occurred in the present study, but with even better results, with a reduction of 39.2% ($p < 0.001$), demonstrating that patients with severe disability to near-disability, after surgery, had moderate disability, classifying it as a good postoperative result. Similarly, Paterakis and Brotis¹² showed similar results with the XLIF, determining an improvement in spine-related disability of 26% (SD = 8.35%) on the ODI scale at a one-year follow-up.

Also similar to this study, the literature⁴ reports positive results concerning improving sagittal balance using the Cobb angle to quantify lordosis. Amaral *et al.*⁴ determined that the mean lumbar lordosis in the study group with a mean age of 57.3 years after one year's follow-up was 36.5 ± 14.7 preoperatively, which increased after lateral access to 43.4 ± 12.4 (an increase of 18.9%; $p < 0.015$) at 12-month follow-up. In this study, the increase in lordosis angulation was 26.3% ($p < 0.001$). It is worth noting that the implants used in our study were probably more anteriorized, which may have favored lordosis gain, a topic that could be evaluated in future studies.

Spinal surgical complications can be divided into complications inherent to the surgery (bleeding requiring transfusion, surgical wound infection), related to the access route (visceral or vascular injury in anterior approaches; dural injury or epidural hematoma in posterior approaches), complications specific to the spinal approach (neural, sensory or motor injuries), as well as general perioperative medical complications.¹⁵ Many studies^{10,15,16} have shown that XLIF may be associated with fewer complications than traditional access procedures. Despite this, the data in the literature has not yet provided sufficient evidence to compare the effectiveness of the techniques.

The complication rate in this study was 8.9%, proportionally lower than the same technique studied by Paterakis *et al.*¹² who had three complications out of 12 patients (25% rate). There were only minor complications in this study: two cases of pleural opening in the thoracic approach (4.4%), one case of lateral migration of the cage (2.2%), and one case of *subsidence* – progressive sinking of the cage into the vertebral body (2.2%). There were no deaths, neurological or abdominal injuries.

The *stand-alone* option (without additional supplementation) performed in 35 patients (77.8%) consists of a technique performed with interbody cages only impacted or threaded into the disc space, without the additional use of screws and plates as occurs in traditional techniques.¹⁷ Its use should be recommended for less unstable lumbar levels, including spondylolisthesis; however, in cases with bone defects, they may generate abnormal movement and result in arthrodesis failure.¹⁸ In patients with bone loss (for example, osteoporosis) or instability, supplementary fixation (posterior or anterior) is recommended to avoid complications such as *subsidence* and cage displacement.⁴ In our study, posterior supplementation was necessary in 10 patients (22.2%), with only one case of *subsidence* (2.2%) and one case of lateral cage migration (2.2%).

A relationship of better results on the Oswestry scale was identified from 2019 onwards ($r_s = -0.359$; $p = 0.016$), the year in which most of the surgeries were performed (60%), which leads us to believe in a possible correlation with the improvement of the technique and the greater skill of the team, which was more trained with a new technique over time.

It is worth highlighting the limitations evident in this study as it was a small series of patients, in addition to the restrictions and reduction in the number of surgeries during 2020 due to the COVID-19 pandemic caused by the new coronavirus (SARS-CoV-2). Future studies with a larger sample size and a longer post-surgical evaluation period could expand our knowledge of the technique.

CONCLUSION

The minimally invasive surgical approach performed via the extreme lateral approach (XLIF) has low complication rates, improves lumbar lordosis, and allows recovery to daily activities in a short period, as well as providing a statistically significant improvement in

quality of life and pain according to the VAS and ODI scales, making it a viable and effective treatment technique.

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

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