

CLINICAL AND RADIOGRAPHIC EVALUATION OF PATIENTS UNDERGOING OBLIQUE LATERAL INTERBODY FUSION WITH ANTEROLATERAL INSTRUMENTATION: PRELIMINARY STUDY

AValiação Clínica e Radiográfica de Pacientes Submetidos à Fusão Intersomática Lateral Oblíqua com Instrumentação Anterolateral: Estudo Preliminar

Evaluación Clínica y Radiográfica de Pacientes Sometidos a Fusión Intersomática Lateral Oblícuca con Instrumentación Anterolateral: Estudio Preliminar

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ABSTRACT

Objective: To evaluate the clinical effects, radiographic outcomes, and complications of oblique lateral interbody fusion combined with anterolateral fixation using unilateral screws and rods in patients with degenerative lumbar disc disease. **Methods:** Fourteen medical records were analyzed, with comparison of preoperative and postoperative radiographs over a 12-month follow-up period. Patients with degenerative lumbar disease, foraminal stenosis, central canal stenosis, grade I or II degenerative spondylolisthesis, and/or adjacent segment degeneration were included, provided they underwent one- or two-level intervention after failure of conservative treatment for at least three months. Cases of spinal infection, trauma, local malignancy, specific L5-S1 pathologies, and loss to postoperative follow-up were excluded. Low back and lower limb pain were assessed using the Visual Analog Scale (VAS), and lumbar function was evaluated with the Oswestry Disability Index (ODI). Radiographic analysis was performed using Surgimap®, assessing the Cobb angle, bone fusion, cage positioning, as well as migration and subsidence. **Results:** Significant improvement in VAS and ODI scores was observed after surgery ($p < 0.001$). Indirect decompression was effective at all operated levels. An increase in lordosis was noted, with significant change in the lumbar Cobb angle ($p < 0.001$), and the fusion rate was 81.4%. Osteolysis and subsidence occurred in 14.3% of cases, particularly in older patients. **Conclusion:** The procedure promoted clinical and functional improvement in more than 80% of patients, bone fusion in 81.4% of cases, and a 4.4-degree increase in lumbar lordosis, with osteolysis and cage subsidence being more frequent, especially in individuals older than 63 years. **Level of evidence II; Retrospective study.**

Keywords: Intervertebral Disc Degeneration; Visual Analog Scale; Minimally Invasive Surgical Procedures; Spinal Fusion.

RESUMO

Objetivo: Avaliar os efeitos clínicos, os resultados radiográficos e as complicações da fusão intersomática lateral oblíqua combinada à fixação anterolateral com parafusos e hastes unilaterais em pacientes com doença degenerativa do disco lombar. **Métodos:** Foram analisados 14 prontuários médicos, com comparação entre radiografias pré e pós-operatórias ao longo de 12 meses de acompanhamento. Incluíram-se pacientes com doença degenerativa lombar, estenose foraminal, estenose do canal central, espondilolistese degenerativa grau I ou II e/ou degeneração de níveis adjacentes, submetidos à intervenção em um ou dois níveis após falha do tratamento conservador por pelo menos três meses. Excluíram-se casos de infecção da coluna, trauma, malignidade local, patologias específicas em L5-S1 e perda de seguimento pós-operatório. A dor lombar e dos membros inferiores foi avaliada pela Escala Visual Analógica (EVA), e a funcionalidade lombar pelo Oswestry Disability Index (ODI). A análise radiográfica foi feita no Surgimap®, avaliando ângulo de Cobb, consolidação óssea, posicionamento do cage, além de migração e subsidência. **Resultados:** Houve melhora significativa nos escores de EVA e ODI após a cirurgia ($p < 0,001$). A descompressão indireta foi eficaz em todos os níveis operados. Observou-se aumento da lordose, com alteração significativa no ângulo de Cobb lombar ($p < 0,001$), e taxa de consolidação de 81,4%. Osteólise e subsidência ocorreram em 14,3% dos casos, sobretudo em pacientes idosos. **Conclusão:** O procedimento promoveu melhora clínica e funcional em mais de 80% dos pacientes, fusão óssea em 81,4% dos casos e aumento de 4,4 graus na lordose lombar, sendo osteólise e subsidência do cage mais frequentes, especialmente em indivíduos acima de 63 anos. **Nível de evidência II; Estudo retrospectivo.**

Descritores: Degeneração do Disco Intervertebral; Escala Visual Analógica; Procedimentos Cirúrgicos Minimamente Invasivos; Fusão Vertebral.

Study conducted by the the Universidade Federal do Paraná, Curitiba, PR, Brazil.

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RESUMEN

Objetivo: Evaluar los efectos clínicos, los resultados radiográficos y las complicaciones de la fusión intersomática lateral oblicua combinada con fijación anterolateral mediante tornillos y barras unilaterales en pacientes con enfermedad degenerativa del disco lumbar. **Métodos:** Se analizaron 14 historias clínicas, con comparación entre radiografías preoperatorias y postoperatorias durante 12 meses de seguimiento. Se incluyeron pacientes con enfermedad degenerativa lumbar, estenosis foraminal, estenosis del canal central, espondilolistesis degenerativa de grados I o II y/o degeneración de segmentos adyacentes, sometidos a intervención en uno o dos niveles tras el fracaso del tratamiento conservador durante al menos tres meses. Se excluyeron casos de infección de la columna, trauma, malignidad local, patologías específicas en L5-S1 y pérdida de seguimiento postoperatorio. El dolor lumbar y de los miembros inferiores se evaluó mediante la Escala Visual Analógica (EVA), y la funcionalidad lumbar mediante el Oswestry Disability Index (ODI). El análisis radiográfico se realizó con Surgimap®, evaluando el ángulo de Cobb, la consolidación ósea, la posición del cage, además de migración y subsidencia. **Resultados:** Se observó una mejoría significativa en las puntuaciones de EVA y ODI después de la cirugía ($p < 0,001$). La descompresión indirecta fue eficaz en todos los niveles operados. Se observó un aumento de la lordosis, con cambio significativo en el ángulo de Cobb lumbar ($p < 0,001$), y una tasa de consolidación del 81,4%. La osteólisis y la subsidencia ocurrieron en el 14,3% de los casos, sobre todo en pacientes de edad avanzada. **Conclusión:** El procedimiento promovió mejoría clínica y funcional en más del 80% de los pacientes, fusión ósea en el 81,4% de los casos y un aumento de 4,4 grados en la lordosis lumbar, siendo la osteólisis y la subsidencia del cage más frecuentes, especialmente en individuos mayores de 63 años. **Nivel de evidencia II; Estudio retrospectivo.**

Descriptor: Degeneración del Disco Intervertebral; Escala Visual Analógica; Procedimientos Quirúrgicos Mínimamente Invasivos; Fusión Vertebral.

INTRODUCTION

Lateral oblique interbody fusion (OLIF), also known as anterior psoas approach arthrodesis, was described by Mayer in 1997 as a minimally invasive surgical alternative for treating degenerative lumbar disease (DDL).^{1,2} The primary objective of this technique is to restore disc height and indirectly decompress the foramina and spinal canal. The procedure involves the removal of the disc and the insertion of an intervertebral spacer, referred to as a cage, through a retroperitoneal access. A corridor is utilized between the blood vessels (aorta, common iliac artery and vein) and the psoas muscle to access the spine.^{1,3,4}

Various studies report advantages that OLIF provides, such as faster recovery, shorter surgical time, minimal intraoperative bleeding, and shorter hospital stays compared to posterior approach arthrodesis. The potential advantages of OLIF over the transpsoas approach (LLIF) would be to reduce the risk of injury to the lumbar plexus and, consequently, a lower chance of cruralgia and neurological deficit in the lower limb.⁵⁻⁷ However, this access route carries specific complication risks such as injuries to major vessels, ureters, lymphatics, contralateral nerve roots, pseudoarthrosis, migration, and subsidence of the cage.^{6,7}

The use of supplemental instrumentation is recommended to provide greater stability to the addressed segment and to prevent subsidence of the cage. Currently, the gold standard consists of the use of bilateral posterior pedicle screws in conjunction with rods, either through traditional open or percutaneous methods, with the execution of these being feasible both through intraoperative position change and in a single position (single position surgery). However, both instrumentation approaches result in an increase in both surgery time and associated costs.^{1,2}

In the anterolateral instrumentation technique, two pedicle screws are inserted into the vertebral bodies adjacent to the implant and are connected by a rod, performed through the same access route and during the same surgical time as the implantation of the cage (Figure 1). This approach avoids the need for additional access, which aids in preserving the muscles around the spinal column, reduces surgical time, and minimizes radiation exposure.⁸⁻¹⁰

Despite the potential benefits, few studies have been conducted on the use of oblique lateral interbody fusion with lateral instrumentation that demonstrate its clinical and biomechanical efficacy.^{10,11}

The primary objectives of this study were to evaluate the clinical outcomes of patients undergoing the proposed surgical procedure, verify the consolidation rates, and assess the Cobb angle in the lumbar segment pre- and post-operatively. Secondly, the objectives were to evaluate the epidemiological pattern of the patients and the main complications related to this surgical technique.

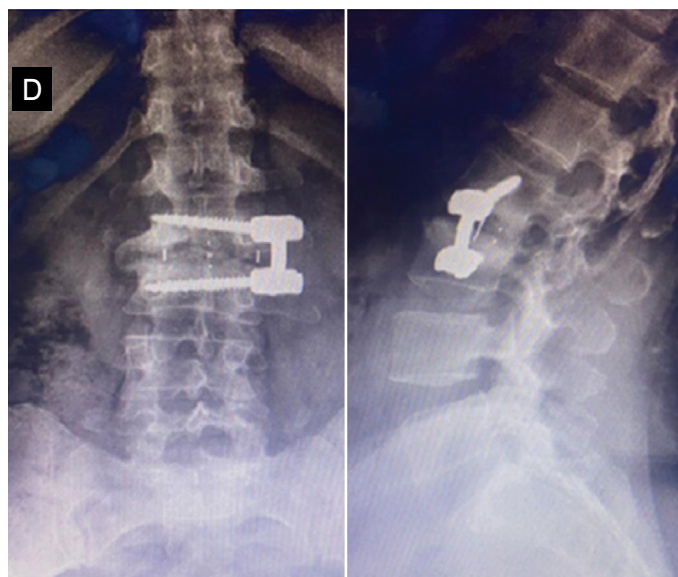


Figure 1. X-ray in anteroposterior and lateral views, demonstrating the technique of arthrodesis performed via an oblique lateral approach with anterolateral supplementation.

MATERIALS AND METHODS

This is a retrospective study that utilized data from medical records and imaging examinations of patients with degenerative lumbar disease surgically treated by the OLIF technique with anterolateral fixation. The surgeries were performed by the same team in the years 2022 and 2023. It was approved by the ethics and research committee (CAAE 77075524.1.0000.5225) and the informed consent form was waived.

The inclusion criteria were: patients of both sexes, adults aged between 18 and 100 years, with degenerative disease in the lumbar region, foraminal stenosis, central canal stenosis, and/or degenerative spondylolisthesis (grades I, II), adjacent level degeneration; the need for intervention at one or two levels and failure of conservative treatment for at least six months. The exclusion criteria were patients with infectious diseases of the spine, trauma, local malignancy, pathologies at the L5-S1 level, and loss of outpatient follow-up.

Age, sex, predominant disease, operated level, and post-surgical follow-up time of the individuals were the epidemiological characteristics verified.

The patients underwent the OLIF procedure, using cages (OLIF 25) from the Medtronic® brand. The devices exhibited a lordosis of

6 degrees, with a width variation between 18 and 22 mm, heights of 8, 10, and 12 mm, and lengths of 40 to 60 mm, in addition to the use of synthetic graft paste inside. In association, anterolateral pedicle screws and rods of the same brand, Medtronic®, were employed.

Clinical and radiographic evaluations were performed in the pre-operative period and 12 months after the surgery. The pre- and post-operative lumbosacral X-rays were taken in anteroposterior and static and dynamic lateral views. For the measurement of angles and dimensions, we utilized the software *Surgimap*®. From the X-ray, in addition to the positioning of the cage, the lumbar Cobb angle was verified, measured between the endplates of the L1 and S1 vertebrae. To measure the angulation of the operated segment, the Cobb angle was drawn between the upper endplate of the vertebra above and the lower endplate of the vertebra below the cage.¹¹

The height of the disc was measured pre-operatively by the distance between the lower endplate of the upper vertebra and the upper endplate of the lower vertebra at the disc, in the lateral X-ray. In the post-operative phase, the height of the cage was verified through the distance from the midline of the cage to the midpoint of the upper and lower terminal plates of the cage. The migration of the cage was considered when its displacement exceeded 2 mm in relation to the margins that limit it in the anteroposterior direction, measured in the X-ray at 12 months post-operatively.^{11,12,13}

For the evaluation of bone consolidation, two aspects were observed: the bony bridging between the vertebral bodies (cage-bone contact) and the mobility of the operated segment. This was performed through dynamic X-ray in flexion and extension and static profile, in which the distance from the midpoint between the spinous processes of the vertebrae of the operated segment was measured. It was defined that if the distance increased by more than 2 mm between the dynamic X-rays compared to the static ones, there would be an indication of failure in bone consolidation.¹² Osteolysis was identified through anteroposterior and lateral X-rays, evidencing the presence of a radiolucent line around the implants (cage and screws). Subsidence was defined as the migration of the cage towards the upper and/or lower terminal plates, with a magnitude equal to or greater than 2 mm.¹³

Clinical data were evaluated using the Visual Analog Scale for Pain (VAS), employed to analyze both lumbar and radicular pain during the pre-operative period and the twelfth month post-operatively, as well as the *Oswestry* questionnaire, in the pre-operative phase and the twelfth month following the surgery.¹⁴

The rates of complications and surgical revisions were obtained from clinical records. Surgical revision was deemed essential in situations of displacement or migration of the cage that resulted in compromise of the vertebral canal, as well as in cases of deep post-operative infections, loosening or fractures of the implants, and in the persistence of symptoms accompanied by residual neural compressions, as evidenced in clinical examination, X-ray, tomography, and magnetic resonance imaging.¹⁵ Additionally, other potential clinical complications were documented, including thrombosis, dysfunctions of the lymphatic system, alterations of the autonomic nervous system, and occurrence of death.

The data were included in a spreadsheet in a format compatible with Excel and subsequently imported into the statistical software JMP® Pro version 13 – SAS Institute Inc., Cary, NC, USA, (1989-2019). Descriptive statistical measures were used, calculating the mean and standard deviation for continuous characteristics and percentage frequencies for attribute measures. To assess whether there was a difference between the groups, the non-parametric *Wilcoxon* test (continuous measures) and the exact *Fisher* test (comparison between percentages) were utilized. The significance level was set at 0.05, which corresponds to a confidence interval of 95%.

RESULTS

Fifteen patients were included in the initial sampling. One patient did not complete the 12-month period due to death and was therefore excluded from the analysis, totaling 14 cases. Regarding

the epidemiological profile of the analyzed individuals, 85.7% were female and 14.2% were male. The average age was 62.3 years, ranging from 45.8 to 81.6. The predominant diagnoses were degenerative disc disease, degenerative spondylolisthesis, and degeneration at the adjacent level. The most commonly performed surgery was at the L3-L4 level, with a frequency of 47%, followed by L4-L5, with 29.4%. The follow-up period varied from 12 to 15 months, with an average of 13.8 months. The complete data are detailed in Table 1.

When analyzing the radiological profile, differences in the measurements of the Cobb angle of the lumbar segment in the pre- and post-operative periods showed a significant angular increase (p -value=0.002), with an average of 43.9 degrees in the pre-operative period to 48.3 degrees after surgery. With respect to the Cobb angle at the operated level, there was a significant gain in lordosis (p -value=0.001), with the average Cobb angle increasing from 7.7 to 10.9 degrees after the surgical procedure.

There was an increase in the intervertebral space at all operated levels. This increase had an average of 2.3 mm, with the average disc height preoperatively being 10.9 mm and postoperatively 13.2 mm (p -value <0.001). There was consolidation in 81.4%. We did not obtain significant percentage differences when comparing sex versus consolidation (p -value = 1.0000), and age versus consolidation (p -value = 0.6714).

Osteolysis around the cage and/or screws was detected in 14.3% of patients (two individuals). There was no statistically significant difference in the rates between genders (p -value = 1.000). However, when examining the association between the average age and the presence of osteolysis, a difference of 13.8 years was identified, with a p -value close to 0.05, indicating a possible trend towards a higher occurrence of osteolysis in elderly patients. Subsidence was observed in two participants, corresponding to 14.3%. No statistically significant difference was found between subsidence and sex (p -value = 1.0000), nor between subsidence and age (p -value = 0.5839).

As a clinical outcome, the average scores of the Visual Analog Scale (VAS) at twelve months postoperatively showed a significant reduction when compared to preoperative values. In the average preoperative assessment, the VAS for lower back pain was 8, ranging from 6 to 10 points. Postoperatively, the average was 1.8, ranging from 0 to 3 points. Regarding the preoperative VAS for the lower limbs, the average was 7, ranging from 5 to 9 points, and postoperatively it was 2, ranging from 0 to 4 points. These data are evidenced in Table 2.

When we examined the *Oswestry* Disability Index (ODI), in the preoperative phase, we obtained an average of 52%, indicating severe disability. In the postoperative phase, the average was 20.9%, indicating a minimal level of lumbar disability twelve months after surgery. These results indicate the functional improvement of patients (Table 2).

Table 1. Descriptive measures for general characteristics.

Characteristic	Group	Outcome
Sex	Female	12 (85.7%)
	Male	2 (14.2%)
Age		62.3 ± 10.7
Surgical Level	L1-L2	1 (5.9%)
	L2-L3	3 (17.6%)
	L3-L4	8 (47.1%)
	L4-L5	5 (29.4%)
Follow-up time in months (average)		13.8

Table 2. VAS for lower back pain, VAS for lower limbs, and ODI before and after surgical intervention.

	Preoperative	Postoperative	p-value
VAS lumbar	8.0 ± 1.1	1.8 ± 1.1	0.005
VAS Lower Limbs	7.0 ± 1.3	2 ± 1.4	0.005
ODI	52 ± 8.7	20.9 ± 6.7	0.0010

During the surgical procedures, no violations were identified in the terminal plates, nor were there any injuries to blood vessels or nerve roots. Additionally, no infections in the intervertebral space, damage to the dura mater, or the presence of cerebrospinal fluid fistulas were recorded.

Moreover, there were no displacements or migrations of the cages used. Among the complications observed, one case of lymphatic alteration and one death due to pulmonary thromboembolism were recorded, resulting in an overall complication incidence rate of 13.3%. Considering osteolysis and subsidence in conjunction with the overall complications, the total rate of observed complications increased to 26.6%.

DISCUSSION

In this study, a predominance of the female sex was observed, with an average age above 60 years. These findings are consistent with previous studies, such as the one conducted by Sahoo et al.,¹⁶ whose predominance in the population subjected to the same surgical technique was elderly women. These same authors concluded that the lateral oblique lateral interbody fusion technique provides indirect decompression with results equivalent to or superior compared to the TLIF technique.

When comparing the data found in this study with analyses conducted in similar works, there was a discrepancy regarding the percentage of operated levels, with 47% for the L3 L4 level and 23% for the L4 L5 level, whereas previously described data indicated that the L4 L5 level was the most addressed, followed by L3 L4 and L2 L3.^{17,18}

In a study conducted by Xie et al.,¹⁷ which utilized lateral oblique lateral interbody fusion with anterolateral supplementation, indirect decompression was achieved, evidenced by the increase in intervertebral disc height. Tomographic analyses showed consolidation in 61 of the 65 patients within the 12-month postoperative period, in addition to a significant increase in disc height and foraminal height, with the maintenance of these results throughout the observed period. In the present study, an average increase of 2.3 mm in the intervertebral space was verified compared to the postoperative period, suggesting indirect decompression.¹⁸ Another indication of this phenomenon was the clinical improvement of the patients, with no need for surgical revision due to the persistence of neurological symptoms. Additionally, in this study through radiographic images, although distinct from the measurement conducted by Xie et al.¹⁷, bone consolidation was revealed in 81.4% of the participants after twelve months of the surgical procedure.

In this analysis, there was an average increase of 4.4 degrees in segmental angulation (p -value = 0.002) and an average increase of 3.2 degrees at the operated level (p -value < 0.005), both measured by the Cobb angle. These results are in accordance with the findings of other studies, which, when investigating sagittal balance with different types of cages, reported an average increase of 4 degrees in lumbar lordosis and a satisfactory correction of sagittal balance when employing the OLIF technique. This correction was particularly evident when compared to patients undergoing arthrodesis with cages of the TLIF type, who did not demonstrate significant improvement in lordosis.^{18,19,20} On the other hand, the study by Emammi et al.²¹ found no significant difference between the preoperative and postoperative lumbar Cobb angles when comparing the XLIF and OLIF techniques.²⁰ In the present study, the significant increase in lumbar lordosis observed in the preoperative and postoperative periods suggests the effectiveness of OLIF arthrodesis associated with anterolateral supplementation in promoting changes in lumbar lordosis. This approach is relevant in surgeries that require an increase in lumbar lordosis to improve sagittal balance. The correction of lumbar lordosis plays an important role in optimizing the biomechanics of the spine, contributing to overall stability and potentially reducing the risks of complications related to sagittal decompensation.

Some studies address the biomechanical supplementation performed through anterolateral fixation in the vertebral body after

the insertion of the cage. However, the scarcity of robust scientific evidence limits the proper assessment of the effectiveness of this technique in vertebral stabilization. As reported in the research by Xin-Yi Cai et al.,²² the biomechanical analysis of segmental range of motion at critical stress points in fixation devices, including cages and cortical terminal plates, indicates that the prevention of mechanical stress associated with complications such as loss of disc height and subsidence of the cage is more effective with bilateral posterior pedicular supplementation compared to unilateral posterior fixation and lateral fixation with a plate.²¹ Despite these claims in the literature, the results of this research demonstrated, through the OLIF technique associated with anterolateral supplementation, an average increase of 2.3 mm in disc height (p -value < 0.001) and signs of consolidation in over 80% of patients within 12 months post-surgery, suggesting a possible efficiency of the technique discussed in this study. Furthermore, the data show that, although two individuals exhibited osteolysis and signs of cage subsidence, the majority of patients achieved a satisfactory clinical outcome, indicating that consolidation was attained in a large proportion of the analyzed cases.

A biomechanical study conducted by Pimenta et al.²³ compared specimens subjected to multidirectional flexibility tests, focusing on the width of the cages inserted via lateral approach and the differences between conventional transforaminal interbody fusion, with and without posterior fixation. The results indicated that cages with a width of 26 mm (XLIF) provided greater stability compared to cages of 18 mm (XLIF) and 11 mm (TLIF). These data suggest that wider lateral spacers exhibit superior biomechanical properties, potentially reducing the need for supplemental fixation.²² However, Marchi et al.²⁴ observed that other factors such as age over 61 years, female sex, presence of spondylolisthesis, and degenerative scoliosis are considered risks for subsidence when utilizing the XLIF technique.

Considering the same principles for anterior spinal fusion through the OLIF technique, the decision not to use supplemental fixation should be evaluated on an individual basis, as a score below 2 on the scale presented in the study by Marchi²⁴ is associated with a subsidence rate of 98% in the analyzed cases. Thus, it is inferred that the use of anterolateral supplementation associated with OLIF may be appropriate in selected cases, where there are favorable anatomical and physiological conditions for the application of the cage without the need for posterior pedicular fixation, such as the use of the implant with the largest possible width, absence of degenerative scoliosis, frank instability, grade I and II spondylolisthesis, as well as the care not to injure the terminal plate to avoid subsidence, or even inadvertent fracture of the terminal plate.^{25,26,27}

Previous studies suggest that the use of supplemental screws in the vertebral body (OLIF-VF) exhibits inferior biomechanical performance compared to pedicular screws (OLIF-PF). The meta-analysis conducted by Fátima et al.¹⁴ did not detect statistically significant differences in clinical and radiological aspects between patients subjected to both approaches. In executing this systematic review by Fátima et al.,¹⁴ five studies were analyzed, totaling 271 patients, which evaluated primary and secondary outcomes related to the fusion rate, intraoperative parameters, clinical reports from patients, and radiographic assessments.

The analysis of primary outcomes did not reveal statistical differences in fusion rates between the OLIF-VF and OLIF-PF techniques. However, secondary outcomes presented specific advantages associated with OLIF-VF, including lower intraoperative blood loss and a reduced duration of procedures compared to OLIF-PF. The outcomes reported by patients, which encompassed measures such as pain scales and functional assessments, as well as radiographic parameters, did not demonstrate significant differences between the two techniques. The present study revealed a significant improvement in lumbar pain (average from 8 points to 1.3) and in pain radiating to the lower limb (average from 7 to 2 points), measured by the Visual Analog Scale, in addition to a decrease in functional lumbar disability, which varied from severe to minimal, as measured by the Oswestry Disability Questionnaire.

This study achieved a fusion rate of 81.4% among patients, along with an increase in intervertebral height and lumbar lordosis. Although the technique was not directly compared with fixation using pedicle screws via the posterior approach, our results demonstrate significant clinical and radiological improvement compared with the preoperative condition, suggesting that anterolateral supplementation in the OLIF technique may constitute a viable option for the treatment of DDD.

Additionally, the study by Xie et al.,¹⁷ reported improvements in pain and functionality, as measured by the instruments used in this research. Pain assessment was conducted using the Visual Analog Scale (VAS) for the lumbar region and lower limbs, while the functionality of the lumbar spine was measured by the ODI scores. These findings corroborate the effectiveness of the adopted approach, suggesting that the technique not only alleviates pain but also promotes functional return, an important factor for the quality of life of patients.¹⁷ Other studies, such as that of Wei He et al.,¹⁸ demonstrated that the use of OLIF as a standalone technique can be as effective regarding pain and functionality criteria as the technique associated with pedicle screws via percutaneous approach. However, the standalone approach is not without complications. The risks associated with this technique, such as implant migration, cage subsidence, instability, loss of indirect decompression, and pseudoarthrosis, indicate the need for a judicious application of the isolated cage.¹⁸

Studies, such as the one conducted by Cheng et al.,⁴ identify cage subsidence as the main complication associated with oblique anterolateral fusion surgeries. In this analysis, despite the adoption of precautions, such as avoiding injury to the terminal plate and excessive distraction during the introduction of the cage, signs of osteolysis and subsidence were observed in 14.3% of cases. This incidence was particularly higher among older patients, corroborating the conclusions of the study de Kotheranurak et al.,²⁸ which identified that individuals over 60 years old, with reduced bone mineral density (values below -2.5), use of cages with excessive distraction of the intervertebral space, and severe degeneration of the multifidus muscles are the main risk factors for the occurrence of subsidence.^{26,27,29} These findings reinforce the importance of a thorough evaluation when considering surgery with the OLIF technique with anterolateral supplementation, especially in populations with greater fragility. The combination of factors such as female sex, advanced age, and low bone mineral density may compromise the stability of the cage, leading to complications that negatively impact clinical outcomes.

In this research, a general complication rate of approximately 13% was observed, with alterations in lymphatic function in one of the lower limbs and death due to pulmonary thromboembolism

in the postoperative period. Kliseley et al.³⁰ highlight that normal intervertebral discs in adults do not have lymphatic vessels; however, disc degeneration causes the growth of reparative fibrous tissue with lymphatic vessels.^{29,30,31} Some studies indicate the possibility of lymphatic injury and lymphocele in anterior lumbar surgeries. Schizas et al.³² discuss the anatomy of lymph nodes and lymphatic vessels, which, at the subdiaphragmatic level, run parallel to the venous system anterior to the spine, especially laterally to the left common iliac artery. These anatomical components are vulnerable to injury during the manipulation of the left ascending lumbar veins, especially during the exposure of the L3-L4 and L4-L5 intervertebral discs. The same author suggests the subcutaneous administration of a blue dye in the left foot, used in oncological surgical procedures, to facilitate the identification and preservation of these structures during dissection.

Deep vein thrombosis (DVT) and pulmonary thromboembolism (PTE), one of the complications found in this work, are possible conditions in anterior lumbar arthrodesis surgeries that utilize the retroperitoneal approach. As discussed by Reddy et al.,³³ the interaction of multiple risk factors, such as smoking, use of contraceptives, blood dyscrasia, ilioacaval compression syndrome (IVCS) along with manipulation and compression by retraction of the large vessels during surgical retraction may predispose patients to DVT/PTE.

This study presents some limitations, including the restricted sample and the short follow-up period. The exclusive use of X-rays, without the complement of tomography for the analysis of consolidation, may also be considered a limitation. Therefore, additional clinical studies will be necessary to allow for a more accurate assessment of long-term clinical and radiological outcomes.

Future research may include larger samples and prolonged follow-up, as well as the adoption of other methodologies, such as computed tomography, for a more detailed evaluation of consolidation, sagittal balance parameters, and associated complications. In this way, it will be possible to establish more robust guidelines for clinical practice, ensuring better outcomes for patients undergoing surgical interventions via OLIF with anterolateral supplementation.

CONCLUSION

The OLIF associated with anterolateral instrumentation promoted clinical and functional improvement in more than 80% of the evaluated patients. The procedure resulted in bone fusion in 81.4% of patients and an increase in lumbar lordosis by 4.4 degrees.

A higher prevalence of elderly women was observed, and the main complications associated with this type of implant were screw osteolysis and subsidence of the cage, with a tendency in patients over 63 years of age.

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. Condi FLF., Kulcheski AL., Santoro PG., Nanni FN., Benato ML., Graells XS: performing surgeries; Sebben AL: data analysis, first reviewer and performing surgeries; Kulcheski AL: final review, intellectual concept of the article and performing surgeries.

DATA AVAILABILITY DECLARATION

The underlying contents of the research text are contained in the manuscript.

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