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LATERAL EXTREME LUMBAR ARTHRODESIS: CONSOLIDATION AND COMPLICATIONS

ARTRODESE LOMBAR EXTREMO LATERAL: CONSOLIDAÇÃO E COMPLICAÇÕES

ARTRODESIS LUMBAR EXTREMO LATERAL: CONSOLIDACIÓN Y COMPLICACIONES

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ABSTRACT

Objective: This study evaluated the effectiveness of extreme-lateral arthrodesis (XLIF) in the lumbar spine, focusing on bone consolidation of the stand-alone XLIF implant and investigating associated complications. Methodology: This is an observational, cross-sectional, retrospective and quantitative study. Electronic medical records and X-ray images of patients with degenerative disc disease and chronic low back pain were reviewed, who underwent surgery using the XLIF technique with stand-alone interbody implants between L1 and L4, in a tertiary hospital, from 2022 to 2023. The sample included patients between 18 and 65 years old, with complete medical records and outpatient follow-up for at least 12 months. Results: 112 patients were analyzed, of which 35 were eligible, the majority were female (60%) and an average age of 53 years. During surgery, cases with anterior longitudinal ligament (ALL) injury and endplate injury, which progressed to posterior complementation, were excluded from the analysis. No patient showed posterior migration, and only 1 patient showed no consolidation on X-ray after 1 year. Conclusion: This study suggests the efficacy and safety of extreme-lateral arthrodesis (XLIF) in the consolidation of the lumbar spine, with low rates of complications and reoperations. ***Level of Evidence III; Systematic Review of Level III Study.***

Keywords: Spine; Low Back Pain; Arthrodesis.

RESUMO

Objetivo: Este estudo avaliou a efetividade da artrodese extremo-lateral (XLIF) na coluna lombar, focando na consolidação óssea do implante XLIF stand alone e investigando as complicações associadas. Metodologia: Trata-se de um estudo observacional, transversal, retrospectivo e quantitativo. Foram revisados prontuários eletrônicos e imagens de RX de pacientes com doença degenerativa discal e dor lombar crônica, que realizaram cirurgia com a técnica XLIF com implantes intersomáticos stand alone entre L1 e L4, em um hospital terciário, de 2022 a 2023. A amostra incluiu pacientes entre 18 e 65 anos, com prontuários completos e acompanhamento ambulatorial por pelo menos 12 meses. Resultados: Foram analisados 112 pacientes, com 35 elegíveis, a maioria do sexo feminino (60%) e idade média de 53 anos. Durante a cirurgia, casos com lesão do ligamento longitudinal anterior (LLA) e lesão da placa terminal, que evoluíram para complementação posterior, foram excluídos da análise. Nenhum paciente apresentou migração posterior, e apenas 1 paciente não mostrou consolidação no RX após 1 ano. Conclusão: Este estudo sugere a eficácia e segurança da artrodese extremo-lateral (XLIF) na consolidação da coluna lombar, com baixas taxas de complicações e reoperações. ***Nível de Evidência III; Revisão Sistemática de Estudo Nível III.***

Descritores: *Coluna Vertebral; Dor Lombar; Artrodese.*

RESUMEN

Objetivo: Este estudio evaluó la eficacia de la artrodesis extrema lateral (XLIF) en la columna lumbar, centrándose en la consolidación ósea del implante XLIF independiente e investigando las complicaciones asociadas. Metodología: Se trata de un estudio observacional, transversal, retrospectivo y cuantitativo. Se revisaron historias clínicas electrónicas e imágenes radiológicas de pacientes con enfermedad discal degenerativa y lumbalgia crónica, sometidos a cirugía mediante la técnica XLIF con implantes intersomáticos autónomos entre L1 y L4, en un hospital terciario, de 2022 a 2023. La muestra incluyó pacientes entre 18 y 65 años, con historia clínica completa y seguimiento ambulatorio durante al menos 12 meses. Resultados: Se analizaron 112 pacientes, de los cuales 35 fueron elegibles, la mayoría fueron del sexo femenino (60%) y una edad promedio de 53 años. Durante la cirugía, se excluyeron del análisis los casos con lesión del ligamento longitudinal anterior (LLA) y lesión de la placa terminal, que progresaron a complementación posterior. Ningún paciente mostró migración posterior y sólo 1 paciente no mostró consolidación en la radiografía después de 1 año. Conclusión: Este estudio sugiere la eficacia y seguridad de la artrodesis extrema lateral (XLIF) en la consolidación de la columna lumbar, con bajas tasas de complicaciones y reintervenciones. ***Nivel de Evidencia III; Revisión Sistemática del Estudio de Nivel III.***

Descriptores: *Columna Vertebral; Dolor de la Región Lumbar; Artrodesis.*

Study conducted by the Hospital do Trabalhador, located in Curitiba-PR, Brazil.
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INTRODUCTION

Thoracolumbar arthrodesis is a treatment option for many spinal pathologies that are refractory to conservative treatment. Among these pathologies, the most common are degenerative disc diseases, deformities, instabilities, among others.[1,2] The fusion between the vertebral bodies can be performed by introducing a structural device, called a Cage or intersomatic device, into the disc space. This implant can be inserted through various approaches in the spine, including anterior, posterolateral, transforaminal, and lateral approaches.[3]

Each approach for performing arthrodesis has its particularities. The most commonly used approach is the posterior approach; however, it has some disadvantages, such as the risk of direct injury to the dural sac or nerve roots, graft displacement, chronic dysfunction of the paravertebral muscles, and pseudarthrosis.[4] Thus, for the greater benefit of the patient, new technologies have developed and provided excellent results, as seen in the case of arthrodesis via the lateral approach.[5]

The extreme-lateral arthrodesis technique (XLIF - *eXtreme Lateral Interbody Fusion*), described by Ozgur and Pimenta in 2006, involves exposing the lateral surface of the disc through the psoas muscle.[6] It is a minimally invasive technique, using a lateral, retroperitoneal access, with a small surgical access (3 to 4 cm incisions), transpsoas, providing wide discectomy and fusion between vertebral bodies.[7] To prevent neurological injuries during passage through the psoas muscle, continuous intraoperative electroneuromiographic monitoring is performed.[8]

This approach provides good visibility of the discs between T12 and L5, although the L5/S1 level is not visible due to obstruction by the iliac crest.[9] Additionally, at more caudal levels, there is a more anterior path of the lumbar plexus and a more lateral path of the iliac vessels, determining the potential risk of injury to these structures.[9,10]

The main indications for the extreme-lateral arthrodesis technique include central or foraminal stenosis, degenerative disc disease, deformities in the sagittal and coronal planes, spondylolisthesis, and cases of pseudarthrosis, as an alternative access route not yet explored.[8-10]

The extreme-lateral arthrodesis technique without posterior supplementation consists of implanting the intersomatic device in the disc space without being fixed with pedicle screws via the posterior approach. The option without posterior supplementation has the potential to reduce surgical time, avoid the use of the posterior approach and its associated complications, as well as minimize blood loss. However, due to presenting lower stability, cases should be carefully selected in the preoperative period. We consider the following important factors to be taken into account: the presence of low bone mineral density, age over 65 years, female sex, the presence of deformities in the coronal and sagittal planes, and spondylolisthesis.[11,12]

This study aims to primarily evaluate the consolidation rates of the stand-alone XLIF implant in the lumbar spine and, as a secondary objective, to assess the complications associated with this technique.

METHODOLOGY

This is a longitudinal, retrospective study conducted in a tertiary hospital, a reference in high-complexity spinal surgeries. The research ethics committee approved it under number CAAE 77005924.5.0000.5225. Electronic medical records of patients undergoing lumbar arthrodesis via extreme lateral (XLIF), without supplementation with pedicle screws via the posterior approach, were reviewed between January 2022 and January 2023.

The surgical procedure was performed through a minimally invasive lateral retroperitoneal access, unique, with constant electroneuromiographic monitoring (Neurovision JJB NuVasive®, RJ, Brazil) and implants made of peek (polyetheretherketone) with a lordosis of 10 degrees (CoRoentXLNuVasive®, RJ, Brazil), performed at only one level of the lumbar spine, without subsequent supplementation via the posterior approach with pedicle screws.

Patients aged 18 to 65 years were included who had complete medical records containing epidemiological data, a description of the surgery, ~~and~~ regular outpatient follow-up for at least 12 months after the procedure. Patients with degenerative disc disease associated with more than 6 months of refractory symptoms of lumbosciatica, low back pain, or neurogenic claudication were submitted to surgical procedures. They were required to present anteroposterior and lateral lumbar spine X-rays in the immediate postoperative period and after one year of the surgical procedure.

Participants who did not belong to the studied age group, had incomplete data in their medical records, lost outpatient follow-up before completing one year, and underwent a surgical technique other than XLIF were excluded from the study. Cases in which anterior longitudinal ligament injury and/or terminal plate injury with evidence of intraoperative subsidence or in the immediate postoperative X-ray (Figure 1) were identified were excluded, as these patients were eligible for supplementation with pedicle screws via the posterior approach. Cases of spondylolisthesis, osteoporosis confirmed by bone mineral density examination, primary or metastatic tumors in the spine, and infections in the spine such as spondylodiscitis were also excluded as they did not present indications for lateral arthrodesis or were candidates for lateral arthrodesis with supplementation with pedicle screws via the posterior approach initially.

Surgical descriptions were evaluated to record the laterality of the access performed, the fused levels, as well as the presence of complications during the procedure, such as anterior longitudinal ligament injury, vertebral terminal plate injury, vascular and visceral injuries.

X-rays were analyzed in the immediate postoperative period and after 12 months of the surgical procedure. Anteroposterior and lateral incidences were used, with the patient in an orthostatic position, weight equally distributed on both feet, and the X-ray beam directed perpendicular to the midpoint of the film, with a focus-film distance of 100 to 150 cm. X-rays were analyzed for the presence of subsidence and the implant's positioning in the immediate postoperative period.

The radiographic analysis performed 12 months after surgery aimed to verify any possible migrations of the implant. In addition, dynamic examinations in flexion and extension were conducted to assess whether there was an increase in the interspinous space. The presence of radiolucency between the implant-bone interface and the presence of intra-cage bone trabeculation were also evaluated.

Therefore, the presence of radiolucency between the implant and bone and the opening of the interspinous space greater than 2 mm, at the midpoint between the adjacent spinous processes,

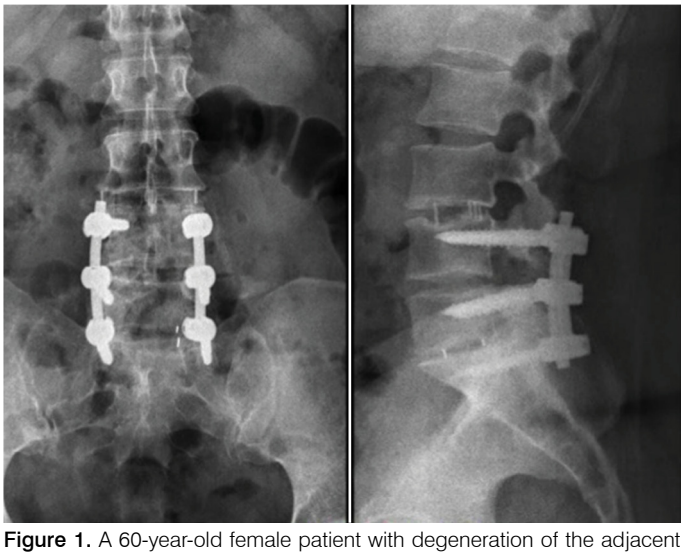

Figure 1. A 60-year-old female patient with degeneration of the adjacent level L3-L4 undergoing XLIF stand-alone surgery, with verification of subsidence in the immediate postoperative period.

was considered non-bone consolidation (pseudoarthrosis). When there was no radiolucency between the implant-bone interface, the presence of intra-cage bone trabeculation, and there was no opening of the interspinous space >2mm, it was considered consolidated.[13,14]

The evaluated variables were presented in tables with absolute and relative frequency distribution. The normality of the variables was assessed using the Shapiro-Wilk test, and associations were evaluated using Pearson's Chi-Square test or Fisher's exact test as necessary. All analyses were performed with a significance level of 5%. The collected information formed a database developed in the Excel® for Windows program, and the statistical analysis was performed using the *SPSS® 26.0* software.

RESULTS

A total of 112 patients were analyzed, of which 34 met the eligibility criteria. Based on analyses, 40 patients who had undergone two or more disc levels were excluded, 10 patients with incomplete follow-up, 15 patients over 70 years old or diagnosed with osteoporosis with bone densitometry, three patients with spondylodiscitis, and nine patients who required subsequent supplementation due to subsidence or injury to the anterior longitudinal ligament were excluded. (Figure 2)

The majority of patients were female, totaling 19 (55.88%), while male patients comprised 15 (44.11%). The average age of the patients was 53 years, ranging from 25 to 69 years for females and from 38 to 70 years for males. Thus, the most observed age group was between 40 and 50 years, followed by patients between 50 and 60 years.

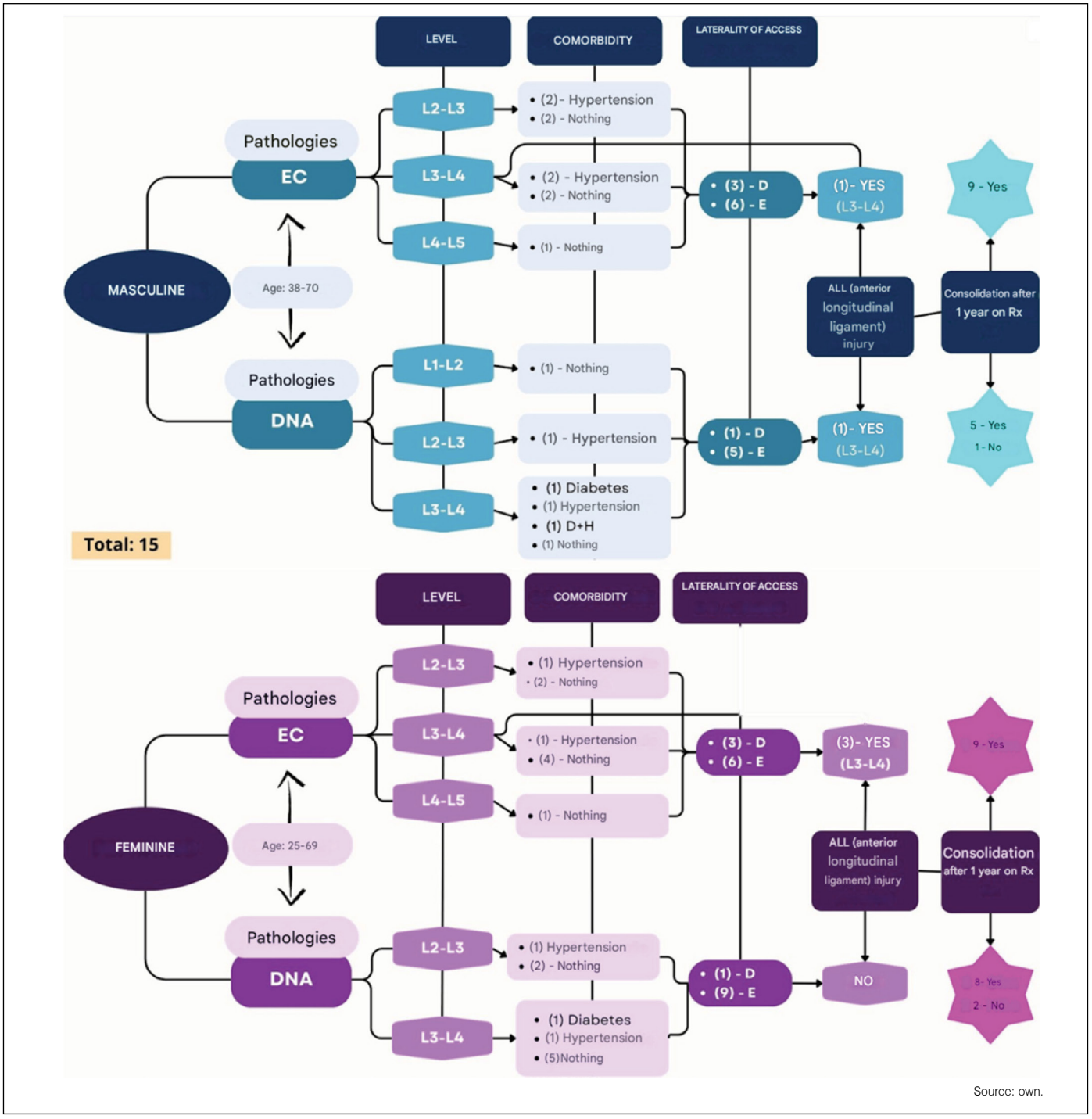

Figure 2. Flowchart outlining relevant information for patients eligible for treatment.

The most addressed level was L3-L4, with 20 patients, followed by the L2-L3 level with 14 patients. With a preferred entry route through the left lateral side (68%), the main indication for this choice is the specific anatomy of the lumbar spine. Among these levels, the most prevalent was canal and foraminal stenosis (70%), followed by pseudoarthrosis (20%).

After the necessary observations, it was found that, after 12 months, bone consolidation was evidenced in 34 patients, with only one case requiring subsequent supplementation due to subsidence on the X-ray during this period. This supplementation was performed using pedicle screws. The specific anatomy of the lumbar spine determined the choice of the left lateral entry route (68%).

There were no reports of complications such as visceral organ injury, vascular injury, or ureter injury, nor the need for surgical abdominal exploration after the procedure. However, 5 patients were recorded with anterior longitudinal ligament injury and 4 patients with terminal plate injury during the intraoperative period. These cases were promptly scheduled for posterior supplementation with pedicle screws and were soon removed from the study analysis.

DISCUSSION

The lateral transpsoas intersomatic fusion technique offers several benefits, including indirect decompression of neural components while preserving the anterior and posterior longitudinal ligaments. It also corrects sagittal and coronal alignment of the spine, without damaging the paravertebral muscles.[15] Furthermore, it provides early mobility and high fusion rates.[16,17]

On the other hand, it presents risks and complications, which include nerve injuries, vascular injuries, intestinal perforations, postoperative paralytic ileus, seroma formation, pseudoarthrosis, subsidence, and the need for reoperations.[18-20] The main risks include neurological injuries related to nerves of the lumbar plexus, ilioinguinal, iliohypogastric, genitofemoral, and lateral femoral cutaneous and subcostal nerves.[16,17] Risks involving injuries to the sacral plexus, especially at the L4/L5 level, and vascular injuries, which can present rates between 0.03% to 0.4%.[21]

The analysis of the data revealed a higher prevalence of female patients and a more common age range between 40 and 60 years. The most addressed levels were L3-L4 and L2-L3, and most procedures were performed via the left lateral approach. These findings align with previous studies, demonstrating a consistent trend in clinical practice. Following the findings of Lamartina and Berjano, a considerable incidence of LLA was found in our group of patients undergoing fusion in the prone position. This suggests that the patient's position during the surgical procedure may be a significant risk factor for anterior ligament rupture. However, while Lamartina and Berjano identified LLA rupture as a specific complication requiring additional intervention, such as the insertion of a cage with screw fixation, our surgical approach and treatment technique differed in some aspects.[9,18,21]

A multicenter study in Italy revealed an overall complication rate of XLIF of 5.07%, with more severe complications representing 0.7722%.[20] Severe complications involved events such as intestinal perforation, injury to the common iliac vein, migration of the implant requiring additional intervention, fractures below the device with loss of anterior column support, pneumoretroperitoneum, incisional hernia, infection in the intersomatic space requiring implant removal, debridement, reconstruction with titanium spacers and grafts, in addition to antibiotic treatment. Other mentioned complications included hematoma in the psoas muscle, causing permanent neurological deficit in the lumbar plexus, late neuralgia in the abdominal wall, and malposition of the cage at the L3-L4 root.[21]

In this present study, there were no complications of vascular injuries or injuries to abdominal viscera, nor was there any case requiring surgical intervention for post-infectious debridement. The complications identified in our research, totaling 14.70%, were related to injuries in the LLA (anterior longitudinal ligament), all of which occurred in surgeries involving the L3-L4 region. This may be attributed to the high complexity associated with this surgical procedure.

Furthermore, the surgical procedure was more frequently performed at the L3-L4 and L2-L3 levels. Lamartina and Berjano[9] chose the transpsoas approach, considering the width of the neurovascular window and/or the coronal inclination of the disc space, with special attention to the L4-L5 disc. By opting for this surgery, it is expected to achieve results such as improved vertebral stability, pain relief, a faster recovery, and a lower risk of complications compared to conventional surgical approaches.

The decision to opt for the left side in 76.4705% of cases was based on the anatomy of the spine, including the location of the common iliac artery and the lumbar plexus, which may favor the left-sided approach. Furthermore, access to the desired intervertebral disc may be safer and more direct from the left side, considering the arrangement of abdominal organs and blood vessels. The agreement of the low complication rates found in this study with the reviewed literature stands out, especially the results presented in the study by Lazzari et al.[18,19] This highlights the importance of proper surgical technique, careful selection of implants, and an individualized approach for each patient, aiming to minimize risks and optimize clinical outcomes.[18]

The XLIF offers stability in both the sagittal and coronal planes, exhibiting less restriction of movement in the sagittal plane and also allowing for subsequent completions through the same access. However, posterior fixation is not without risks, such as improper positioning of pedicle screws and wound infections. However, when performed in isolation, the procedure can reduce these risks.[19] Research highlights the relevance of careful selection of implants to prevent displacements, such as using wider implants, for example. Specific algorithms for the use of stand-alone intersomatic devices guide the choice of method and patient selection.[18,19]

When analyzing the data, no evidence of posterior migration was observed. Most presented radiographic consolidation one year after surgery. There was no consolidation in one case due to factors such as diabetes, elderly bone fragility, and a smaller implant. As shown in Figure 3, the evolution of the consolidation process of the extreme lateral cage can be observed over the 12-month follow-up period. The images obtained in dynamic incidence demonstrate the progressive stability of the implanted structure, contributing to the analysis of the effectiveness of the procedure over time.

Over time, there has been an increasing search for less invasive and more effective surgical techniques in correcting deformities. This occurs, especially considering the primary situations in which the use of intersomatic devices, with or without structured grafts, is indicated, such as in cases of degenerative diseases, neoplasms, infections, and deformities.[20]

Among the methods developed for the insertion of intersomatic devices, anterolateral approaches represent the most recent, distinguishing themselves by having a lower risk of injury to neurological structures. Additionally, the preservation of posterior structures results in reduced surgical times and practically insignificant bleeding.[22]

When the surgical approach is conducted exclusively with the use of the intersomatic device, without the addition of posterior fixation, it is not advisable in patients with instability and other adjacent deformities due to high biomechanical stress. However, there are reports of favorable results, with low complication rates, in the treatment of conditions such as spondylolisthesis, using intersomatic devices via transpsoas without posterior supplementation.[19]

According to the examinations performed, it was found that the psoas muscle was in unfavorable conditions. Most of the identified degenerations occurred after the L4-L5 and L5-S1 arthrodesis. As a consequence, subsequent degeneration occurred at the L3-L4 level. The study was conducted with people in unfavorable situations. Most of the degeneration occurred after the L4-L5-S1 arthrodesis, subsequently resulting in degeneration at L3-L4. Therefore, these are the significant limitations of the present study.

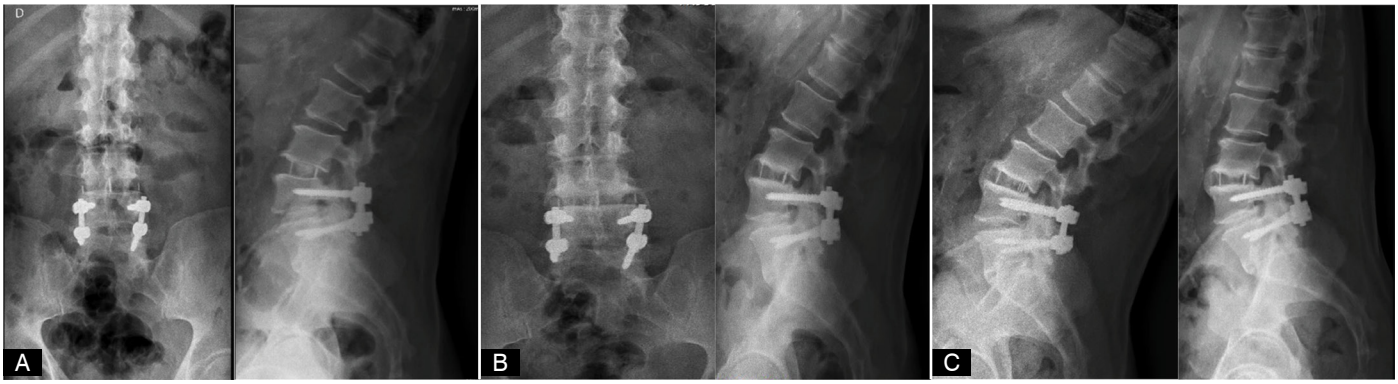

Figure 3. Immediate postoperative X-ray. B) After 12 months, evidence of bone consolidation around the implant. C) X-ray with dynamic profile incidence demonstrating bone consolidation.

CONCLUSION

This study suggests the efficacy and safety of extreme-lateral arthrodesis (XLIF) in lumbar spine consolidation, with low rates of complications and reoperations. The results underscore the importance of carefully selecting patients, taking into account factors such as age and osteoporosis. The absence of significant complications reinforces the safety of the technique, which proves to be a safe and effective option, particularly when employed with a personalized approach.

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 manuscript. The study was conceived by ALK and ALS, while the overall coordination of the work was the responsibility of XSIG. The writing of the text had the main contributions of ASA, ALS, XSIG and PGDS. The surgical procedures, as well as the monitoring and collection of clinical data, were conducted by ASA, ALS, XSIG and PGDS. The statistical analysis and interpretation of the data were performed by FNN. The literature search, critical review of the content and contributions to the intellectual concept of the study were carried out by MLB, ASA and FNN. The final review and editing of the manuscript were carried out by all authors.

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