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# The crooked tree

## Carlos María Autorino

*Hospital Universitario Austral*  
*Head of the Department of Orthopedics and Traumatology (2000-2023)*  
*Consultant (since 2023)*  
*Universidad Austral School of Biomedical Sciences*  
*Professor of Orthopedics and Traumatology*  
*Director of the OT Specialization Program*  
*Asociación Argentina para el Estudio de la Cadera y la Rodilla*  
*Accredited Member. Honorary Member. Former President (2012-2013)*  
*Asociación Argentina de Ortopedia y Traumatología*  
*Consulting Specialist. Presidente (2024)*



## A tree

Since ancient times, the tree has symbolized defined circumstances for human beings. Thus, it is possible to establish analogies with personal, family, social, and academic structures.

The **roots**, either hidden underground or, depending on the plant species, partially visible, are the body's sustenance. They symbolize the founding principles.

The **trunk** represents the column that supports and contains the nutritive ducts. In some species, it is erect, in others, it is curved and at the same time elastic: in both cases, solid. It symbolizes organizational stability.

**Leaves** are a source of shade. They symbolize immanent protection; we will find shelter beneath them. Their temporary color change and fall identify natural cycles.

The **branches**, temporarily bare, represent the autumn; definitely bare, the final drought.

The **fruits** symbolize seasonality and the bounty of providence.

“Ye shall know them by their fruits. Do men gather grapes of thorns, or figs of thistles? Even so every good tree bringeth forth good fruit; but a corrupt tree bringeth forth evil fruit. A good tree cannot bring forth evil fruit, neither can a corrupt tree bring forth good fruit. Every tree that bringeth not forth good fruit is hewn down, and cast into the fire. Wherefore by their fruits ye shall know them.”

## A logo

A logo is a distinctive graphic symbol for a company, commemoration, brand, or product.

What is the Asociación Argentina de Ortopedia y Traumatología logo's distinctive tree?

- The roots are hidden.
- The trunk is crooked, braced to a stake.
- No fruits are visible.

I will try to answer the following question:

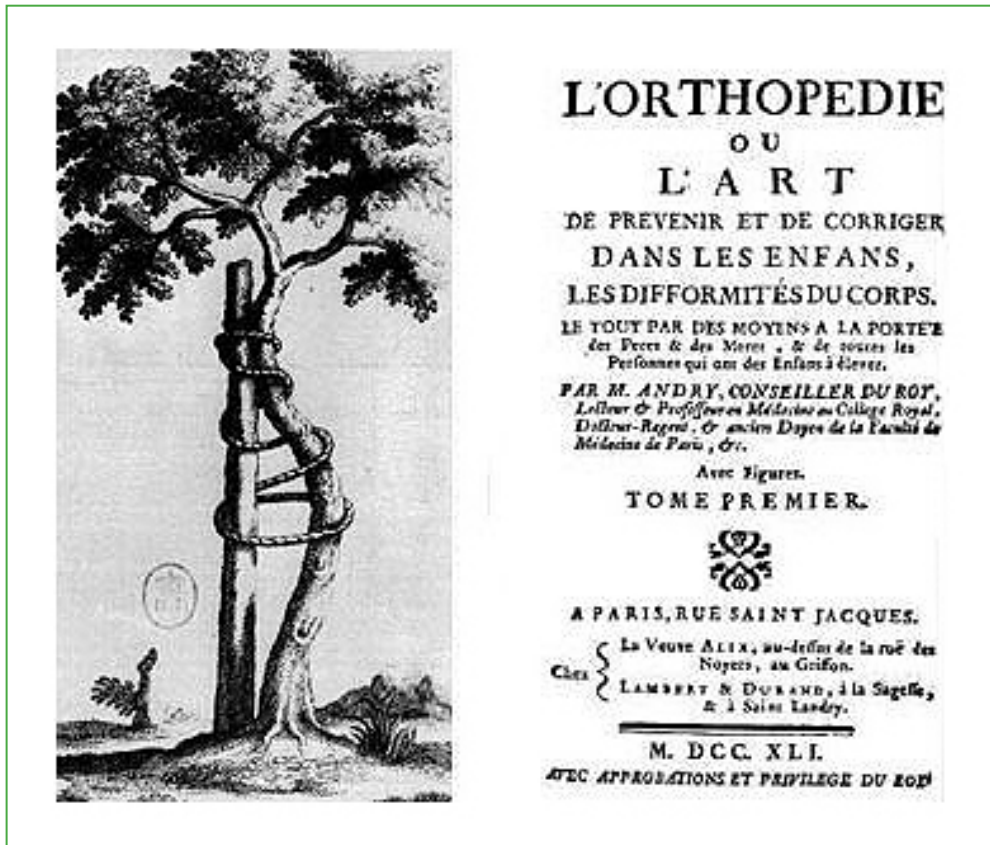
**Is the current AAOT logo representative of its background, role and strategic vision?**

## Origin of the AAOT logo

Nicolas Andry de Boisregard (Lyon 1658-Paris 1742) published in 1741 his work *L'Orthopédie, ou l'Art de prévenir et de corriger dans les enfants les difformités du corps* (*Orthopaedia: Or, the Art of Correcting and Preventing Deformities in Children*) (Figure).

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**How to cite this article:** Autorino CM. The crooked tree. *Rev Asoc Argent Ortop Traumatol* 2024;89(1):1-4. <https://doi.org/10.15417/issn.1852-7434.2024.89.1.1919>



The name ‘Orthopedics’ originates by linking two words of Greek origin: ὀρθός *orthos* (“correct”, “straight”) and παιδεία *paideia* (“education or training”).

The image chosen by the author to symbolize “the correction and prevention of deformities in children” is precisely the one adopted two centuries later by the AAOT.

In sum, **in Nicholas Andry’s original conception, the “crooked tree” conceptually represented deformity.** It was not intended to identify a curriculum, a training level qualification, a Code of Ethics, or an Association.

### AAOT Background

**The title of this Editorial is not intended to be derogatory, far from it:**

- I love the specialty and devote my life to it.

I entered medical school with a definite vocation to become an orthopedist. As a child, I witnessed my father’s (an exponent of the Finochietto School, one of the founders of the Specialty at the Cosme Argerich Hospital) commitment to serving those in need and continuing his training every day.

- I respect the AAOT and the separate entities that stem from the original trunk.

I am concerned about any distortions in ethical professional practice.

### I propose to reflect on fundamental milestones in the historical evolution of the AAOT

Until the first part of the twentieth century, Orthopedics and Traumatology were unified, both clinically and academically, into the Clinical Surgery Services. In 1922, the Chair of our specialty was created at the School of Medicine of the University of Buenos Aires.

Second quarter of the 20th century:

On May 8, 1936, the *Sociedad Argentina de Cirugía Ortopédica* (Argentine Society of Orthopedic Surgery) was created. In 1949, the institutional name was changed to *Sociedad Argentina de Ortopedia y Traumatología* (SAOT).

**The specialty was no longer part of Clinical Surgery, but rather recognized as an independent specialty with its own set of theoretical training and skill acquisition requirements.**

On July 13, 1982, the *Asociación Argentina de Ortopedia y Traumatología* (Argentine Association of Orthopedics and Traumatology - AAOT) was founded.

<b>Sociedad Argentina de Cirugía Ortopédica</b>		<b>1936</b>
<b>Sociedad Argentina de Ortopedia y Traumatología</b>		<b>1949</b>
SAMECIPP	Leg, ankle and foot	1969
AACM	Hand and Upper Limb	1974
SAPCV	Spine	1976
SAOTI	Pediatric orthopedics	1979
<b>AAOT</b>	<b>Asociación Argentina de OT</b>	<b>1982</b>
ACARO	Hip and Knee	1983
AATD	Sports	1986
AAA	Arthroscopy	1987
ASAMI	Lengthening and reconstruction	1989
AAHC	Shoulder and Elbow	1992
AATO	Trauma	1994
AAOO	Orthopedic oncology	1994
SANEO	Neuro orthopedics	1996
AAOT	Trade union	2021

### The “crooked tree”

Based on the above, I believe that **the AAOT logo does not objectively represent the historical essence of the institution: the roots are hidden, the trunk is weak, there are no fruits.**

On the contrary, the AAOT tree has evidently been healthy and has provided abundant and good fruits.

The originally named ‘Guest’ and then ‘Member’ Associations originated within the AAOT, but they are no longer identified in the same way. Following the current denomination in Spain, it is reasonable to recognize them as ‘Monographic’.

When compared to a family, the AAOT is similar to a vital paterfamilias who has been prolific and generous. Its offspring (the ‘Monographic’ societies) are already qualified entities in advanced post-basic specialized training. They are similar to grown children who leave their parents’ homes to forge their own path while maintaining the family bond.

The AAOT continues to bear fruit:

- The AAOT has concentrated its work on guiding and consolidating the training stages in the basic and post-basic specialty,
- the AAOT has led the standardization of a Reference Framework,
- The AAOT attracts colleagues from other latitudes to train in Argentina,
- the Library, the Journal and the Congress are national and regional references,
- The Skills Committee has consolidated a repertoire of workshops of great educational value,
- The Association directs the implementation of legitimate policies and collective action measures in defense of shared interests, in accordance with current regulations.

*Guild* is not intrinsically a bad word. Neither is *union*.

In terms of national life, the front pages of newspapers have repeatedly served as examples of **what not** to be. Those who walk the streets of Florence recognize in their names the guilds that existed in Dante’s day.

Anyone who passes through Salzburg and other historical European cities recognizes the guild banners in the bars. These were then used to identify primitive Masonic lodges; this is not surprising given that *maçon* is the French term for masons.

When I think of an exemplary leader (it is very difficult for me to identify a contemporary Argentinian one), I immediately think of Lech Walesa, former President of Poland and a fervent Catholic. He was a shipyard electrician who led the Union after working during the day.

His role was instrumental in the fall of communism in Poland. It was not in vain that the great Saint John Paul II trusted him and rewarded him with his friendship.

Being an orthopedist entails not just implanting prostheses, but also **working with patients**.

Since the beginning of my professional practice, my family's livelihood has been based on my work. I personally experienced severe problems in overcoming the last 7 to 10 days of the month when patacones were in circulation and there was hyperinflation. I overcame this difficult situation with the help of my wife and by working harder, sometimes to the point where my eyelids collapsed while holding retractors. Today, I reflect on how helpful a trade union would have been back then.

Before I say goodbye, I would like to share with the reader a memory of my youth. My father, an exemplary person, was a personal friend of one of the founding members of the *Asociación Argentina de Anestesia, Analgesia y Reanimación* (Argentine Association of Anesthesia, Analgesia, and Resuscitation).

At the time, professional practice consisted of hospital mornings (many years without an appointment) and private office afternoons. This anesthesiologist had been criticized by colleagues for leading a project with a holistic perspective that included, as I mentioned before, *working with patients* in addition to medical care. **Today, I see him as a role model.**

*I thank my parents for the example they have set for me since I was a child.*

*I thank my wife and daughters for their love and patience.*

# The Pursuit of Excellence

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Every academic institution's activities are supported by at least three main pillars: education, community outreach, and research.

The first spine society in Latin America, Sociedad Argentina de Patología de la Columna Vertebral (SAPCV), has a long educational trajectory in the field. This includes biannual courses, ongoing physician training in accredited services, and classroom and online training activities both within and outside of SAPCV and AAOT congresses.

The second pillar, community outreach, was historically limited to the care provided to our patients. However, since 2022, we have embraced a new paradigm in this area. We incorporated communication professionals, renewed our image, website and social media, and got involved with the community to carry out prevention activities. We instituted the "Spine Week and Day" to commemorate the founding date of our Society. We brought together prominent figures from the arts, sports, and other fields to launch preventive campaigns and raise awareness. I must say that it was a success, and the current president, Dr. Pablo Plater, has ensured its continuation.

The third pillar is clinical and laboratory research conducted by our members, the results of which are presented in publications and at congresses. We encourage communication in our language on the results obtained, make tenure more accessible to accredited members, and increase the amount of time spent on scientific paper presentations at congresses. This resulted in a historic record of over 120 works received, including award-winning papers, presentations, and posters. This prompted the AAOT Journal's Editorial Committee to provide us with the exceptional opportunity to publish an exclusive issue on spine, so the Board of Directors immediately began working on this project, which has resulted in an excellent quality issue.

Without intending to, this is my final task as President of the SAPCV and marks the transition of authority to the new Board of Directors.

I would like to acknowledge the Editor and my personal friend, Dr. Ernesto Bersusky, and the young and brilliant spine specialist, Dr. Guillermo Ricciardi, as well as all of the journal's physicians and staff, for their daily efforts to provide us with quality readings in the orthopedic field.

I hope you enjoy this issue as much as I did.

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**How to cite this article:** Sarotto AJ. The Pursuit of Excellence. *Rev Asoc Argent Ortop Traumatol* 2024;89(1):5. <https://doi.org/10.15417/issn.1852-7434.2024.89.1.1865>

# Initial Clinical Signs of Naka's Grade III Lumbar Epidural Lipomatosis: A Case Series

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## ABSTRACT

**Introduction:** Spinal epidural lipomatosis (SEL) is a rare pathology characterized by the overgrowth of nonencapsulated adipose tissue within the epidural space. This generates spinal stenosis, which might result in compression symptoms. The typical presentation is insidious pain that lasts months or years. The objective of this study was to carry out a descriptive analysis of the initial clinical signs of patients with Naka's grade III Lumbar SEL. **Materials and Methods:** Retrospective observational study in the Spinal Pathology Unit of 4 institutions, from 2010 to 2023. Patients over the age of 18, of both sexes, who consulted for low back pain with or without radiation and presented Naka's grade III lumbar lipomatosis on magnetic resonance imaging (MRI) were included. **Results:** We included 40 patients, with a mean age of 62.5 years; 75% were obese, there were no smokers. The most frequent reason for consultation was low back pain, with a median duration of 5.5 months. **Conclusion:** The most common reason for consultation was low back pain, with the exception of L3-S1 level involvement, which caused lumbar pain with radiation to the thigh. Patients with a longer period of pain (>6 months) were younger and had a lower BMI; although this was not statistically significant.

**Keywords:** Lumbar epidural lipomatosis, low back pain, clinical signs

**Level of Evidence:** IV

## Manifestación clínica inicial de la lipomatosis epidural lumbar grado III de Naka: serie de casos

## RESUMEN

**Introducción:** La lipomatosis epidural espinal es una enfermedad infrecuente caracterizada por el sobrecrecimiento del tejido adiposo no encapsulado dentro del espacio epidural. Esto genera una estenosis del conducto espinal que puede provocar sintomatología compresiva. La presentación típica es insidiosa a lo largo de meses o años. El objetivo de este estudio fue realizar un análisis descriptivo de la manifestación clínica inicial en pacientes con lipomatosis epidural espinal grado III de Naka. **Materiales y Métodos:** Estudio observacional retrospectivo en la Unidad de Patología Espinal de 4 instituciones, de 2010 a 2023. Se incluyó a pacientes >18 años, de ambos sexos, que acudieron por dolor lumbar con irradiación o sin irradiación, y presentaban lipomatosis lumbar Naka III en la resonancia magnética. **Resultados:** Se incorporó a 40 pacientes (edad promedio 62.5 años). El 75% era obeso, ninguno era fumador. El motivo de consulta más frecuente fue lumbalgia, con una mediana de evolución del dolor de 5.5 meses. **Conclusión:** La lumbalgia fue la consulta más frecuente, con excepción del compromiso de L3-S1 que fue la lumbocrualgia. Los pacientes que sufrieron dolor más tiempo (>6 meses) eran más jóvenes y tenían un índice de masa corporal menor; sin embargo, no resultó estadísticamente significativo.

**Palabras clave:** Lipomatosis epidural lumbar; lumbalgia; manifestaciones clínicas.

**Nivel de Evidencia:** IV

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**How to cite this article:** Erausquin TI, Rosado Pardo JA, Vital JM, Sarotto AJ, Besse M. Initial Clinical Signs of Naka's Grade III Lumbar Epidural Lipomatosis: A Case Series *Rev Asoc Argent Ortop Traumatol* 2024;89(1):6-14. <https://doi.org/10.15417/issn.1852-7434.2024.89.1.1808>

## INTRODUCTION

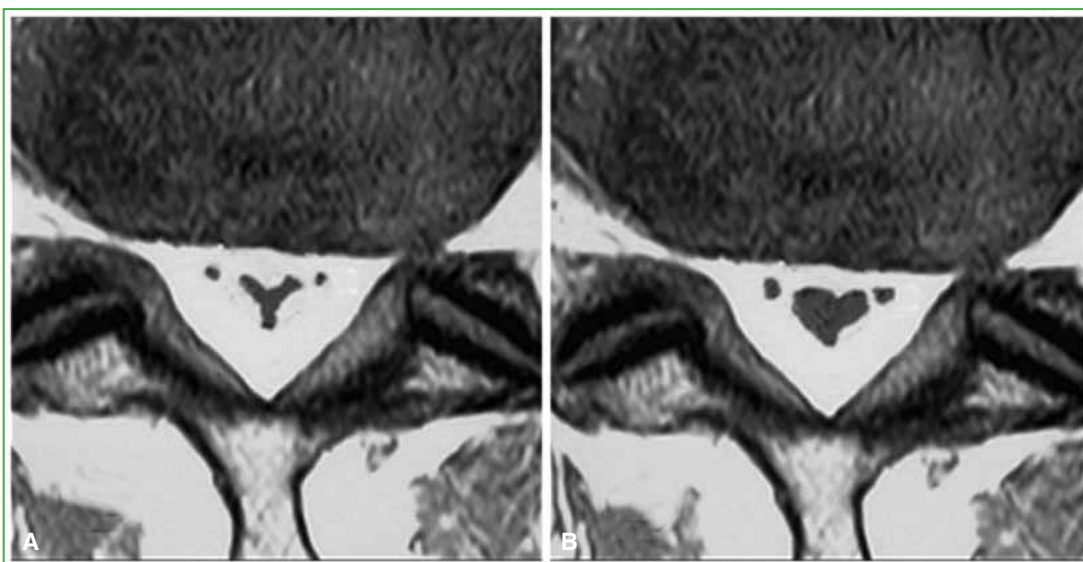
The epidural space is located between the dural sac and the spinal walls. It is a virtual space occupied by fat and veins extending from the foramen magnum to the distal end of the spinal canal.<sup>1-3</sup> Spinal epidural lipomatosis (SEL) is a rare disease characterized by overgrowth of unencapsulated adipose tissue within the epidural space. This generates spinal canal stenosis, which can cause compressive symptomatology.<sup>3-5</sup>

The first case of symptomatic SEL was described by Lee et al.<sup>5</sup> in 1975 in a kidney transplant patient who had received prolonged corticosteroid treatment. The prevalence is 1.1-21%, it predominates in males and patients with obesity, and is infrequent in the pediatric population.<sup>4,6-10</sup> The highly variable incidence is probably due to different diagnostic criteria. Borré<sup>8</sup> describes a mild overgrowth as SEL grade 1, while in more recent studies, the diagnosis is stricter, with SEL being considered in the presence of an evident adipose overgrowth.<sup>6,7,8</sup>

It may be idiopathic or associated with an excess of endogenous or exogenous corticosteroids. The most common form (26-50%) is associated with prolonged treatment with corticosteroids. Some conditions related to corticotherapy are: organ transplantation, autoimmune diseases, multiple sclerosis, diabetes mellitus, ulcerative colitis, and Crohn's disease.<sup>7,10-15</sup> The excess of endogenous corticosteroids causes a low percentage of SEL (3%), and is associated with diseases that generate hypercortisolemia, such as Cushing syndrome, hypothyroidism, prolactinoma, etc. The idiopathic form (17%) is that of unknown cause, in patients who were not exposed to excess corticosteroids, nor have obesity. Obesity is the most common cause of SEL when corticosteroid use is excluded (24.5%).<sup>10-16</sup>

The typical presentation is insidious over months or years. Lumbar or thoracic pain usually precedes the rest of the symptoms; exceptionally, patients may develop acute symptoms, and present with compressive symptoms, such as myelopathy, radiculopathy and, on rare occasions, as cauda equina syndrome. This variable presentation is largely related to the accumulation of adipose tissue in different locations of the spinal canal.<sup>16-19</sup>

Magnetic resonance imaging (MRI) is the preferred method of diagnosis; the images typically show hyperintense tissue in the posterior epidural space in the T1 sequence, intermediate signal in the T2 sequence and hypointense with fat suppression, which is characteristic of fatty tissue.<sup>14,20-23</sup> The typical image in the axial section was described by Kuhn et al.<sup>2</sup> as the 'Y' sign by circumferential compression of the dural sac at the lumbar level. Borré et al.<sup>8</sup> and Naka et al.<sup>21</sup> propose different gradings for SEL, where grade III is the most severe and symptomatic, and the characteristic 'Y' image is usually observed (Figures 1 and 2).



**Figure 1.** MRI of the lumbar spine, axial T1 sequence, axial slices. Fat accumulation in the L5-S1 intervertebral disc. A. 'Y' shape. B. Polygonal shape.



**Figure 2.** Classification of epidural lipomatosis according to Naka et al. MRI of the lumbar spine, T1 sequence, sagittal slices. **A.** Grade I, the fat is located between the indicated line and the extremities of the neighboring posterior arches (arrow). **B.** Grade II, the fat crosses the line, but is located between the extremities of the posterior arches (arrowheads). **C.** Grade III, fat crosses the line (arrowhead) and is seen over the extremes of the arches (arrows).

Since not all patients with grades I and II are symptomatic, SEL may be an incidental finding. For this reason, the aim of this study was to perform a descriptive analysis of the initial clinical manifestations of patients with Naka grade III lumbar spinal epidural lipomatosis (LEL).

## MATERIALS AND METHODS

An observational, descriptive, retrospective study was conducted in the Spinal Pathology Unit of four institutions between January 2010 and January 2023. We included patients >18 years of age of both sexes who presented with low back pain with or without radiation, and had Naka grade III LEL on MRI.

Patients receiving corticosteroids, those suffering from endocrinopathies with cortisol alterations, those who discontinued follow-up or had incomplete records, and those with extradural disease, such as hematomas, angioliomas or epidural metastasis, were excluded.

### Data collection

Data collection was based on an exhaustive analysis of office medical records and the imaging archives of the institutions. Those who met the inclusion criteria were incorporated into a database developed by the same researchers from the medical records. The variables recorded included clinical parameters (age, sex, body mass index [BMI], comorbidities), imaging parameters (level affected on MRI), and symptomatic presentation parameters (reason for consultation, period of evolution).

The images were evaluated by two senior members of the team.

### Ethical considerations

This study was approved by the corresponding Ethics and Research Committee of each institution. Given the retrospective nature of the study, participants' informed consent was not needed, and personally identifiable information was protected by coding it in a database to which only the investigators had access.

## Statistical Analysis

Categorical variables are expressed as absolute number of presentation and percentage. Continuous variables that had a normal distribution are presented as mean and standard deviation; otherwise, as median and interquartile range (IQR). The Shapiro-Wilk test was used to verify the distribution of the sample.

Comparison of pre- and postintervention pain was performed with Student's t test for related samples or Wilcoxon signed-rank test for related samples, as appropriate. Comparisons between independent variable groups were performed with Student's t test for independent samples or the Mann-Whitney U test, as appropriate.

Data were analyzed using the IBM SPSS Macintosh program, version 24.0 (IBM Corp., Armonk, NY, USA).

## RESULTS

Forty patients with Naka grade 3 LEL who presented for consultation to the spinal pathology team due to pain were included. Ten (25%) were women. The average age was  $62.5 \pm 12.9$  years, none were smokers. The rest of the characteristics are detailed in [Table 1](#).

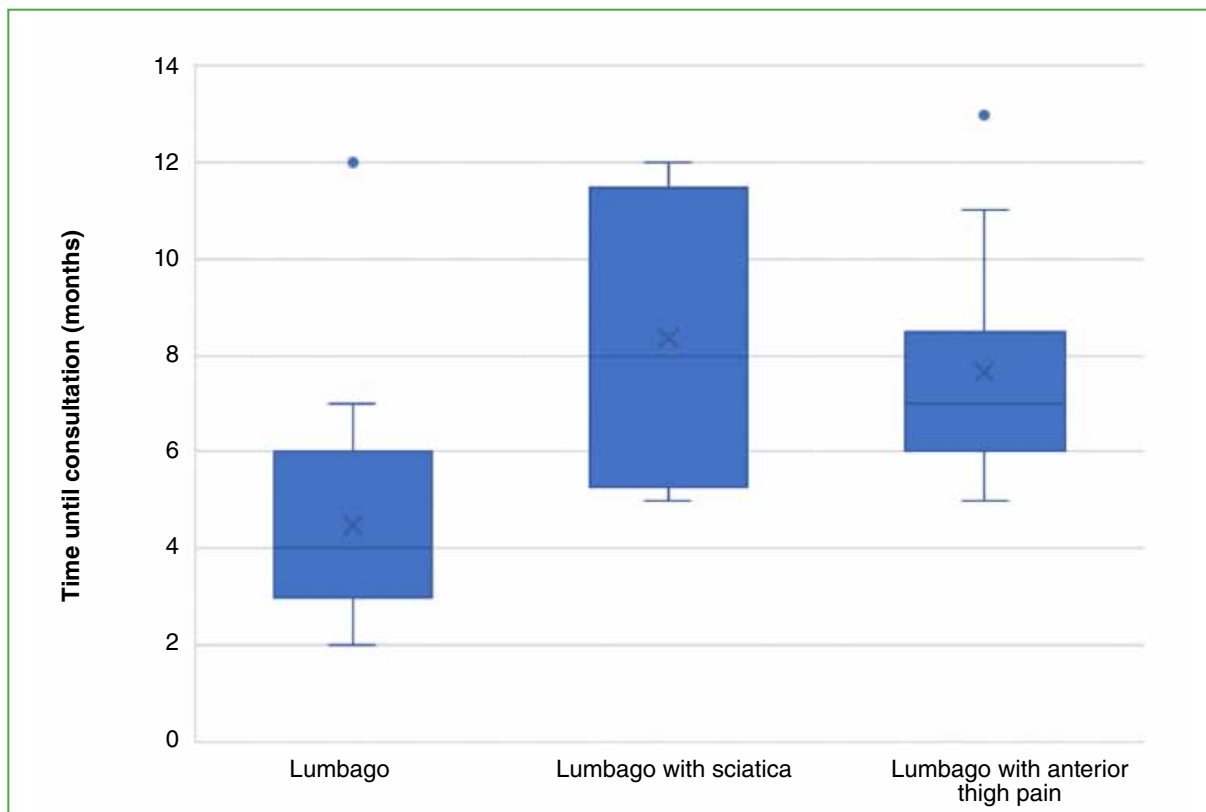
**Table 1.** Sample characteristics

Variables	Total (n = 40)
Female sex, n (%)	10 (25)
Age, mean (SD)	62.5 (12.9)
BMI, median (IQR)	31.7 (29.6, 33.3)
Time of evolution, median (IQR), months	5.50 (3.75, 7.00)
Comorbidities, n (%)	
None	6 (15)
Arterial hypertension	13 (32.5)
Dyslipidemia	7 (17.5)
Diabetes	6 (15)
Asthma/COPD	5 (12.5)
Other	22 (56.4)
>1 comorbidity	6 (14.6)

SD = standard deviation; IQR = interquartile range; BMI = body mass index; COPD = chronic obstructive pulmonary disease

The median pain evolution was 5.50 months (IQR 3.75-7). In terms of clinical presentations, pain evolution lasted longer in radiculopathy-associated forms than in low back pain, with a statistically significant difference in low back pain ( $p = 0.017$ ) ([Figure 3](#)).

The most affected level was L5-S1 ( $n = 22$ , 55%), followed by L4-S1 (35%). The L3-S1 group was older (median 60.5 vs. 59 and 59.5 years;  $p = 0.9$ ), had suffered pain for longer (8.25 vs. 5.57 and 5.75 months;  $p = 0.32$ ), and had a higher BMI (35.5 vs. 31.1 and 31.9  $p = 0.069$ ), but these findings were not significant. The most frequent reason for consultation was low back pain ( $n = 23$ , 56%); when the clinical presentation was analyzed according to the level affected, the most frequent clinical presentation in patients with L3-S1 involvement was lumbar and anterior thigh pain; this difference was not significant ([Table 2](#)).



**Figure 3.** Distribution of time until consultation based on clinical diagnosis.

**Table 2.** Patient characteristics according to the compromised level.

	L3-S1 (n = 4)	L4-S1 (n = 14)	L5-S1 (n = 22)	p
Age, median [C1, C3]	60.5 [55.0, 64.8]	59.5 [51.5, 78.5]	59.0 [54.0, 71.0]	0.930
Female sex	1 (25.0)	3 (21.4)	6 (27.3)	1.000
Clinical manifestation				
Lumbago	1 (25.0)	9 (64.3)	13 (59.1)	0.366
Lumbago and anterior thigh pain	3 (75.0)	3 (21.4)	5 (22.7)	
Lumbago with sciatica	0 (0)	2 (14.3)	4 (18.2)	
Evolution, months				
Mean (SD)	8.25 (3.59)	5.57 (3.16)	5.73 (2.85)	0.322
Median [C1, C3]	7.50 [5.75, 10.0]	5.50 [3.00, 7.00]	5.00 [4.00, 6.75]	
I BMI				
Mean (SD)	35.1 (3.43)	31.9 (3.42)	31.1 (2.51)	0.069
Median [C1, C3]	34.0 [33.5; 35.6]	31.4 [29.5; 33.1]	30.8 [29.3; 33.2]	
Diabetes				
Yes	0 (0)	1 (7.14)	5 (22.7)	

SD = standard deviation; BMI = body mass index.

To facilitate the multivariate analysis, the variables time of evolution (<6 months vs. ≥6 months) and BMI (<30 vs. ≥30) were dichotomized.

When comparing the groups, bivariate analysis revealed that those with pain for a longer period of time were younger (65.8 vs. 59.1 years;  $p = 0.1$ ) and had a lower BMI (31.3 vs. 32.2;  $p = 0.39$ ); however, these values were not significant (Figure 4). Patients with a BMI >30 predominated (75%), who consulted mainly for low back pain (69 vs. 27%,  $p = 0.018$ ), with a predominance of the male sex (86.2 vs. 45.5%,  $p = 0.014$ ); the differences between age, time of evolution and affected level were not significant (Table 3).

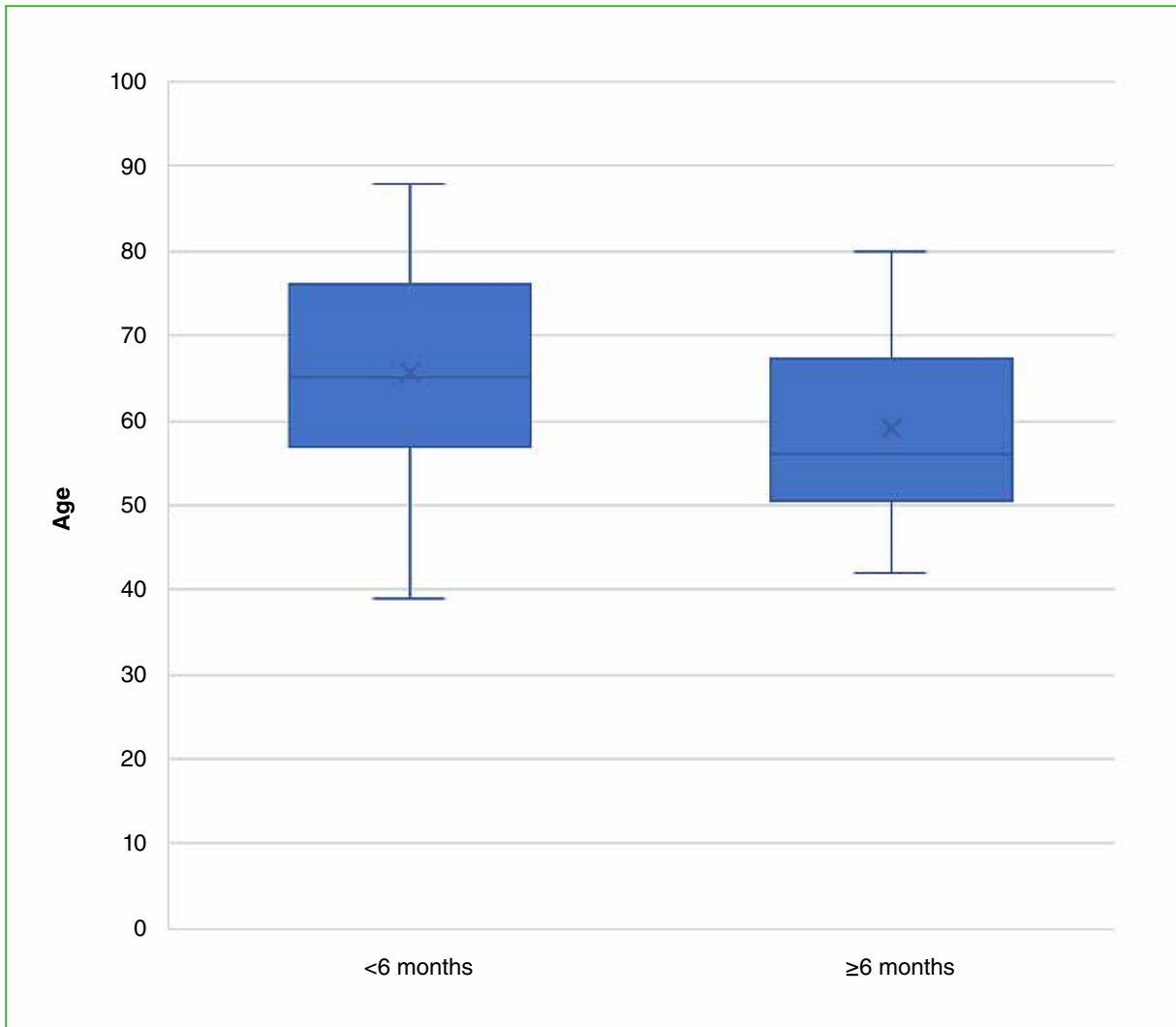


Figure 4. Distribution of age in the bivariate analysis according to time of evolution.

**Table 3.** Patient characteristics according to body mass index (BMI)

	IMC ≤30 (n = 11)	IMC >30 (n = 29)	p
Age, mean (SD)	59.0 (13.8)	63.8 (12.5)	0.331
Male sex	5 (45.5)	25 (86.2)	0.0144
Clinical manifestation			
Lumbago	3 (27.3)	20 (69.0)	0.018
Lumbago with sciatica (l/r)	4 (36.4)	2 (6.90)	
Lumbago and anterior thigh pain	4 (36.4)	7 (24.1)	
Time of evolution, median [C1, C3], months.	6.00 [5.00, 6.50]	5.00 [3.00, 7.00]	0.179
Level affected			
L3-S1	0 (0)	4 (13.8)	0.459
L4-S1	5 (45.5)	9 (31.0)	
L5-S1	6 (54.5)	16 (55.2)	

SD = standard deviation.

## DISCUSSION

In this study, 40 patients with Naka grade III LEL and a mean age of 62.5 years, with male predominance, were evaluated. Seventy-five percent of the sample had a BMI >30. The most frequent reason for consultation was low back pain, with a median pain evolution of 5.5 months.

Idiopathic LEL accounts for approximately 17% of cases. The first case of idiopathic SEL was published by Badami and Hinck<sup>19</sup> in 1982. Years later, the idiopathic form was established: that which affects non-obese patients, without treatment with corticosteroids or any other underlying cause that justifies the entity; it is the least frequently reported form.<sup>10-16</sup> In this study, almost 25% of the patients had the idiopathic form and the rest were associated with obesity. It should be noted that this higher percentage than those published could be attributed to the exclusion of cases related to excess corticosteroids.

LEL usually predominates in the male sex (68-75%), is more frequent at 65 ± 10 years of age, and the duration of symptoms varies greatly according to the literature (4-27 months).<sup>2-8,14,15,15,23-25</sup> Typically, excessive adipose tissue accumulation occurs slowly and progressively, from a diminished thecal sac in the early stages to a completely obliterated one in the advanced stages. This excessive tissue generates a mass effect, causing mechanical compression and also venous compression leading to engorgement and compression of the dural sac, spinal cord, and roots.<sup>18-22</sup>

In our study, there were no patients with the acute form, the median evolution of pain was 5.5 months, with male predominance and a mean age similar to previous publications.

The location on the spine may vary according to the etiology of the disease, the thoracic form being the most frequent. Fogel et al.<sup>15</sup> reported a predominantly thoracic location (55.8%) when associated with exogenous corticosteroids, thoracolumbar involvement in cases of endogenous hypercortisolism, and a predilection for the lumbosacral area in idiopathic SEL and in those associated with obesity.<sup>11-15</sup> Naka et al. described the predilection of the middle thoracic and lower lumbar area in idiopathic cases, the thoracic forms being the ones most associated with neurological alterations (up to 70% of cases of myelopathy).<sup>21</sup>

In our study, as in previous reports, the low lumbar level (L5-S1) predominated in patients with idiopathic LEL and LEL associated with obesity.

There are several gradings according to MRI, but none correlates with clinical manifestations.<sup>2,8,20-22</sup> Borré et al.<sup>8</sup> proposed a classification of SEL on MRI from 0 to 3 according to the percentage of the spinal canal occupied by fatty tissue; grade 3 is always symptomatic (with canal occupation >70%). Naka used axial and sagittal MRI slices for classification from 0 to III, advanced forms are associated with the 'Y' image described by Kuhn et al.<sup>2</sup>

In our study, the clinical presentation of patients with Naka grade III LEL was analyzed, with a predominance of low back pain (56%).

The weaknesses of the study are its retrospective design and relatively small number of patients. On the other hand, non-probability sampling may be subject to possible selection bias. In spite of this, we highlight as a strength that it is the first to analyze the clinical presentation of Naka grade III LEL in our field and that the results obtained were similar to those of international publications on the subject, indicating an original contribution from our setting.

## CONCLUSIONS

Our sample included 40 patients with Naka grade III LEL. Male sex predominated, the average age was 62.5 years, and there was greater involvement of the lumbosacral segment.

The most common presentation was low back pain, with the exception of L3-S1 involvement, which caused lumbar and anterior thigh pain. Seventy-five percent of the sample was obese, with no significant differences in terms of age, pain evolution and level affected with respect to patients with a BMI  $\leq 30$ . Patients who reported pain for  $>6$  months were younger and had a lower BMI; however, these findings were not statistically significant.

Conflict of interest: The authors have no conflicts of interest to declare.

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# Spinal Fractures Caused by Speed Bumps

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## ABSTRACT

**Objective:** To present a case series of spinal fractures in bus passengers caused by passing over speed bumps. **Materials and Methods:** A descriptive and retrospective study of a case series of thoracic and lumbosacral spinal injuries suffered by passengers as a result of vehicle impacts with speed bumps was conducted. Patients treated at two institutions from January 1, 2012 to January 1, 2023 were included. **Results:** 23 patients with vertebral injuries of the thoracolumbosacral spine were recorded: 14 women (60.9%) and 9 men (39.1%), average age 43 years (SD±12; range=25-62). Almost all of the patients were passengers (n=22, 95.7%) sitting in the last row of seats on the bus (n=20, 86.5%). A single case was documented involving the vehicle's driver. 29 spinal injuries were recorded, 28 thoracolumbar fractures (from T10 to L2; 96.6%) and 1 coccyx fracture (3.4%). The most frequently involved vertebra was L1 (n=16; 55%). The most severe fractures (A3/A4) were associated with surgical treatment (p=0.007) and a longer median hospital stay (p=0.005). **Conclusions:** Spinal injuries during vehicular impact with speed bumps are caused by an axial compression mechanism, with greater involvement of passengers who are located in the last row of seats. They primarily affect the thoracolumbar joint, with the L1 vertebra and exclusively one of the vertebral endplates being fractured most frequently.

**Keywords:** Thoracolumbar vertebral fracture; bus; speed bump; trauma.

**Level of Evidence:** IV

## Fracturas vertebrales causadas por reductores de velocidad o “lomos de burro”

## RESUMEN

**Objetivo:** Presentar una serie de casos de fracturas vertebrales en pasajeros de autobús asociadas al pasaje por reductores de velocidad. **Materiales y Métodos:** Se realizó un estudio descriptivo y retrospectivo de una serie de casos de lesiones vertebrales torácicas y lumbosacras sufridas por pasajeros a causa del impacto del vehículo con reductores de velocidad. Se incluyó a pacientes tratados en dos instituciones, entre el 1 de enero de 2012 y el 1 de enero de 2023. **Resultados:** Se registraron 23 pacientes con lesiones vertebrales de la columna toraco-lumbosacra, 14 mujeres (60,9%) y 9 hombres (39,1%), promedio de la edad 43 años (DE ± 12; rango 25-62). Casi todos eran pasajeros (n = 22; 95,7%) que viajaban sentados en la última fila del autobús (n = 20; 86,5%). Un solo caso correspondía aun conductor del vehículo. Se documentaron 29 lesiones vertebrales, 28 fracturas toracolumbares (de T10 a L2; 96,6%) y una fractura de coxis (3,4%). La vértebra más comprometida fue L1 (n = 16; 55%). Las fracturas más graves (A3/A4) se asociaron con tratamiento quirúrgico (p = 0,007) y una mayor mediana de días de internación (p = 0,005). **Conclusiones:** Las lesiones vertebrales asociadas al impacto vehicular con reductores de velocidad son fracturas causadas por un mecanismo de compresión axial, más frecuentes en pasajeros ubicados en la última fila de asientos del autobús. Comprometen predominantemente la charnela toracolumbar y la vértebra fracturada con más frecuencia es L1 y exclusivamente uno de los platillos vertebrales.

**Palabras clave:** Fractura vertebral toracolumbar; autobús; reductores de velocidad; lomo de burro; trauma.

**Nivel de Evidencia:** IV

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**How to cite this article:** Formaggin S, Ricciardi GA, Fosser G, Garfinkel I, Carrioli G, Ricciardi DO. Spinal Fractures Caused by Speed Bumps. *Rev Asoc Argent Ortop Traumatol* 2024;89(1):15-21. <https://doi.org/10.15417/issn.1852-7434.2024.89.1.1807>

## INTRODUCTION

Spinal fractures resulting from high-energy trauma are a widely developed topic in the literature, and traffic accidents are the leading cause of traumatic spinal injury, accounting for 38% of cases.<sup>1</sup> However, a subgroup of indirect traumatic spinal injuries occurring in bus passengers has been briefly described, which has prompted the development of our study. They comprise spinal injuries sustained when a vehicle passes abruptly over a speed bump (in Argentina, *lomo de burro*), which primarily affect bus passengers in the last row of seats.<sup>2-4</sup>

Speed bumps are elements used on streets as road safety measures to reduce the speed of traffic in certain urban areas. In Argentina, there is no exact record of when they began to be implemented, but in the 1990s, they became increasingly important as an instrument to control speed in residential areas, schools or intersections with high traffic without traffic lights, in order to avoid accidents. It should be noted that, under National Traffic Act No. 24,449, there is no precise definition that contemplates the use of speed bumps, so their construction and placement are not regulated, and therefore the types of design and signage differ.<sup>5</sup>

The aim of this study is to describe a series of cases of spinal fractures in bus passengers caused by speed bumps.

## MATERIALS AND METHODS

We conducted a descriptive and retrospective study of a series of cases of thoracic and lumbosacral spine injuries sustained by bus passengers during vehicular impact with speed bumps, treated in two institutions of the Autonomous City of Buenos Aires' occupational and private systems between January 2012 and January 2023.

We included patients with spinal injuries affecting the thoracic, lumbar and sacrococcygeal spine, who had traumatic antecedents reported as "indirect trauma while driving or riding a bus due to vehicular impact with speed bumps". Cervical injuries were not included, in line with previous publications that have described this mechanism for thoracolumbar fractures specifically.<sup>4</sup> We excluded patients with oncological disease, severe or established osteoporosis documented in the clinical records (according to the World Health Organization classification that defines severe osteoporosis when a fragility fracture has already occurred), or impact against third parties or other objects that may bias the relationship with the typically described mechanism of injury.<sup>4,6</sup>

Data were collected from medical records and the image archive of radiographs, computed tomography and spinal magnetic resonance imaging on admission. The following variables were considered: age, sex, role in the vehicle (driver or passenger), place in the vehicle (last row of seats/driver/other), fracture classification according to the AO Spine classification system for thoracolumbar vertebral injuries,<sup>7</sup> neurological status on admission according to the *American Spinal Injury Association Impairment Scale*,<sup>8</sup> level and topography of the injury (thoracic: T1 to T9; thoracolumbar junction: T10 to L2; low lumbar: L3 to sacrococcygeal spine); previous comorbidities, treatment (conservative, surgical), complications, days of hospitalization, and days off work.

Vertebral compression fractures were grouped according to the severity of the vertebral body injury according to the AO classification morphology ("A0, A1 and A2" types vs. "A3/A4") for comparison.

All images were evaluated by two of the authors, the two most experienced spine surgery specialists on the team, for independent classification of the lesions. Disagreements were resolved by consensus among the research authors.

## Statistical Analysis

Categorical variables are described as number and percentage. Numerical variables are expressed as mean and median according to their distribution (parametric or nonparametric) and their respective measures of dispersion, standard deviation and range. For comparison of categorical variables, the  $\chi^2$  test or Fisher's test was used. Numerical variables were compared with Student's t test for independent samples or the Mann-Whitney U test, according to their distribution. A p-value <0.05 was considered statistically significant. SPSS v25 statistical software was used.

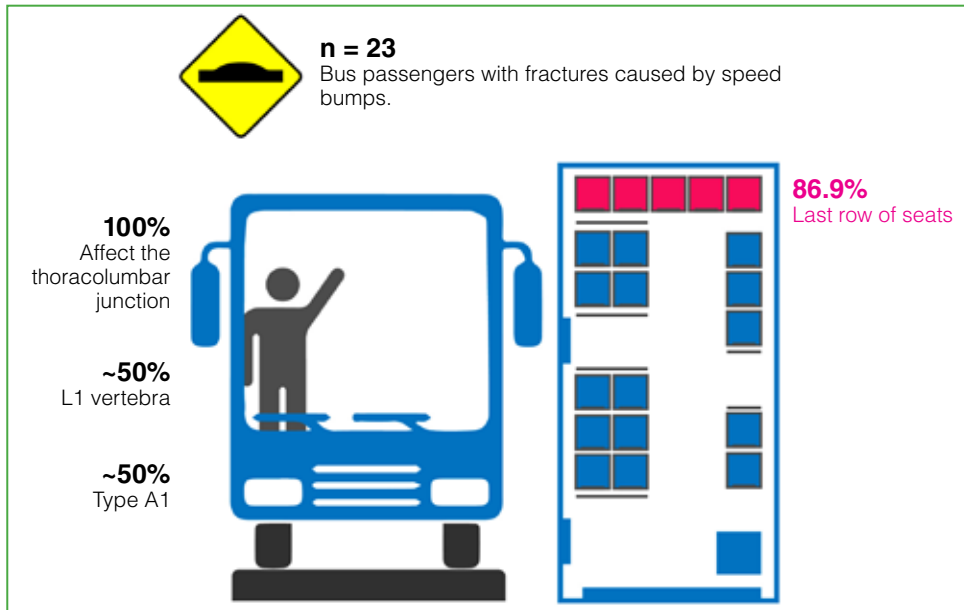
## RESULTS

**Table 1** shows the characteristics of the sample. Initially, 25 patients with vertebral fractures sustained during a bus trip were included. Two patients were excluded because the mechanism of injury was different from that typically described: one by direct trauma caused by another passenger and one by severe traumatic brain injury in the context of syncope. Finally, a sample of 23 patients with thoracolumbosacral spine injuries was obtained. Fourteen (60.9%) were female and nine (39.1%) were male, with a mean age of 43 years (SD  $\pm$  12; range 25-62). 82% were under 55 years of age. Almost all were passengers (n = 22; 95.7%) who were seated in the last row of the bus (n = 20; 86.5%). Only one subject was the driver of the vehicle. There were 29 vertebral injuries, 28 thoracolumbar fractures (from T10 to L2; 96.6%) and one coccyx fracture (3.4%). The most frequently involved vertebra was L1 (n = 16; 55%), followed by T12 (n = 6; 20.6%), T11 (n = 3; 10.4%) and L2 (n = 3; 10.4%). According to the AO Spine classification,<sup>6</sup> type A1 fractures (exclusive involvement of a single vertebral endplate, without involvement of the posterior wall) were the most frequent (n = 11; 50%), followed by type A3 (involvement of a single vertebral endplate and the posterior wall; n = 8; 36.4%). No injuries involving the anterior or posterior ligamentous complex, or signs of translation, were documented (**Figures 1 and 2**).

**Table 1.** Sample description (n = 23)

Variables		Results	
Age; mean (SD; range)		43	( $\pm$ 12; 25-62)
Sex, n (%)	Female	14	(60.9)
	Male	9	(39.1)
Role in the vehicle; n (%)	Driver	1	(4.3)
	Passenger	22	(95.7)
Place in the vehicle; n (%)	Driver	1	(4.3)
	Last row of seats	20	(86.9)
	Not documented	2	(8.7)
AO classification; n (%)	A1	11	(50.0)
	A2	2	(9.1)
	A3	8	(36.4)
	A4	1	(4.5)
Multiple fractures; n (%)		5	(22.7)
Neurological deficit; n (%)		1	(4.3)
Comorbidities; n (%)		6	(26.1)
Initial treatment; n (%)	Conservative	11	(47.8)
	Surgical	12	(52.2)
Complications; n (%)		5	(21.7)
Sick leave (days); median (range)		157	(55-518)
Length of hospital stay (days); median (range)		12	(1-31)

SD = standard deviation.



**Figure 1.** Infographic: summary of the main characteristics of the sample.



**Figure 2.** Case example: 51-year-old man with L1 fracture and involvement of the superior vertebral endplate and posterior wall, type A3 (A-D). Percutaneous short fixation (E-G).

Regarding initial treatment, 11 (47.8%) patients received conservative treatment: one with coccyx fracture (analgesia, rest and rehabilitation) and 10 with thoracolumbar fractures (A1 n = 8; A3 n = 1) who were immobilized with a Jewett brace. Three patients developed persistent and severe pain after eight weeks of treatment and underwent kyphoplasty as salvage treatment. 52.2% underwent initial surgical treatment. Surgical patients included: four with type A1 fracture treated with kyphoplasty (segmental kyphosis >20°, n = 2; brace intolerance, n = 1; decreased bone mineral density according to Hounsfield units on CT scan, n = 1); seven with type A3 fracture treated with short arthrodesis (n = 5), double-approach minimally-invasive arthrodesis (n = 1) or percutaneous fixation (n = 1) and finally, one with type A4 fracture and associated neurologic involvement treated with decompression and arthrodesis. The rate of complications in the sample was 21.7%: three cases of failure of conservative treatment (already mentioned) and two postoperative complications (one associated with the implant and the other, Guillain-Barré syndrome).

When comparing patients with thoracolumbar fractures according to injury severity (A1/A2 vs. A3/4), no statistically significant differences were found in the variables predictive of severity; however, posterior wall involvement had a statistically significant association with surgical indication (p = 0.007) and a higher median number of days of hospitalization (p = 0.005). Table 2 summarizes the results of the comparison.

**Table 2.** Comparison according to severity

Variables		Results				p
		A1/A2 (n = 13)		A3/A4 (n = 9)		
Age; mean (SD; range)		45	13 (25-62)	41	(11; 25-54)	0.562
Sex; n (%)	Female	8	(61.5)	6	(66.7)	0.806
	Male	5	(38.5)	3	(33.3)	
Role in the vehicle; n (%)	Driver	1	(7.7)	0	(0)	0.394
	Passenger	12	(92.3)	9	(100)	
Place in the vehicle; n (%)	Driver	1	(8.3)	0	(0)	0.402
	Last row	11	(91.7)	8	(100)	
Multiple fractures; n (%)		4	(17.39)	1	(11.1)	0.279
Neurological deficit; n (%)		0	(0)	1	(11.1)	0.219
Comorbidities; n (%)		4	(30.8)	2	(22.2)	0.658
Initial treatment; n (%)	Conservative	9	(69.2)	1	(11.1)	0.007
	Surgical	4	(30.8)	8	(88.9)	
Complications; n (%)		3	(23.1)	2	(22.2)	0.962
Time off work (days); median (range)		134	(55-518)	207	(127-499)	0.62
Days of hospitalization; median (range)		6	(1-28)	18	(12-31)	0.005

SD = standard deviation.

## DISCUSSION

Few studies have been published on speed bump fractures. Bowrey et al. are believed to have described the first two cases of spinal injuries caused by a vehicle passing over a “road hump” at high speed.<sup>2</sup> Nine years later, Aslan et al. reported five patients with such fractures, but, so far, without reference to the mechanism of injury.<sup>3</sup> Subsequently, Munjin et al. published the largest series of patients to date, with 46 cases and 52 spinal fractures

secondary to trauma caused by a vehicle passing over speed bumps.<sup>4</sup> They also described in detail the characteristics of the injury mechanism, proposing that when the vehicle rises as it passes over the speed bump, an upward vertical force is generated, which is determined by the speed at which the vehicle impacts the speed bump and the distance between its point of application and the center of support. Then, as the vehicle speed increases, a catapult-like effect on the vehicle suspension system is exacerbated. As a consequence, the passenger or driver rises suddenly from his seat and then falls abruptly due to the force of gravity, generating an axial compression mechanism on the spine.<sup>4</sup>

The demographic characteristics of our series were similar to those of the published series, with a predominance of female sex (60%) and a mean age of 43 years.<sup>2-4</sup>

In our series, the majority of patients were passengers seated in the back row, which is similar with the three previously published series in which more than 90% had this context.<sup>2-4</sup> Munjin et al. suggested that the position of the back row of seats represents the farthest distance to the rear wheel of the bus and the location of the bus with the least amount of damping. The upward inertial force generated at this level is of greater amplitude and length. In turn, the posterior axial compression force created by the passengers' sudden descent is greater due to the distance traveled and the lack of a closer support point in relation to the damping system. This is why passengers in the rear row of seats absorb the greatest force of impact and are at the highest risk of sustaining traumatic spinal injuries.<sup>4</sup>

Our data on the most frequent location, vertebra and type of fracture were similar to those published.<sup>4</sup> The thoracolumbar junction was the most frequently involved spinal region (96.6%; n = 28) and the L1 vertebra (55%; n = 16) was the most frequently fractured. The energy of the impact is absorbed, to a greater extent, by the group of vertebrae that are in the transition zone between the rigid dorsal spine and the mobile lumbar spine. The most frequent type of fracture according to the AO Spine classification was A1 (50%, n = 11).<sup>7</sup>

There were no cases of injuries to the anterior or posterior ligament complex (type B and C fractures) as in the published series, in line with the predominant axial compression mechanism proposed in the literature.<sup>2-4</sup>

The overall complication rate was 21.7% (n = 5). It should be noted that strictly surgical complications were low: only one patient presented implant failure. Surprisingly, one patient developed Guillain-Barré syndrome 14 days after surgery, an extremely rare association but documented in the literature, which resolved completely.<sup>9,10</sup> In three patients, conservative treatment failed due to brace intolerance, prompting rescue treatment with kyphoplasty.

It should be noted that most of the patients were treated in the context of an occupational accident on their way to or from work. During the initial evaluation of patients with occupational accidents, it is often necessary to diagnose a pre-existing condition, unrelated to the accident, which may interfere with the pathogenesis of the injury. Bone fragility, for example, makes the patient more likely to sustain a fracture with low energy trauma. We believe it is relevant to highlight that most of the patients in the sample (n = 19; 82%) were young adults, <55 years old, and that patients with documented severe osteoporosis or pathological fracture causes were excluded. In the authors' opinion, this reflects the severity of the kinetics of trauma in the context of vehicular impact against speed bumps, and configures the injury as a traumatic vertebral fracture. In addition, in nine patients, the kinetics of the accident resulted in severe vertebral injuries, with posterior wall involvement and evident or potential mechanical instability. More severe vertebral fractures, with posterior wall involvement, were associated with a higher indication for surgery and longer hospitalization times. In agreement with our results, Munjin et al. published a series of 10 patients with severe injuries and indication for surgery. On the other hand, they also highlighted the positive history of bone metabolism disorders in 23%, and suggested that patients with osteoporosis should avoid the last row of seats in the bus.<sup>4</sup>

The main weaknesses of our study are its descriptive and retrospective design, the low number of patients that prevents generalizing its conclusions, and the probable selection, measurement and recording biases. Some patients were most likely excluded because their injury mechanism was not documented in the clinical record. However, given the small number of published cases, with only one series reported in indexed journals according to our literature search, we believe our work contributes to promoting a better clinical interpretation of a known cause of injury that has received little attention in the literature.

## CONCLUSIONS

Spinal injuries caused by vehicular impact against speed bumps are fractures generated by an axial compression mechanism, and they occur more frequently in passengers seated in the last row of the bus. They primarily affect the thoracolumbar junction, with the most often fractured vertebra being L1 and only one of the vertebral endplates involved. They could potentially cause more serious injuries to the posterior wall or generate evident or potential mechanical instability. Our study suggests that spine fractures caused by vehicular impact with speed bumps (or ‘sleeping policemen’) should be classified as traumatic spinal injuries due to the high prevalence of young adult patients (<55 years) without bone metabolism conditions.

Conflict of interest: The authors declare no conflicts of interest.

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# Modification of the Safe Corridor for Oblique Lumbar Interbody Fusion Based on Postural Changes and Body Composition. An Observational, Multicenter Study Using MRI

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## ABSTRACT

**Introduction:** Minimally invasive spine surgery (MISS) has gained popularity in recent years. New and less invasive techniques have emerged as the preferred procedures for certain pathologies. The size of the aorta-psoas corridor is decisive when choosing the oblique interbody fusion technique. **Objectives:** To describe the changes in the size of the aorta-psoas corridor in the right lateral decubitus and supine decubitus positions by magnetic resonance imaging and their association with body mass index.

**Materials and Methods:** 13 volunteers underwent MRI of the disc spaces from L1-L2 to L4-L5 in the supine and right lateral decubitus positions. The corridor was measured, and the sizes at each level were compared. **Results:** A statistically significant increase in the size of the aorta-psoas corridor and the artery-disc distance was obtained when positioning the patient in the right lateral decubitus position. However, these have no significant relationship with BMI. **Conclusions:** The use of MRI in pre-surgical planning is extremely important. This study reveals the mobility of the abdominal structures. We can conclude that, as stated in the objective of the study, significant changes occur in the aorta-psoas corridor and the artery-disc distance when the patient is positioned in the right lateral decubitus position.

**Keywords:** OLIF; MISS; minimally invasive spine surgery.

**Level of Evidence:** IV

## Modificación del corredor aorto-psoas para el acceso oblicuo lumbar intervertebral según los cambios posturales y la composición corporal. Estudio multicéntrico observacional mediante resonancia magnética

## RESUMEN

**Introducción:** La cirugía mínimamente invasiva de columna se ha vuelto cada vez más popular en los últimos años. Se han desarrollado técnicas nuevas y menos invasivas que se han convertido en procedimientos de elección para determinadas enfermedades. El tamaño del corredor aorto-psoas es un factor determinante al elegir la técnica oblicua de fusión intersomática. **Objetivos:** Describir las modificaciones en el tamaño del corredor aorto-psoas en decúbito lateral derecho y decúbito supino mediante resonancia magnética y su asociación con el índice de masa corporal. **Materiales y Métodos:** Se realizó una resonancia magnética de los espacios discales de L1-L2 a L4-L5 a 13 voluntarios en decúbito supino y decúbito lateral derecho. Se midió el corredor y se comparó el tamaño en cada nivel. **Resultados:** El tamaño del corredor aorto-psoas y de la distancia arteria-disco tuvo un aumento estadísticamente significativo al posicionar al paciente en decúbito lateral derecho. **Conclusiones:** La resonancia magnética es de suma importancia en la planificación prequirúrgica, pues deja en evidencia la movilidad de las estructuras abdominales. Se producen cambios significativos en el corredor aorto-psoas y la distancia arteria-disco al ubicar al paciente en decúbito lateral derecho. Sin embargo, estos cambios no tienen una relación significativa con el índice de masa corporal.

**Palabras clave:** Fusión intersomática lumbar oblicua; cirugía mínimamente invasiva; cirugía de columna.

**Nivel de Evidencia:** IV

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**How to cite this article:** de Zavalía M, Gobbi E, Mazzeo JJ, Verna B, Lanari Zubiaur F, Yeregui S. Modification of the Safe Corridor for Oblique Lumbar Interbody Fusion Based on Postural Changes and Body Composition. An Observational, Multicenter Study Using MRI. *Rev Asoc Argent Ortop Traumatol* 2024;89(1):22-29. <https://doi.org/10.15417/issn.1852-7434.2024.89.1.1806>

## INTRODUCTION

Since lumbar interbody fusion techniques were first described, the most widely adopted procedures by spine surgeons have been those performed via the traditional posterior approach: posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF).<sup>1-7</sup> In the last 15 years, multiple anterolateral approaches have been gaining ground and becoming established as the techniques of choice for specific cases. Unlike posterior interbody techniques, anterolateral approaches allow wide exposure of the disc space, which is not obstructed by the dural sac and neural elements.<sup>4,7-10</sup> Consequently, large interbody devices can be placed far in excess of the size and dimensions of posterior devices.<sup>4,7,11,12</sup> The rise of anterolateral approaches has been accompanied by minimally invasive spine surgery techniques that have become procedures of choice for many spine surgeons worldwide.<sup>4,7-10</sup> Several minimally invasive procedures have been described for the lumbar intervertebral space, including anterior lumbar interbody fusion (ALIF), oblique lumbar interbody fusion (OLIF), lateral lumbar interbody fusion (LLIF), TLIF, and PLIF.<sup>1-5,7-10</sup>

The OLIF technique is a minimally invasive procedure described by Mayer in 1977 that emerged as a possible solution to the disadvantages of the ALIF and LLIF techniques.<sup>7-10,12-16</sup> Examples of these include nerve and psoas muscle injury, which cause discomfort and weakness.<sup>12-13,17,18</sup> The ALIF technique in particular is associated with a higher risk of vascular injury, ureteral injury and even sacral plexus injury.<sup>7,9,12,18</sup> To avoid this type of injury, retroperitoneal lumbar interbody fusion (OLIF) methods using an approach between the aorta and the psoas have been applied.<sup>7-10,18-21</sup> Another factor that influenced the rise of OLIF as an alternative surgical technique is that, at L4-L5, the iliac crests create an anatomical impediment to the use of LLIF. In contrast, this technique allows for interbody device insertion at L5-S1 with minimal vascular complications by modifying the technique for safe iliac vessel mobilization by first ligating the iliolumbar vein.<sup>20-24</sup> The surgical technique consists of a lateral approach in the right lateral decubitus (RLD) position. Discectomy and interbody device placement are performed through an oblique corridor whose limits are located between the medial border of the psoas major muscle and the lateral border of the lumbar vessels (aorta/iliac), a space known as the safe corridor.<sup>18,20-29</sup>

Magnetic resonance imaging (MRI) is considered a mandatory preoperative study when planning the OLIF technique; it can define its feasibility by assessing the size of the corridors and the position of the vascular components.<sup>30,31</sup> However, this study is usually performed in the dorsal decubitus position, that is, in a different position from the one in which the surgical procedure is performed. We believe that abdominal structures are more mobile the more the patient's abdominal fat; therefore, patients with a narrow corridor in the supine decubitus (SD) position may be candidates for an oblique approach if evaluated with an MRI in RLD.

The aim of this study was to describe the modifications that occur specifically in the corridor size used for the OLIF technique when changing the patient's position from SD to RLD during an MRI, and to describe its association with body composition.

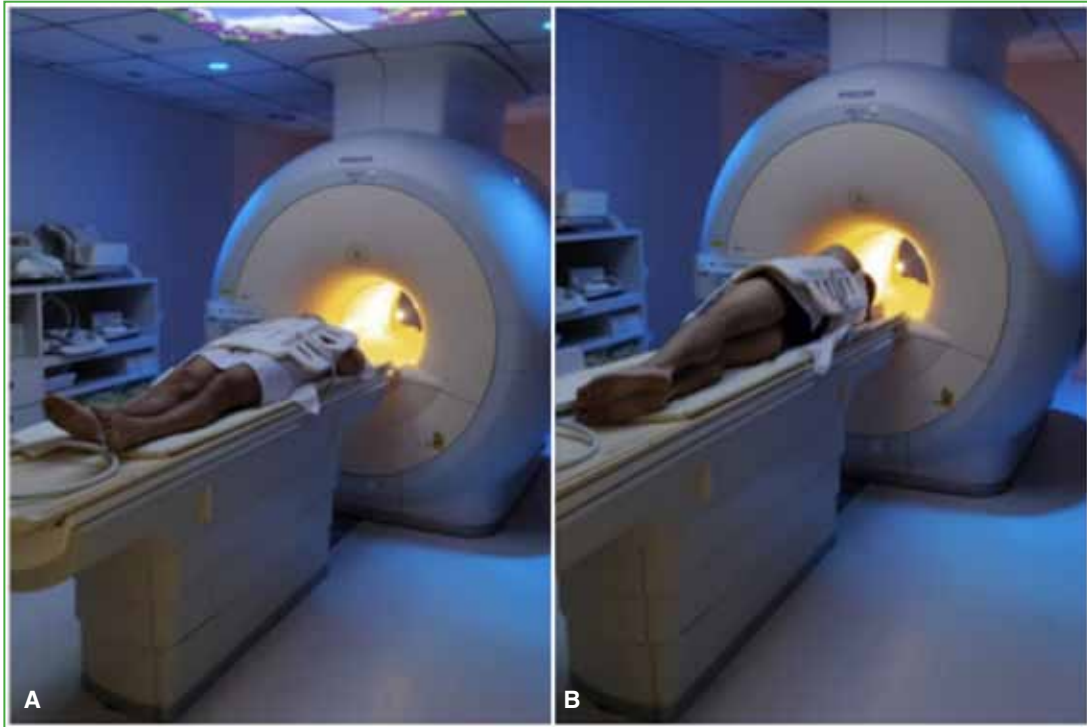
## MATERIALS AND METHODS

A descriptive, observational study was carried out. The study was approved by the Ethics Committee of Hospital Alemán de Buenos Aires, Argentina (PRIISA.BA system registry number: 1997).

Thirteen volunteers, of both sexes, >18 years old who had undergone MRI between April and June 2020 were included. Exclusion criteria were: pregnancy, vertebral fractures, previous abdominal or thoracic surgery, or any contraindication for MRI.

Twenty-six MRIs were performed in 13 patients. A 1.5 Philips© Tesla Multiva scanner was used in two different centers. In the first instance, the study was performed with the patient positioned in SD and then in RLD (Figure 1). Sagittal and axial slices were taken in T1-weighted and T2-weighted sequences. Using a scale with a measuring rod (the same in all cases), body height and weight were determined and the body mass index (BMI) was obtained for each patient. Measurements were always taken in the morning before the MRI.

The OsiriX® system version 12.5.2. was used to measure the aorta-psoas safe corridor and the artery-disc distance in the L1-L2, L2-L3, L3-L4 and L4-L5 spaces, in both the SD and RLD positions (Figure 2). All measurements were performed by an orthopedic physician specializing in spine.



**Figure 1.** Magnetic resonance imaging. **A.** Patient in the supine decubitus position. **B.** Patient in the right lateral decubitus position.



**Figure 2.** Magnetic resonance imaging of the intervertebral disc, axial section, where measurements are exemplified. For the artery-disc distance, it is from the most anterior point of the artery to the most anterior point of the intervertebral disc. For the aorta-psoas corridor, it is from the most lateral point of the artery to the most medial point of the psoas muscle.

## Statistical Analysis

For comparisons between variables with normal distribution, Student's t test for related samples (parametric) was applied, while when an asymmetric distribution was found in at least one of the variables to be compared, Wilcoxon's test (nonparametric) was used. For correlation results, Pearson's correlation test was used. BMI was calculated with the formula weight (kg)/height (m)<sup>2</sup>.

Statistical analysis was performed with IBM SPSS version 23.

## RESULTS

The sample consisted of five men and eight women, with a mean age of  $49 \pm 15$  years (min. 29 years, max. 73 years). Mean height was  $1.69 \pm 0.08$  m (min. 1.59 m, max. 1.87 m). Mean weight was  $74 \pm 17.43$  kg (min. 56 kg, max. 111 kg). Mean BMI was  $25.51 \pm 4.27$  (min. 20.8, max. 34.6).

### Aorta-psoas corridor

In the SD position, the aorta-psoas corridor or safe corridor at L1-L2 is distributed over a range of 2.02 cm (min. 0.15 cm, max. 2.17 cm), with an arithmetic mean of  $1.25 \pm 0.56$  cm and a median of 1.39 cm. At L2-L3, it is distributed over a range of 1.63 cm (min. 0.99 cm, max. 2.62 cm), with an arithmetic mean of  $1.66 \pm 0.48$  cm and a median of 1.72 cm. At L3-L4, it is distributed over a range of 1.4 cm (min. 0.9 cm, max. 2.3 cm), with an arithmetic mean of  $1.56 \pm 0.42$  cm and a median of 1.58 cm. Finally, for L4-L5, it is distributed in the range of 2.23 cm (min. 0.19 cm, max. 2.42 cm), with an arithmetic mean of  $1.03 \pm 0.65$  cm and a median of 1.00 cm.

When switching to RLD, the aorta-psoas corridor at L1-L2 is distributed over a 2.30 cm range (min. 0.37 cm, max. 2.67 cm), with an arithmetic mean of  $1.68 \pm 0.68$  cm and a median of 1.83 cm. At L2-L3, it is distributed over a range of 1.67 cm (min. 0.90 cm, max. 2.57 cm), with an arithmetic mean of  $1.82 \pm 0.52$  cm and a median of 1.78 cm. At L3-L4, it is distributed over a range of 1.46 cm (min. 0.98 cm, max. 2.44 cm), with an arithmetic mean of  $1.69 \pm 0.52$  cm and a median of 1.54 cm. Finally, at L4-L5, it is distributed over a range of 2.32 cm (min. 0.24 cm, max. 2.56 cm), with an arithmetic mean of  $1.26 \pm 0.72$  cm and a median of 1.33 cm.

### Artery-disc distance

In the SD position, the artery-disc distance at L1-L2 is distributed over a range of 0.99 cm (min. 1.37 cm, max. 2.36 cm). At L2-L3, it is distributed over a range of 1.10 cm (min. 1.40 cm, max. 2.50 cm). At L3-L4, it is distributed over a range of 1.70 cm (min. 1.16 cm, max. 2.86 cm). Finally, at L4-L5, it is distributed over a range of 0.92 cm (min. 0.85 cm, max. 1.77 cm).

When positioning the patient in RLD, at L1-L2, the artery-disc distance is distributed over a range of 1.02 cm (min. 1.62 cm, max. 2.64 cm). At L2-L3, it is distributed over a range of 1.35 cm (min. 1.49 cm, max. 2.84 cm). At L3-L4, it is distributed over a range of 2.14 cm (min. 1.15 cm, max. 3.29 cm). Finally, at L4-L5, it is distributed in a range of 1.20 cm (min. 0.94 cm, max. 2.14 cm).

### Aorta-psoas corridor in the supine vs. right lateral decubitus position

The statistical tests used to compare the two positions (SD and RLD) show that the aorta-psoas corridor presents statistically significant differences at the L1-L2 level (Student's  $t = -3.040$ ;  $p = 0.010$ ) between measurements taken in SD (mean = 1.25 cm) and RLD (mean = 1.67 cm). At L2-L3, no statistically significant differences were found (Student's  $t = -1.438$ ;  $p = 0.176$ ) between measurements taken in SD (mean = 1.66 cm) and RLD (mean = 1.81 cm). At L3-L4, there were also no statistically significant differences (Student's  $t = -0.941$ ;  $p = 0.365$ ) between measurements taken in SD (mean = 1.56 cm) and RLD (mean = 1.68 cm). At L4-L5, statistically significant differences were found (Student's  $t = -3.076$ ,  $p = 0.010$ ) between measurements taken in SD (mean = 1.03 cm) and RLD (mean = 1.26 cm).

### Artery-disc distance in the supine vs. right lateral decubitus position

In the space between the artery and the intervertebral disc, no statistically significant differences were found at L1-L2 (Student's  $t = -6.629$ ;  $p < 0.0001$ ) between measurements in SD (mean = 1.79 cm) and RLD (mean = 2.05 cm). For L2-L3, statistically significant differences were obtained between measurements in SD (mean = 1.86 cm) and RLD (mean = 2.05 cm) (Wilcoxon z-rank test =  $-2.483$ ;  $p = 0.008$ ). At L3-L4, there were statistically significant differences between measurements in SD (mean = 1.82 cm) and RLD (mean = 1.99 cm) (Wilcoxon z-rank

test = -2.667;  $p = 0.008$ ). Finally, at L4-L5, statistically significant differences (Student's  $t = -4.122$ ;  $p = 0.001$ ) were obtained between measurements in SD (mean= 1.23 cm) and RLD (mean= 1.46 cm) (Table 1).

**Table 1.** Values (in cm) of the aorta-psoas corridor and the artery-disc distance at different levels.

	Aorta-psoas corridor		Artery-disc distance	
	SD	RLD	SD	RLD
L1-L2	1.25 ± 0.56	1.68 ± 0.68*	1.80 ± 0,31	2.05 ± 0.37
L2-L3	1.66 ± 0.48	1.82 ± 0.52	1.86 ± 0.37	2.06 ± 0.50*
L3-L4	1.56 ± 0.42	1.69 ± 0.52	1.82 ± 0.54	1.99 ± 0.65*
L4-L5	1.03 ± 0.65	1.26 ± 0.72*	1.23 ± 0.28	1.46 ± 0.35*

SD = supine decubitus; RLD = right lateral decubitus.

\* $p < 0.05$

### Correlation with BMI

Correlation analysis was performed using Pearson's or Spearman's correlation coefficient as appropriate. For this purpose, the assumptions of identical distribution, normality and independence were controlled. First, the null hypothesis was tested, which states that there is no linear association between BMI and corridor level, whereas the alternative hypothesis states that there is a correlation between the two variables. The strength of the association was described by rho. Interpretation of Pearson's and Spearman's correlation coefficient: 0.00-0.10 insignificant correlation; 0.10-0.39 weak correlation; 0.40-0.69, moderate correlation; 0.70-0.89 strong correlation; 0.90-1 very strong correlation. A  $p$ -value  $< 0.05$  was considered statistically significant. Statistical analysis was performed with R software version 1.2.5042© 2009-2020 R Studio, Inc.

The degree of association between BMI and corridor space obtained negative and positive results. In six associations, the results were negative, from -0.01 to -0.74, the lower the BMI, the greater the space of the corridors. In 10 associations, the results were positive, from 0.41 to 0.60, the higher the BMI, the greater the space of the corridors.

With the exception of the decubitus (L2-L3 space and L3-L4 space), supine aortic (L2-L3 space) and decubitus aortic (L2-L3 space) corridors that showed a  $p$  value  $< 0.05$  in the association with BMI, the null hypothesis of no linear association between BMI and the spaces of the other corridors is not rejected. Thus, 12 of the 16 associations are not correlated ( $p > 0.05$ ). Of the four spaces (L1-L2, L2-L3, L3-L4 and L4-L5) in each corridor, the one shown to have the highest correlation with the corridors was L2-L3, with an association between BMI and decubitus corridor of -0.59, supine aortic corridor of 0.60 and decubitus aortic corridor of 0.59. There was a moderate correlation between each of these three corridors and BMI (Table 2).

**Table 2.** Correlation values of body mass index and corridors.

		Corridor			
		Supine	Decubitus	Aortic supine	Aortic decubitus
L1-L2	p	0.08	0.96	0.05	0.10
	CCP	-0.49	-0.01	0.54	0.47
L2-L3	p	0.11	0.03*	0.03*	0.03*
	CCP	-0.46	-0.59	0.60	0.59
L3-L4	p	0.11	0.003*	0.05	0.13
	CCP	-0.45	-0.74	0.54	0.43
L4-L5	p	0.14	0.16	0.06	0.09
	CCP	0.42	0.41	0.52	0.47

PCC = Pearson's correlation coefficient; \* $p < 0.05$ .

## DISCUSSION

Several published studies analyze the changes that occur when the patient is placed in the SD and RLD positions. In 2016, Molinares et al.<sup>31</sup> analyzed 333 MRI scans of patients in the dorsal decubitus position and concluded that the size of the aorta-psoas corridor increases when the patient is placed in lateral decubitus. Zhang et al.<sup>28</sup> published contradictory results, reporting that the aorta-psoas corridor decreases when the patient is placed in the RLD position. The mobility of the psoas and the fixation of the abdominal aorta to the retroperitoneum play a fundamental role. Finally, Zehri et al.<sup>32</sup> conducted a study in which they evaluated corridors in 33 patients and concluded that size does indeed increase when going from SD to RLD, but it has no relationship with BMI or age. This last study coincides with the results obtained in our research.

Regarding the complications of the technique, Silvestre et al.<sup>33</sup> reported a rate of 11.2% in 179 patients with OLIF. Complications related to the approach were: iliac vein injury (3 cases), peritoneal tear (1 case), sympathetic trunk injury (3 cases), neurological deficit (2 cases), psoas muscle weakness or numbness (2 cases). In a retrospective study of 2998 LLIF cases between 2013 and 2015 that included 1003 OLIF cases, Fujibayashi et al.<sup>34</sup> published a complication rate of 15.3% for patients operated on with the OLIF technique. Abe et al.<sup>35</sup> conducted a retrospective study of 155 cases of OLIF. The complication rate was 48.3% and the three most frequent complications were: endplate fracture/subsidence (18.7%), transient psoas weakness and thigh numbness (13.5%), and segmental artery injury (2.6%). We believe that several of these injuries could be avoided if a correct study of the patient is carried out, accurately assessing the distance of the corridors.

One of the limitations of our study was the difficulty of evaluating patients with high BMI given the impossibility of performing the study in lateral decubitus due to the size of the patients and the physical dimensions of the scanner used. Therefore, we consider it important that further studies evaluating the corridor in a larger number of patients be carried out.

## CONCLUSIONS

As stated in the objective of the study, significant changes occur in the aorta-psoas corridor and the artery-disc distance when the patient is positioned in RLD. However, these have no significant relationship with BMI. Therefore, surgical planning for the OLIF technique is inaccurate if the patient is only assessed using MRI in the SD position.

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Conflict of interest: Dr. Enrique Gobbi is a spokesperson for NuVasive. The rest of the authors declare no conflicts of interest.

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# Prevalence of Low Back Pain in Orthopedics and Traumatology Specialists: A Cross-sectional Study

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## ABSTRACT

**Introduction:** Up to 85% of the population will suffer at least one episode of low back pain throughout their lives. It is one of the most common complaints among healthcare workers, with a reported annual prevalence of 77%. Orthopedic surgeons have multiple risk factors for developing this condition. The objective of this study was to evaluate the prevalence of low back pain and identify possible contributing factors in a sample of orthopedic surgeons. **Materials and Methods:** A cross-sectional observational analytical study on low back pain in Orthopedics and Traumatology specialists who are members of the AAOT. Over the course of one month, a questionnaire was sent weekly. **Results:** 393 responses were received, the predominant sex was male, and the mean age was 46 years. More than 50% of the sample reported being overweight, whereas 43% reported being sedentary. The average self-perceived work stress was 7.86% of respondents reported at least one episode in the previous year, with 38% reporting more than four. **Conclusions:** The prevalence of low back pain was high. Acute episodes predominated, and complementary studies were not necessary. Less than 10% took time off work. Sedentary habits, comorbidities, and age were all associated with an increased likelihood of suffering >2 episodes of pain.

**Keywords:** Low back pain; orthopedics and traumatology specialists; epidemiology; prevalence.

**Level of Evidence:** III

## Frecuencia del dolor lumbar en médicos especialistas en Ortopedia y Traumatología: estudio transversal

## RESUMEN

**Introducción:** Hasta el 85% de la población padecerá, al menos, un episodio de dolor lumbar a lo largo de su vida. Representa una de las principales quejas del personal de salud, y tiene una prevalencia anual del 77%; los traumatólogos tenemos múltiples factores de riesgo para desarrollar este cuadro. El objetivo de este estudio fue evaluar la prevalencia de lumbalgia e identificar posibles factores asociados, en una muestra de médicos traumatólogos. **Materiales y Métodos:** Estudio analítico observacional transversal sobre el padecimiento de dolor lumbar en médicos especialistas en Ortopedia y Traumatología, miembros de la AAOT. El cuestionario se envió semanalmente durante un mes. **Resultados:** Se recibieron 393 respuestas, predominó el sexo masculino, y la media de la edad era de 46 años. Más del 50% de la muestra refirió sobrepeso, y el 43%, sedentarismo. La media de autopercepción de estrés laboral fue de 7. Un 86% afirmó haber sufrido, al menos, un episodio en el último año y un 38%, más de 4 episodios. **Conclusiones:** La prevalencia de lumbalgia fue alta. Predominaron los episodios agudos, no fueron necesarios estudios complementarios. Menos del 10% hizo reposo laboral. El hábito sedentario, el número de comorbilidades y la edad se asociaron con un riesgo más alto de sufrir >2 episodios de dolor.

**Palabras clave:** Lumbalgia; especialistas en Ortopedia y Traumatología; epidemiología; prevalencia.

**Nivel de Evidencia:** III

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**How to cite this article:** Besse M, Ricciardi GA, Cubecino AE, Bulos CE, Rosado Pardo JA, Ricciardi DO, Sarotto AJ. Prevalence of Low Back Pain in Orthopedics and Traumatology Specialists: A Cross-sectional Study. *Rev Asoc Argent Ortop Traumatol* 2024;89(1):30-41. <https://doi.org/10.15417/issn.1852-7434.2024.89.1.1815>

## INTRODUCTION

Lumbago or low back pain are medical terms used to refer to pain, stiffness or muscle tension in the region from the last rib to the intergluteal area, with or without radiation to the lower limbs.<sup>1</sup> It is one of the main reasons for medical consultation and the first cause of absenteeism from work, and its socioeconomic impact is high. It affects both men and women and up to 85% of the population will suffer at least one episode of low back pain in their lifetime.<sup>2</sup>

In Argentina, low back pain is the main cause of disability and is one of the main reasons for medical consultation, both in the public and private sectors. Although there are no reliable statistics on the prevalence of low back pain in our country, some publications indicate that it is the third most frequent cause of occupational disease and the most frequent cause of hospitalization within musculoskeletal conditions between 2006 and 2010.<sup>3,4</sup>

Low back pain is one of the most common complaints among health professionals; the documented annual prevalence is 77%. Working conditions, a lack of exercise, and psychosocial factors such as stress, holding multiple jobs, and working long hours are all considered risk factors for experiencing these episodes. In various studies, it has been shown that the branches within health professionals with a higher risk of suffering low back pain are: Obstetrics and Gynecology, Orthopedics and Traumatology, Nursing, and Kinesiology, with an incidence ranging from 34.3% to 83.9%.<sup>5-8</sup>

Orthopedics and Traumatology specialists are susceptible to repetitive twisting and bending movements, lifting loads and non-ergonomic postures, even wearing lead aprons for long periods of time. All of the above are considered risk factors for episodes of low back pain.<sup>9,10</sup>

The objectives of this study were to describe the prevalence of low back pain and to identify possible factors associated with its appearance in a sample of physicians specializing in Orthopedics and Traumatology.

## MATERIALS AND METHODS

A cross-sectional observational analytical study on low back pain was conducted using a questionnaire distributed to physicians specializing in orthopedics and traumatology who are members of the *Asociación Argentina de Ortopedia y Traumatología* (Argentine Association of Orthopedics and Traumatology- AAOT). The questionnaire was sent out weekly for one month between March 1 and 31, 2023 and was distributed with the collaboration of the AAOT Morbidity and Mortality Committee.

The questionnaire was sent by e-mail and other messaging applications to physicians registered in the AAOT database who agreed to receive e-mails from the institution. Male and female physicians specializing in Orthopedics and Traumatology affiliated with the AAOT were included. Incomplete or blank questionnaires were excluded.

The study variables were recorded in a digital questionnaire prepared by the research team. The dependent variable "low back pain" was recorded as the number of episodes of low back pain in the last year. Information was also obtained on the duration of the episode, pain intensity, diagnosis, treatment and the need for sick leave.

Sociodemographic variables were included (age, sex, work sector [public or private], region of the country where he/she works, marital status, number of children, and subspecialty), as well as clinical and anthropometric variables, such as comorbidities, smoking, weight and height (with calculation of body mass index), level of weekly physical activity, previous spinal disease, and history of spinal surgery. Variables associated with the work activity of the orthopedic surgeons were recorded, such as professional seniority, private practice activity, operating room and on-call activity, use of lead aprons during surgeries, perception of job satisfaction, and stress level.

The survey was conducted in accordance with the Declaration of Helsinki, respecting the anonymity of the research subjects and health centers. All physicians gave their consent for their participation by answering the form.

## Statistical Analysis

Categorical variables are expressed as number and percentage, and were analyzed with the  $\chi^2$  test or Fisher's test. Interval variables are described with the mean and median, according to their distribution and their measures of dispersion, standard deviation (SD) and range. Student's t test or Mann-Whitney U test were used to compare continuous variables, according to the distribution expressed. Two groups were formed for comparison according to the frequency of the dependent variable, considering trauma specialists with "1 or no episodes of low back pain" versus those with "2 or more episodes of low back pain". To dichotomize the dependent variable, the criterion used was that low back pain is a frequent condition in the adult population and it is estimated that 84% of adults suffer at least one episode of low back pain at some point in their lives.<sup>1,10-11</sup> A bivariate analysis was performed to estimate the association between independent variables and the outcome variable. Subsequently, binary logistic regression was performed as a multivariate analysis model to measure the strength of the associations that were statistically significant in the bivariate analysis. A p-value <0.05 was considered statistically significant. SPSS Statistics 25 was used for the analysis.

## RESULTS

Data were obtained from 393 completed questionnaires. The mean age of respondents was 46 years (SD =  $\pm 12$ ; range 28-81); 323 (82.2%) were male and 68 (17.3%) were female. Two (0.5%) chose not to answer about their sex. **Table 1** summarizes the sociodemographic characteristics of the sample.

Anthropometric characteristics were recorded according to body mass index and the presence of comorbidities among the trauma specialists in our sample (**Table 2**). 72.8% (n = 286) reported having one or no comorbidities. The median number of comorbidities is 1 (range 0-7). Smokers accounted for approximately 10% of the sample (n = 39; 9.9%). Considering the World Health Organization recommendations on weekly physical activity (2.5 to 5 h),<sup>12</sup> 43% (n = 170) had sedentary habits. According to body mass index, more than 50% were overweight, obese or morbidly obese (n = 260; 66.1%).

Regarding work activity, almost half of the sample worked more than 20 hours per week in the office and 41% (n=164) worked on call every week. The median time spent on surgical activity was 10 h per week (range 0-72). Surgeons stood for the majority of surgeries and sat for fewer than 25% of the procedures (n = 315; 80%). Approximately one-third (n = 123; 31%) used a lead apron during more than 50% of surgeries. The perception of job stress level of the surveyed specialists registered a median of 7 (range 0-10). The median perceived level of job satisfaction was 7 (range 0-10) (**Table 3**).

### Low Back Pain in Trauma Specialists

The majority of respondents (n = 338; 86%) reported having suffered at least one episode of low back pain in the last year and 38% (n = 149) more than four episodes (**Figure 1**). Fifty percent (n = 173) suffered pain with intensity >5 (according to the 0-10 visual analog scale), with a median low back pain score of 6 (range 0-10) (**Figure 2**). Acute episodes lasting less than 10 days predominated (n = 279; 81%) (**Figure 3**), with no request for complementary studies (n = 279; 81%) (**Figure 4**) or referral to a specialist (no referral: n = 312; 79.4%). Fewer than 10% of the trauma specialists who had suffered episodes of low back pain in the previous year took sick leave (n = 25; 6.4%). The median time off work was three days (range 0-30).

### Comparison according to low back pain

To facilitate multivariate analysis, categorical variables were dichotomized: work sector (public; private/both), body mass index ( $\geq 25$ ), weekly physical activity (<2 h of activity per week), years of work experience (>10 or <10), weekly office hours (>20 or <20), weekly on-call hours (0-12 h, >12 h), sitting during surgeries (>25% or <25% of surgeries), use of lead apron (>50% or <50% of surgeries), perception of work stress (>5 or <5).

**Table 1.** Sociodemographic characteristics of the sample

Variables		Results
Age; mean (SD; range)		46 ( $\pm$ 12; 28-81)
Sex, n (%)	Male	323 (82.2)
	Female	68 (17.3)
	Prefer not to say	2 (0.5)
Region, n (%)	AMBA	181 (46.2)
	Cuyo	18 (4.6)
	Northeast	29 (7.4)
	Northwest	27 (6.9)
	Pampa region	99 (25.3)
	Patagonia	38 (9.7)
Marital status; n (%)	Single	55 (14.1)
	Married	214 (55.0)
	Cohabiting	91 (23.4)
	Widowed	4 (1.0)
	Divorced	25 (6.4)
Number of children; median (range)		2 (0-4)
Work sector; n (%)	Public	43 (10.9)
	Private	143 (36.4)
	Both	207 (52.7)
Subspecialty; n (%)	Hip and knee (arthroplasty)	69 (17.6)
	Spine	43 (10.9)
	Arthroscopy	52 (13.2)
	Sports	13 (3.3)
	Pediatric orthopedics	32 (8.1)
	Upper limb	32 (8.1)
	Orthopedic oncology	3 (0.8)
	Leg, ankle and foot	49 (12.5)
	Trauma	57 (14.5)
	Other	43 (10.9)
Years in practice; median (range)	<5 years	94 (23.9)
	5-10 years	74 (18.8)
	11-15 years	67 (17.0)
	16-20 years	43 (10.9)
	>20 years	115 (29.3)

SD = standard deviation. AMBA = Buenos Aires Metropolitan Area (Autonomous City of Buenos Aires and districts of the province of Buenos Aires); Cuyo = Mendoza, San Juan, and San Luis; Northeast = Chaco, Corrientes, Formosa, and Misiones; Northwest = Catamarca, Jujuy, Tucumán, Salta, La Rioja, and Santiago del Estero; Pampa region = La Pampa, Buenos Aires, Córdoba, Entre Ríos, and Santa Fe; Patagonia = Neuquén, Río Negro, Santa Cruz, Tierra del Fuego.

**Table 2.** Clinical variables of the trauma specialists included in the sample.

Variables		Resultados
Number of comorbidities; median (range)		1 (0-7)
Smoking; n (%)		39 (9.9)
Physical activity; n (%)	None	73 (18.6)
	<2 h per week	97 (24.7)
	3-5 h per week	142 (36.1)
	5-8 h per week	62 (15.8)
	>8 h per week	19 (4.8)
Leisure time in hours per week; median (range)		6.50 (0-72)
BMI; n (%)	Underweight	1 (0.3)
	Normal	124 (32.2)
	Overweight	179 (46.5)
	Obesity	63 (16.4)
	Morbid obesity	18 (4.7)
Spinal pathology; n (%)		92 (23.4)
Spine surgery; n (%)		13 (3.3)

BMI = body mass index.

**Table 3.** Respondents' employment characteristics

Variables		Results
Office hours per week; n (%)	<20	198 50.4
	20-30	156 39.7
	>30	39 9.9
Operating room hours per week; median (range)		10 (0-72)
% of surgeries performed seated; n (%)	0	186 (47.3)
	0-25	129 (32.8)
	26-50	36 (9.2)
	51-75	25 (6.4)
	>75	17 (4.3)
On-call hours per week (minimum); n (%)	0	229 (58.3)
	12	25 (6.4)
	24	86 (21.9)
	36	11 (2.8)
	48	33 (8.4)
	72	9 (2.3)
% of surgeries with lead vest; n (%)	<25	203 (51.7)
	26-50	67 (17.0)
	51-75	86 (21.9)
	>75	37 (9.4)
Stress level; median (range)*		7 (0-10)
Level of job satisfaction; median (range)*		7 (0-10)

\*According to the ordinal scale from 0 to 10.

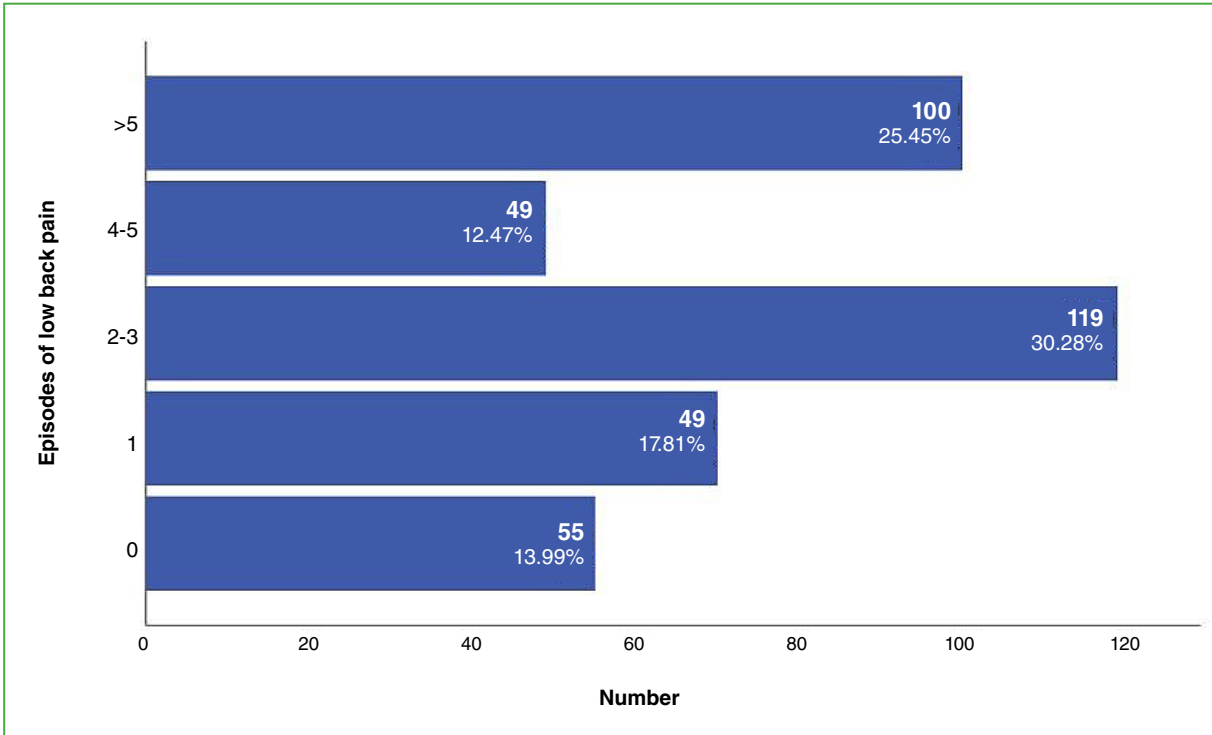


Figure 1. Bar graph: distribution of the number of episodes of low back pain in the previous year.

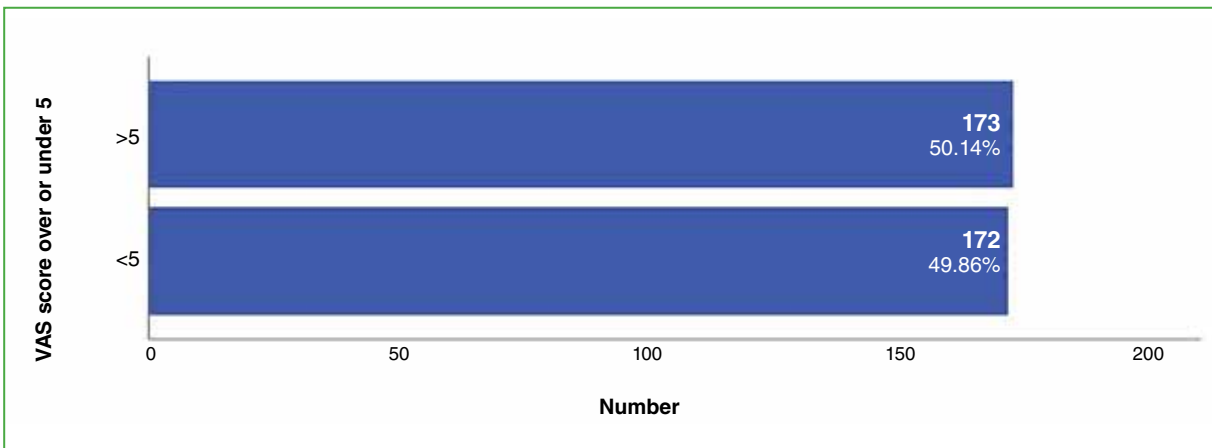


Figure 2. Bar graph: distribution of low back pain intensity (>5 or <5) according to the visual analog scale.

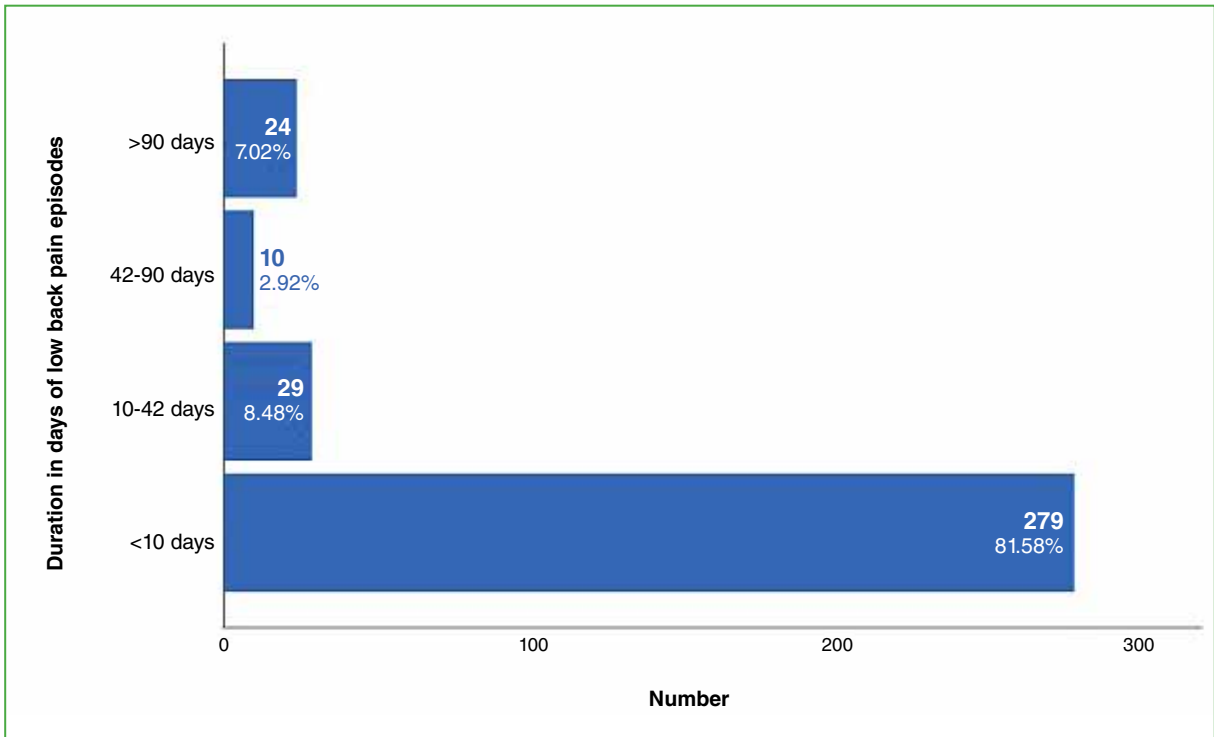


Figure 3. Bar graph: distribution of the duration of episodes of low back pain.

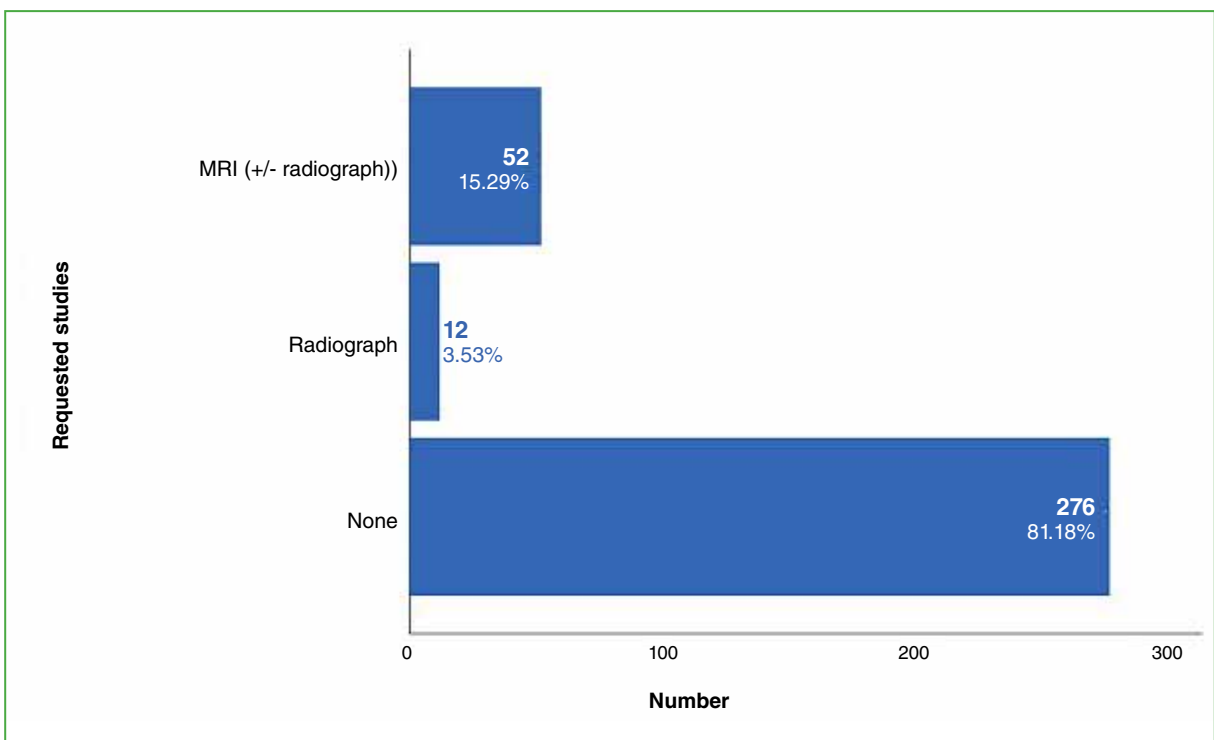


Figure 4. Bar graph: distribution of the request for studies.

As a result of the bivariate analysis when comparing the groups according to low back pain, “<1 episode” vs. “2 or more episodes”, the variables age ( $p = 0.046$ ), number of comorbidities ( $p < 0.001$ ), physical activity <2 h per week ( $p = 0.004$ ), previous spinal disease ( $p = 0.001$ ) and perception of work stress >5 ( $p = 0.026$ ) were statistically significant. **Table 4** lists all the variables included in the comparison.

**Table 4.** Comparison according to episodes of low back pain in the previous year ( $n = 393$ ).

Variables		<1 episodes (n = 125)	2 or more episodes (n = 268)	p
Age; mean (SD; range)		48 ( $\pm$ 11; 30-77)	45 ( $\pm$ 12; 28-81)	0.046
Sex, n (%)	Male	102 (81.6)	221 (82.5)	0.851
	Female	22 (17.6)	46 (17.2)	
	Prefer not to say	1 (0.8)	1 (0.4)	
Marital status; n (%)	Single/widowed/divorced	26 (20.8)	58 (21.6)	0.850
	Married/Cohabiting	99 (79.2)	210 (78.4)	
Work sector; n (%)	Public	11 (8.8)	32 (11.9)	0.353
	Private or both	114 (91.2)	236 (88.1)	
Number of comorbidities; median (range)		1 (0-4)	1 (0-7)	<0.001
BMI $\geq$ 25; n (%)		80 (64.0)	184 (68.7)	0.360
Smoking; n (%)		10 (8.0)	29 (10.8)	0.384
Physical activity <2 h per week; n (%)		41 (32.8)	129 (48.1)	0.004
Spinal pathology; n (%)		16 (12.8)	76 (28.4)	0.001
Spine surgery; n (%)		2 (1.6)	11 (4.1)	0.196
>10 years of experience; n (%)		80 (64.0)	145 (54.1)	0.065
>20 office hours per week; n (%)		62 (49.6)	133 (49.6)	0.996
On-call hours per week; n (%)	0-12	88 (70.4)	166 (61.9)	0.102
	>12	37 (29.6)	102 (38.1)	
Surgical hours per week; median (range)		10 (0-90)	10 (0-72)	0.470
Surgeries performed seated; n (%)	<25% of surgeries	97 (77.6)	218 (81.3)	0.386
	>25% of surgeries	28 (22.4)	50 (18.7)	
Use of lead vest; n (%)	<50% of surgeries	83 (66.4)	187 (69.8)	0.501
	>50% of surgeries	42 (33.6)	81 (30.2)	
Work stress >5; n (%)		103 (82.4)	242 (90.3)	0.026

SD = standard deviation.

Subsequently, as a result of the multivariate analysis through the binary logistic regression model, only the association of the variables age (odds ratio [OR] = 0.958; 95%CI = 0.938-0.979;  $p < 0.001$ ), number of comorbidities (OR=1.874; 95%CI=1.421-2.472;  $p < 0.001$ ), and physical activity  $< 2$  h (OR=1.813; 95%CI=1.139-2.887;  $p < 0.001$ ) remained statistically significant (Table 5).

**Table 5.** Binary logistic regression

Variables	OR	CI95%		p
		Lower	Upper	
Age	0.958	0.938	0.979	<0.001
Number of comorbidities	1.874	1.421	2.472	<0.001
Physical activity $< 2$ h/week	1.813	1.139	2.887	0.012

OR = odds ratio; 95%CI = 95% confidence interval.

The magnitude of the OR was higher for the number of comorbidities and for a sedentary lifestyle, estimated at  $< 2$  h of physical activity per week. Both variables were associated with an 87.4% and 81.3% increase, respectively, in the probability of having two or more episodes of low back pain. In the case of age, the odds ratio was close to 1 (0.958) and, from its value, it can be deduced that the probability of suffering two or more episodes of low back pain per year decreases by 4% for each year that age increases.

## DISCUSSION

Health professionals are exposed to occupational risk factors that predispose to the development of low back pain. Orthopedic and Traumatology physicians are constantly exposed to demanding physical conditions that result in a high risk of musculoskeletal disorders. It has been shown that long hours in the operating room, the use of radioprotection, poor posture, repetitive movements, and weight lifting in non-ergonomic postures are factors that predispose to chronic pain and altered quality of life. According to international literature, 40-83.9% of orthopedic surgeons have experienced episodes of low back pain or cervical discomfort, and awareness of the condition and how to prevent it is not a protective factor in this population.<sup>5-8,13-21</sup>

In the field of Traumatology and Trauma Surgery, Scheidt et al.<sup>17</sup> found that using lead aprons causes postural overload, which is associated with more frequent pain, even in healthy young surgeons. In this study, one-third of the sample used a lead vest during more than 50% of the surgeries, but this was not associated with a significant increase in the incidence of low back pain.

Occupational low back pain is considered the most costly form of work disability; the expenses caused by chronic low back pain exceed by a large margin those caused by acute episodes.<sup>20</sup> This highlights the importance of identifying the different risk factors associated with low back pain episodes. Several publications have identified personal factors (age, sex, smoking, obesity) and occupational factors (number of hours standing/sitting, weight load, stress). The findings regarding body mass index and its association with low back pain are contradictory; in some studies, there is a significant association.<sup>21-23</sup>

In agreement with published findings,<sup>7,21,25</sup> physical activity acts as a protective factor; in our study, a significant association was found between a sedentary lifestyle and episodes of low back pain. There was a significant positive association between the presence of comorbidities and low back pain. Although stress was significant, this was disregarded in the multivariate analysis; in both groups, the level of stress was high, with a mean perception of 7/10. No significant relationship was found with sex, smoking, years of work experience, weekly on-call duty, use of vests and operating from a sitting position.

In terms of age, the probability of suffering two or more episodes of low back pain per year decreases by 4% for each year that age increases. This finding, in addition to being counterintuitive, is related with an increase in prob-

ability; nonetheless, the researchers believe it is not clinically significant, despite its statistical significance. Other studies (Alnaami et al.,<sup>21</sup> Terzi and Altın,<sup>26</sup> Grant et al.,<sup>27</sup> and Cacciatori et al.<sup>28</sup>) have obtained similar results and associated them with greater stress and greater economic activity in young surgeons, and with the adaptation of the activity that is acquired with experience.<sup>24</sup>

Xu et al.<sup>28</sup> conducted a systematic review of the literature on musculoskeletal injuries in trauma specialists associated with the biomechanics of the specialty's surgeries. They found a high incidence of injuries, with a predominance of low back pain (15-89.5%), cervical pain, (14-74%) and upper limb pathologies (particularly tendinopathies, 50%). However, despite the high rates of chronic pain, trauma specialists were less likely to seek treatment and miss work than a typical patient. The findings of our study are similar: fewer than 10% took sick leave. These authors reported that up to one-third of the specialists would require surgery to resolve their musculoskeletal disease with the consequent need for sick leave and the possible alteration of their surgical performance (letting a less experienced assistant perform certain surgical procedures), which could generate an impact on care. Furthermore, they emphasized the need to improve the conditions of these specialists in order to protect them from injury and satisfy the growing requirements of an aging global population in need of greater trauma solutions.

The weakness of the present study is its cross-sectional design, which is less capable of estimating the relationship between variables and does not allow the precise establishment of cause-and-effect relationships like longitudinal designs. On the other hand, non-probability sampling may be subject to possible selection bias. The variable "geographic region" was heterogeneous and had unbalanced groups. Most of the professionals documented were working in the Buenos Aires Metropolitan Area and the Pampa region, with less representation from the rest of the geographical areas. For this reason, it was not evaluated in the comparison and was only documented for descriptive purposes.

The strength of the study is that, according to the authors, it is the first study to analyze the prevalence of low back pain in this subgroup of health professionals in our country, and that the results are similar to those reported in international publications on the subject. It represents an original contribution to our field.

## CONCLUSIONS

In our sample of physicians specializing in Orthopedics and Traumatology in Argentina, the prevalence of episodes of low back pain was high. Eighty-six percent reported having had at least one episode in the last year and 38% reported >4 episodes. Acute episodes lasting <10 days predominated, with no need for complementary studies. Fewer than 10% of the trauma specialists took sick leave due to low back symptoms. After multivariate analysis, the number of comorbidities, age, and having a sedentary lifestyle were associated with suffering two or more episodes of low back pain.

Conflict of interest: The authors have no conflicts of interest to declare.

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# Safety of Surgical Treatment for Thoracolumbar Fracture-Dislocations According to Surgical Timing

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## ABSTRACT

**Introduction:** Thoracolumbar fracture-dislocations account for 10% of traumatic spinal injuries and typically occur in the context of high-energy trauma. Our objective is to compare early complications in patients with thoracolumbar fracture-dislocation based on surgical timing, either before or after 24 hours from the trauma. **Materials and Methods:** This is a multicenter, retrospective cohort study of patients surgically treated for thoracolumbar dislocations, from January 1, 2014 to January 1, 2023. We included adult patients (>18 years old) of any gender, surgically treated for high-energy thoracolumbar fracture-dislocations. Patients were grouped based on when they underwent spinal surgery: before or after 24 hours following trauma. Total and grouped complications were recorded. **Results:** Our sample comprised 72 patients, with 64 men (88.9%) and 8 women (11.1%) at an average age of 35.94 years. Occupational health care centers were predominant (n=60; 83.3%). Road traffic accidents (n=42; 58.3%) were the most frequent cause of injury, followed by falls from height (n=26; 36.1%). Furthermore, 86% of patients had one or more associated injuries. In total, 283 complications were recorded, with 67 patients (93.1%) suffering at least one complication, and 26 patients (36.1%) experiencing surgical complications. The median number of complications was significantly higher in late-operated patients (p=0.004). **Conclusions:** Patients with thoracolumbar dislocations who underwent surgery after the first 24 hours following trauma had a significantly higher median rate of complications than those who underwent early surgery.

**Keywords:** Complications; thoracolumbar dislocations; spinal cord injury; reduction and arthrodesis; spine surgery; safety.

**Level of Evidence:** IV

## Seguridad de la cirugía de luxofracturas vertebrales toracolumbares según la oportunidad quirúrgica

## RESUMEN

**Introducción:** Las luxofracturas vertebrales toracolumbares se producen por traumatismos de alta energía, representan el 10% de las lesiones traumáticas de la columna vertebral y se asocian frecuentemente con otras lesiones. El objetivo de este estudio fue comparar las complicaciones tempranas en pacientes con una luxofractura toracolumbar según la oportunidad quirúrgica, antes o después de las 24 h del trauma. **Materiales y Métodos:** Estudio multicéntrico, analítico, observacional y retrospectivo de una cohorte de pacientes operados por una luxofractura toracolumbar, desde el 1 de enero de 2014 hasta el 1 de enero de 2023. Se incluyó a pacientes de ambos sexos, >18 años, operados por una luxofractura vertebral de alta energía. Se los agrupó según si habían sido operados de columna antes o después de las 24 h del trauma. Se registraron las complicaciones totales y agrupadas. **Resultados:** Se evaluó a 72 pacientes, 64 hombres (88,9%) y 8 mujeres (11,1%), con una edad promedio de 35.94 años. Predominaron las instituciones laborales (n = 60; 83,3%). El mecanismo de lesión más frecuente fueron los accidentes de tránsito (n = 42; 58,3%), seguidos de las caídas de altura (n = 26; 36,1%). El 86% sufrió una o más lesiones asociadas. Se registraron 283 complicaciones en 67 (93,1%) pacientes y 45 complicaciones quirúrgicas en 26 pacientes (36,1%). La mediana de complicaciones fue mayor en pacientes operados tardíamente (p = 0,004). **Conclusiones:** Los pacientes con luxofractura toracolumbar operados después de las primeras 24 h presentaron una mediana de complicaciones totales significativamente mayor que los operados precozmente.

**Palabras clave:** Trauma vertebromedular; luxofracturas vertebrales; reducción y artrodesis; cirugía de columna; complicaciones; seguridad.

**Nivel de Evidencia:** IV

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**How to cite this article:** Ricciardi GA, Pons Belmonte R, Cirillo JI, Garfinkel I, Ortiz F, Zuliani P, López F. Safety of Surgical Treatment for Thoracolumbar Fracture-Dislocations According to Surgical Timing. *Rev Asoc Argent Ortop Traumatol* 2024;89(1):42-52. <https://doi.org/10.15417/issn.1853-7434.2024.89.1.1853>

## INTRODUCTION

Thoracolumbar fracture dislocations (TLFD) are caused by high-energy trauma. They account for 10% of traumatic spinal injuries and are frequently associated with other injuries (vertebral and non-vertebral).<sup>1-3</sup>

The morbidity of polytraumatized patients, as well as the usual concomitant neurological injury, may condition the therapeutic window of opportunity of TLFDs.<sup>1-5</sup> This occurs because these are highly unstable injuries that require reduction and surgical stabilization, usually with long instrumentation and through a conventional posterior approach. As a result, the procedure will include the physiological impact of surgery, as well as the risk of second injury and eventual complications.<sup>4-6</sup> As an additional complexity, the definition of 'polytrauma' is highly variable in the literature on the therapeutic approach to patients with thoracolumbar fracture-dislocation. This implies a possible selection bias when including polytraumatized patients, or registration bias when documenting polytrauma as a variable. The Berlin definition was proposed by consensus in 2014 to resolve this conflict; however, it is still not widely used in spinal trauma publications.<sup>1-6</sup> This definition combines the severity of the associated injuries with at least one of five complementary parameters (age, systolic blood pressure, Glasgow scale, APTT value or base excess).<sup>7</sup>

The first 24 hours after trauma represent the crucial interval for decompression in patients suffering spinal trauma and associated neurological injury.<sup>8-12</sup> TLFDs additionally include mechanical instability, which plays an important role in the development of traumatic neurological injury. This leads to a greater difficulty in complying with the critical intervals proposed in the literature, which are related to the need for implants in an emergency.<sup>13</sup> Furthermore, the safety of the procedure is controversial, especially because TLFDs have a higher rate of complications compared to other traumatic spinal injuries of lesser magnitude.<sup>14-16</sup>

Our objective was to compare the rate of early complications (90 days) in patients with thoracolumbar fracture-dislocation according to surgical timing: within or after 24 hours following trauma.

## MATERIALS AND METHODS

Analytical, observational, retrospective study of a multicenter cohort of patients operated on for TLFD between January 2014 and January 2023.

Adult patients of both sexes, >18 years old, operated on for traumatic TLFD were included. Thoracolumbar dislocations and fracture-dislocations were considered, according to the definition of the *AO Spine Thoracolumbar Injury Classification System*.<sup>17</sup> This system groups as type C any traumatic spinal injury with segmental involvement of both anterior and posterior structures and translation (potential or evident) beyond the physiological range in any of the three planes of space (coronal, axial or sagittal). Patients with incomplete records, revision surgeries, penetrating trauma or follow-up <90 days were excluded.

The presence of early complications, defined as complications within 90 days of admission, was considered the primary outcome measure. In addition, to facilitate their description, complications were divided into the following subgroups: clinical or systemic, surgical, related to spine and spinal cord trauma, and others. Surgical complications were sub-grouped according to the Clavien-Dindo classification (categories I to V according to severity).<sup>18</sup> Due to the severity of this injury and the frequent complications in patients with spinal fracture dislocations, the variable "major complications" (presence or absence) was defined and dichotomized as the presence of one or more of the following complications: clinical complications (sepsis, hemodynamic shock, multiple organ failure, respiratory distress, nosocomial pneumonia), grade III or greater surgical complications (according to the Clavien-Dindo classification); or complications of the spinal trauma, which resulted in re-intervention, surgical intervention, or death of the patient. Secondly, the time frame of functional and neurological recovery was analyzed. The time elapsed in days from spinal injury to functional independence was considered for rehabilitation, either sitting at the edge of the bed or in the wheelchair in the case of severe neurological injury, or walking for those without injury or mild neurological injury. The evolution of the neurological status was recorded with the *American Spinal Injury Association Impairment Scale* (AIS) at the last available follow-up record.<sup>19</sup>

The following variables were also recorded: age, sex, type of health institution, mechanism of trauma, comorbidities, neurological status on admission, associated traumatic injuries, hemodynamic instability, Glasgow

scale, vertebral injury topography, classification, presence of other vertebral fractures, days of hospitalization, days of intensive care, days of mechanical ventilation, type of surgery and instrumentation levels.

Patients were grouped according to surgical timing, before or after 24 h, a cut-off value chosen according to the current literature.<sup>8-12</sup>

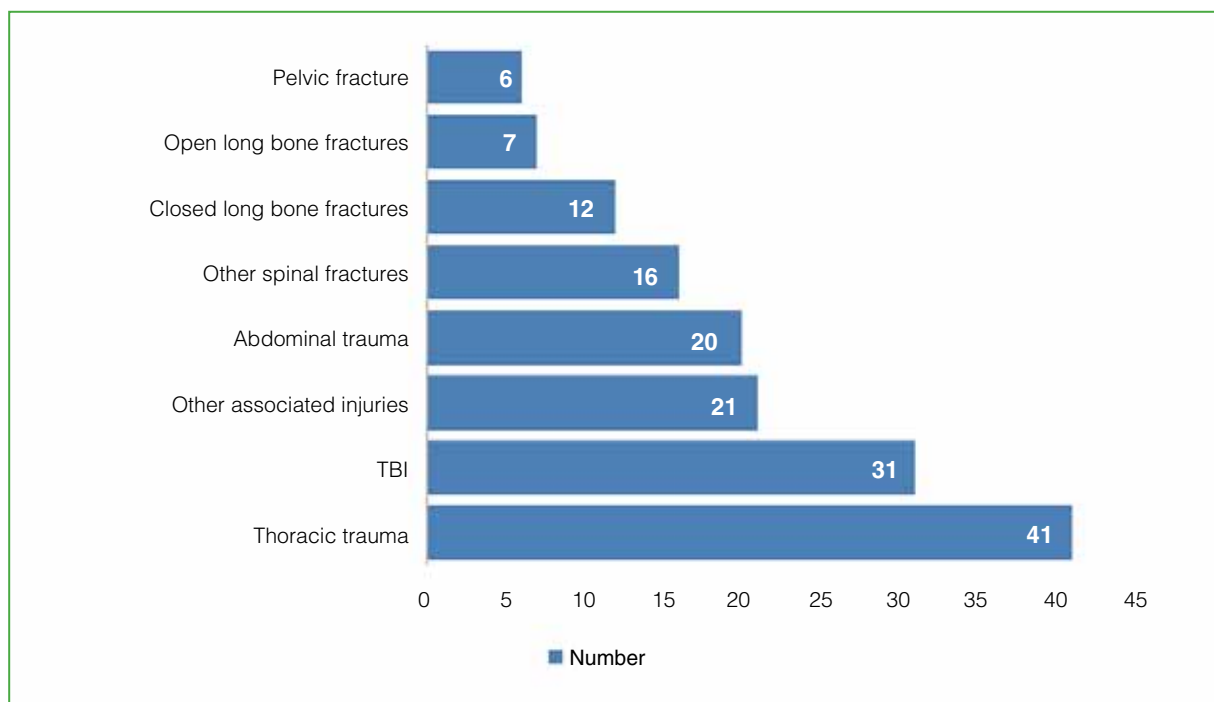
This study was conducted in accordance with the Declaration of Helsinki regarding observational research with personally identifiable information. The records were anonymous and confidential.

### Statistical Analysis

Categorical variables are expressed as number and percentage, and were analyzed with the  $\chi^2$  test or Fisher's test. Numerical variables are described as mean and median, according to their distribution and their measures of dispersion, standard deviation and range. For the comparison of continuous variables, Student's t test or Mann-Whitney's U test were used, according to the distribution expressed. The correlation between the numerical variable 'complications' and the variables 'surgical timing', 'days of hospitalization', 'days in intensive care', and 'days of mechanical ventilation' was studied. Pearson's correlation (parametric variables) or Spearman's rho coefficient (nonparametric variables) was used, according to the result of the normality tests of the variables. The analysis was performed with SPSS Statistics 25.

## RESULTS

Ninety-two patients were included and 20 were excluded after applying the selection criteria. The study sample consisted of 72 patients, 64 men (88.9%) and eight women (11.1%), with an average age of 35.94 years, mostly treated in labor institutions (n = 60; 83.3%). The predominant origin of trauma was traffic accidents (n = 42; 58.3%), followed by falls from great heights (n = 26; 36.1%). Thoracic (n = 34; 47.2%) and thoracolumbar junction (n = 31; 43.1%) fracture-dislocations predominated; less than 10% of the injuries were to the lower lumbar spine. The majority had at least one associated injury (n = 62; 86.1%). Thoracic trauma was the most frequent associated injury (n = 41; 56.9%), followed by traumatic brain injury (n = 31; 43%), and abdominal trauma (n = 20; 27.7%) (Figure 1). Table 1 describes the demographic and clinical characteristics of the entire sample.



**Figure 1.** Horizontal bar graph: distribution of the number of associated injuries. The category "Other associated injuries" groups together various injuries that are poorly represented individually.

**Table 1.** Sample description ( n = 72)

Variables		Results
Age; mean (range)		35.94 ( $\pm$ 12.9; 8-79)
Sex, n (%)	Male	64 (88.9%)
	Female	8 (11.1%)
Type of institution; n (%)	Public	10 (13.9%)
	Private	2 (2.8%)
	Occupational	60 (83.3%)
Mechanism of injury; n (%)	Traffic accident	42 (58.3%)
	Fall from a great height	26 (36.1%)
	Direct trauma	3 (4.2%)
	Other	1 (1.4%)
Topography; n (%)	Thoracic (T1-T9)	34 (47.2%)
	Thoracolumbar junction (T10-L2)	31 (43.1%)
	Lower lumbar spine (L3 to sacrum)	7 (9.7%)
Direction of displacement; n (%)	Anteroposterior	54 (79.4%)
	Lateral	10 (14.7%)
	Rotational	4 (5.9%)
Comorbidities (number); median (range)		2 (0-4)
Associated injuries in number; median (range)		2 (0-8)
AIS at admission; n (%)	A	36 (50.0%)
	B	7 (9.7%)
	C	5 (6.9%)
	D	3 (4.2%)
	E	14 (19.4%)
	Not assessable	7 (9.7%)
Complications, n (%)		67 (93.1%)
Complications (number); median (range)		3 (0-11)
Neurological recovery; n (%)		10 (20.0%)
Deaths; n (%)		1 (1.4%)
Follow-up in days; median (range)		580 (90-4503)

SD = standard deviation; AIS = ASIA Impairment Scale.

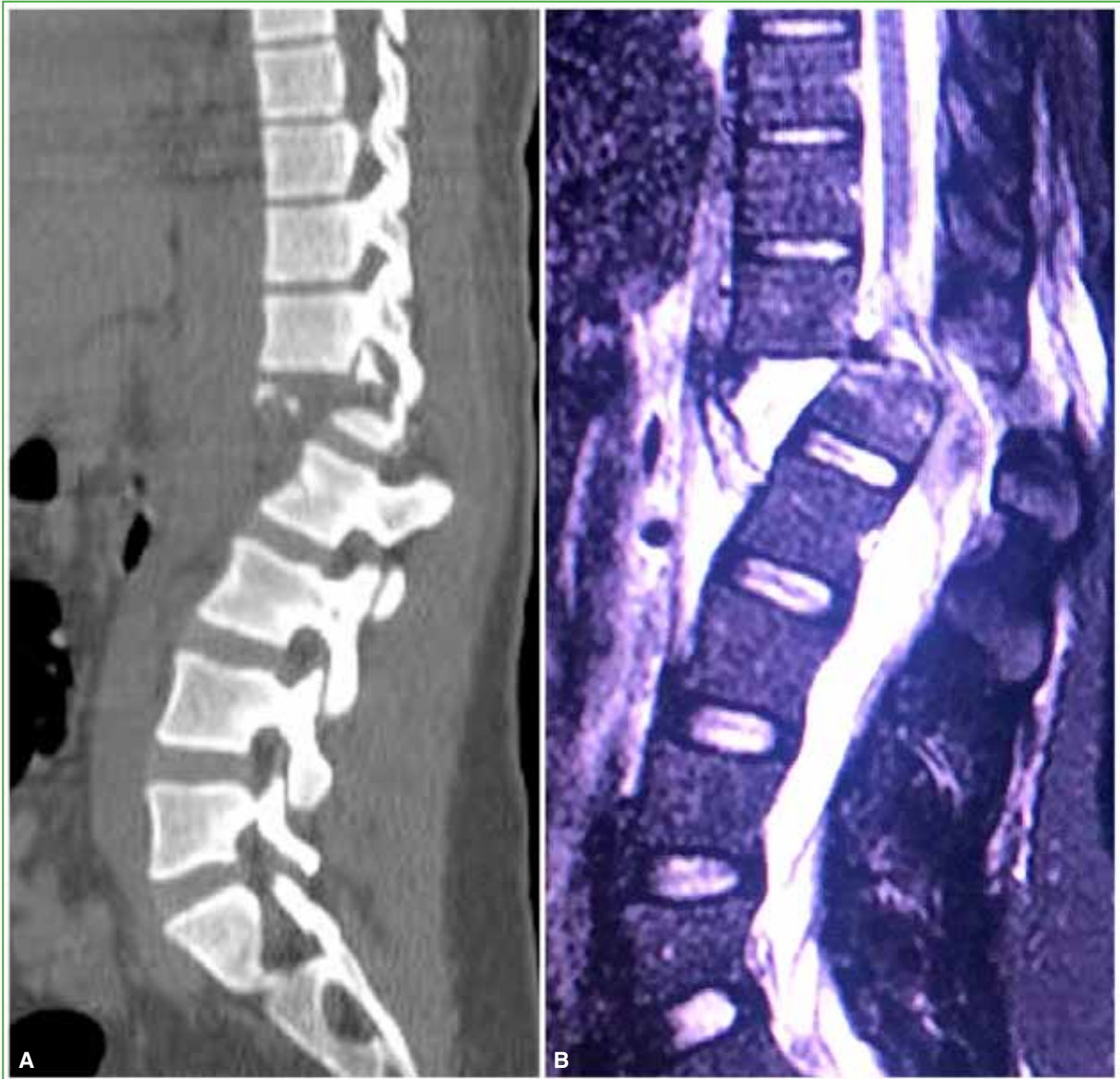
A total of 283 complications were recorded in 67 (93.1%) patients. There were 45 surgical complications in 26 patients (36.1%), 22 of which (48%) were grade III of the Clavien-Dindo classification (complications requiring some surgical, endoscopic or radiographic intervention) (Table 2, Figure 2).

Seventy percent had neurological deficits on admission; 50% of the sample was admitted with a complete spinal cord syndrome (AIS A). Neurological recovery was documented in 10 patients (20%). The 90-day mortality rate was less than 2% (n = 1; 1.4%).

**Table 2.** Types of complications

Complications	n	(%)
Neurogenic bladder or bowel	53	(73.6)
Urinary tract infection	28	(38.9)
Depression	28	(38.9)
Decubitus bedsores	22	(30.6)
Pneumonia	20	(27.8)
Surgical site infection	15	(20.8)
Other infections	14	(19.4)
Wound dehiscence	12	(16.7)
Neurogenic shock	11	(15.3)
Sepsis	10	(13.9)
Other clinical complications	10	(13.9)
Hypovolemic shock	8	(11.1)
Other complication associated with spinal trauma	7	(9.7)
DVT/PTE	6	(8.3)
Septic shock	5	(6.9)
Empyema	5	(6.9)
Respiratory distress	5	(6.9)
Incomplete reduction	5	(6.9)
Acute renal failure	4	(5.6)
Hematoma at the surgical site	3	(4.2)
Implant loosening/breakage	3	(4.2)
Loss of reduction	2	(2.8)
Nonunion	2	(2.8)
Multiple organ failure	1	(1.4)
Neurovascular injury	1	(1.4)
Progression of neurological status	1	(1.4)
Other surgical complications	1	(1.4)
Cerebrospinal fluid fistula	1	(1.4)

DVT/PTE = deep vein thrombosis/pulmonary thromboembolism.

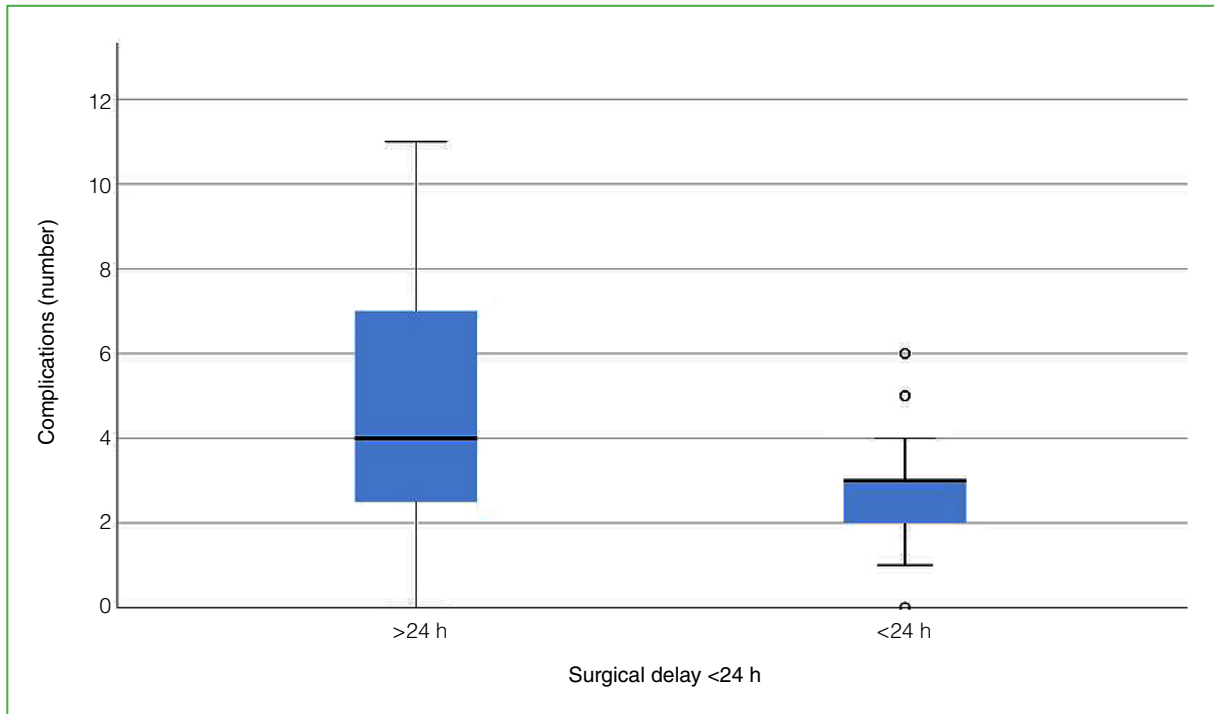


**Figure 2.** Images of a thoracolumbar fracture-dislocation. A. Computed tomography of the thoracolumbar spine, sagittal view. An L1-L2 fracture-dislocation is observed. B. Magnetic resonance imaging, thoracolumbar spine, sagittal view. The completely severed neuraxis is observed.

### Comparison according to surgical timing (before or after 24 h).

Two groups were obtained according to the timing of spinal surgery: before ( $n = 33$ ) or after the first 24 h ( $n = 36$ ) following trauma. The median number of total complications was higher in patients operated on late, a statistically significant finding ( $p = 0.004$ ) (Figure 3). Major complications were more frequent in patients operated on after 24 h, but without statistical significance ( $p = 0.125$ ).

Other variables with a statistically significant association with surgical treatment after 24 h were: type of institution ( $p = 0.005$ ; no patient outside the occupational sector underwent surgery within 24 h and, in the public sector, within 14 days from trauma); number of associated injuries ( $p < 0.001$ ), thoracic ( $p = 0.001$ ), abdominal ( $p = 0.004$ ) and long bone ( $p = 0.017$ ) trauma; days in intensive care ( $p < 0.001$ ); and mechanical ventilation ( $p = 0.006$ ).



**Figure 3.** Box plot: distribution of complications according to surgical timing.

There was a positive linear correlation between the number of complications and surgical timing in hours from trauma to surgery (Spearman's  $\rho = 0.403$ ;  $p = 0.001$ ) and total days of hospitalization (Spearman's  $\rho = 0.423$ ;  $p < 0.001$ ), days in intensive care (Spearman's  $\rho = 0.588$ ;  $p < 0.001$ ), and mechanical ventilation (Spearman's  $\rho = 0.640$ ;  $p < 0.001$ ).

Neurological recovery by at least 1 grade on the AIS scale was more frequent in patients operated on before 24 h; however, the difference was not statistically significant ( $p = 0.065$ ). The onset of functional recovery was early in patients operated on before 24 h ( $p < 0.001$ ). [Table 3](#) summarizes the results of the comparison.

## DISCUSSION

TLFDs are caused by high-energy trauma involving simultaneous and multidirectional forces (flexion/extension, rotation and compression), resulting in a circumferential capsule-disc-ligament injury and the development of spinal injuries with translational instability.<sup>17</sup> These types of severely mechanically unstable injuries should be reduced and stabilized as soon as possible, but surgical timing remains controversial. It is mostly influenced by polytrauma in the patient, as well as vertebral/spinal cord trauma.<sup>7-12</sup>

The magnitude of the first trauma-associated injury is the main prognostic parameter for the clinical outcome of the patient after multiple high-energy trauma.<sup>20</sup> It should be noted that the eventual complications that may ensue during the initial evolution will determine the beneficial or adverse outcome of this group of patients. These secondary events include, among others, septic complications, single or multiple organ dysfunction, and acute lung injury or acute respiratory distress syndrome.<sup>20</sup> The potential unfavorable impact of surgical procedures on the physiologic response to trauma has been estimated; in this scenario, definitive spine surgery is typically associated with higher mortality rates in early operated patients.

**Table 3.** Comparison according to surgical timing before or after the first 24 h.

Variables		Surgical timing				p
		More than 24 h after trauma (n = 36)		Within the first 24 h after trauma (n = 33)		
Age; mean (SD; range)		37	15 (8-79)	36 (11; 20-60)		0.814
Sex, n (%)	Male	30	(83.3)	31	(93.9)	0.169
	Female	6	(16.7)	2	(6.1)	
Hospital; n (%)	Public	8	(22.2)	0	(0)	0.005
	Private	2	(5.6)	0	(0)	
	Occupational	26	(72.2)	33	(100)	
Mechanism of injury; n (%)	Traffic accident	23	(63.9)	17	(51.5)	0.269
	Fall from a great height	12	(33.3)	14	(42.4)	
	Direct trauma	0	(0.0)	2	(6.1)	
	Other	1	(2.8)	0	(0.0)	
Topography; n (%)	Thoracic (T1-T9)	18	(50.0)	15	(45.5)	0.931
	Thoracolumbar junction (T10-L2)	15	(41.7)	15	(45.5)	
	Lower lumbar spine (L3 to sacrum)	3	(8.3)	3	(9.1)	
Displacement; n (%)	Anteroposterior	29	(82.9)	24	(75.0)	0.691
	Lateral	4	(11.4)	6	(18.8)	
	Rotational	2	(5.7)	2	(6.3)	
Classification; n (%)	A0/A1/A2	5	(13.90)	6	(15.90)	0.627
	A3/A4	31	(86.10)	27	(81.80)	
Comorbidities (number); median (range)		2	(0-4)	1	(0-4)	0.101
Associated injuries (number); median (range)		2	(0-8)	1	(0-5)	<0.001
Specific injuries; n (%)						
TBI		18	(50.0)	12	(36.4)	0.254
Thoracic trauma		27	(75.0)	11	(33.3)	0.001
Abdominal trauma		14	(38.9)	3	(9.1)	0.004
Closed fractures of long bones		10	(27.8)	2	(6.1)	0.017
Open fractures of long bones		3	(8.3)	2	(6.1)	0.716
Pelvic fracture		4	(11.1)	2	(6.1)	0.457
Other vertebral fractures		10	(27.8)	5	(15.2)	0.204
Other associated injuries		14	(39)	6	(18)	0.058
Hemodynamic instability; n (%)		11	(31)	4	(12)	0.64
Glasgow $\leq 8$ ; n (%)		6	(17)	4	(12)	0.592
Neurological deficit; n (%)		22	(61)	27	(82)	0.058
AIS at admission; n (%)	A	18	(50)	16	(48)	0.137
	B	1	(3)	6	(18)	
	C	2	(6)	3	(9)	
	D	1	(3)	2	(6)	
	E	8	(22)	5	(15)	
	Not assessable	6	(17)	1	(3)	
Days in ICU; median (range)		14	(0-90)	4	(0-34)	<0.001
Days of hospitalization; median (range)		55	(11-329)	44	(5-205)	0.112
Days of mechanical ventilation; median (range)		0	(0-30)	0	(0-25)	0.006
Complications (number); median (range)		4	(0-11)	3	(0-6)	0.004
Major complications; n (%)		27	(75)	19	(58)	0.125
Neurological recovery; n (%)		2	(9)	8	(31)	0.065
Functional recovery (days); n (%)		23	(4-246)	6	(2-75)	<0.001

SD = standard deviation; TBI = traumatic brain injury; ICU = intensive care unit.

According to the *Advanced Trauma Life Support* guidelines, surgical specialties should prioritize, during the initial hours, damage control surgery procedures and, in the case of unstable vertebral lesions, perform an individual analysis of each case, considering, in the absence of neurological damage, the possibility of delaying the definitive surgical treatment until the inflammatory response associated with the trauma has been overcome.<sup>20</sup> The persistent controversies in this regard, the lack of a specific cut-off point for definitive surgical timing and especially the remarkable mechanical instability of these lesions motivated the authors to describe the results on the safety of TLF treatment according to surgical timing.

In our series, the predominant mechanism of injury was traffic accidents, followed by falls from great heights. In agreement with previous publications, young adult male patients predominated.<sup>2-7</sup>

Concomitant traumatic injuries are frequent. In a study of 733 patients with traumatic spinal injuries, Reinhold et al. described associated injuries in 66% of the cases.<sup>6</sup> In our sample, 86% of the patients had at least one concomitant traumatic injury, the most frequent being thoracic trauma, followed by traumatic brain injury.

There are differences between countries and regions of the world in the care of vertebral/spinal cord trauma, which has an impact on surgical timing.<sup>13</sup> In a multicenter retrospective cohort of Latin American institutions that included 547 patients with unstable thoracolumbar fractures (type B and type C), Guiroy et al. documented surgical time frames beyond 72 h in more than half of the patients and >1 week in a quarter of the sample. In our series, 50% of patients underwent surgery after 24 hours. It should be noted that patients operated on in occupational accident centers predominated. No patient in the public sector was able to undergo surgery before 14 days of evolution of the trauma.

The high complication rate of thoracolumbar fracture-dislocations has been recorded in previous publications.<sup>3,6,7,13,15,16,21</sup> In our region, Latin America, Guiroy et al. described a rate of 47% in 113 patients with type C fractures.<sup>13</sup> In our series, the complication rate was high, as at least one complication was documented in almost all patients in the sample (n = 67; 93.1%). Major complications occurred in 63.8% and 26 had surgical complications. This could be related to multiple factors specific to our sample, such as the high prevalence of associated injuries (86%) and the linear correlation obtained between the number of complications and the surgical time frame in hours from trauma to surgery, general hospitalization, intensive care hospitalization, and mechanical ventilation. The median number of complications was significantly higher in patients operated on beyond 24 h; however, there were no statistically significant differences in the presence or absence of major complications based on surgical timing before or after 24 h. It is estimated that the early surgery strategy did not significantly increase morbidity in this group of patients, which is consistent with the reported results.<sup>22,23</sup>

The efficacy of early surgery in the recovery of patients with vertebral and spinal cord trauma and neurological deficit has been extensively studied and remains a controversial issue.<sup>8-12,22,23</sup> However, there is consensus on the safety of early intervention (before 24 h) and its recommendation.<sup>22,23</sup> In our sample, 10 patients had neurological recovery in at least one grade of the ASIA scale, and 80% of the cases of recovery occurred in the group of those operated on early. It should be noted that this difference was not statistically significant (p = 0.065). The authors assume that the lack of statistical significance of this estimate may be related to the insufficient statistical power of our research for this result. In addition, patients with type C fractures (all fractures in our sample) have a worse prognosis for neurological recovery and the amount of preoperative spinal translation is highly predictive of complete spinal cord injury and the likelihood of postoperative neurological recovery.<sup>24,25</sup> Lambrechts et al. have suggested that preoperative spinal translation >6.10 mm would be predictive of complete spinal cord injury.<sup>25</sup>

The weaknesses of this study are its observational, retrospective nature and the low sample size, which prevent generalization of its conclusions. Additionally, it was not possible to differentiate between the causes that led to surgery after the first 24 hours of trauma. Its methodological design does not allow establishing a cause-effect relationship between surgical timing and the outcome in terms of complications. However, it provides us with an estimate of the safety of early treatment in a multicenter cohort of patients with spinal fracture-dislocations, injuries with frequent severe neurological damage and associated injuries that condition timely treatment. It also provides regional data on a situation that requires the timely allocation of a large amount of human and economic resources and that constitutes a challenge to be resolved in our country and in Latin America.

## CONCLUSIONS

Patients with TLFDD operated on after the first 24 h had a significantly higher median total complications than those operated on earlier. These findings suggest the importance of considering the timing of surgery before 24 h, without detriment to the safety of the intervention and with the possibility of positively influencing the neurological and functional recovery of patients.

Conflict of interest: no conflicts of interest to declare.

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# Treatment of Isolated “Floating Lateral Mass” Fractures of the Cervical Spine: A Case Series

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## ABSTRACT

**Introduction:** We report a series of patients with “floating lateral mass” cervical fractures, focusing on the role of disc injury in potential segmental instability. **Materials and Methods:** We conducted a descriptive and retrospective study on a case series of isolated floating lateral mass facet fractures diagnosed between January 1, 2016 and January 1, 2022. Patients with floating lateral mass lesions according to the AO classification, diagnosed by computed tomography, and at least 6 months of follow-up were included. Patients with pathological fractures, bone fragility injuries and incomplete records were excluded. **Results:** We included 16 cases, the average age was 42.86 (SD 12.396), and the majority were male (n=13; 81.25%). 68.75% (n=11) had intervertebral disc injury in the fractured segment, while 18.75% (n=3) had anterolisthesis. Conservative treatment was proposed for 12 weeks in 11 patients (68.75%), of whom 5 (45.4%) achieved fracture healing and 6 (54.6%) progressed to translation. Cases where conservative treatment failed were associated with intervertebral disc injury. Eleven patients were treated surgically, mostly with monosegmental anterior cervical arthrodesis. **Conclusions:** We report a series of cases in which the existence of an associated intervertebral disc injury was more frequent in patients with failed conservative treatment and in those initially treated with arthrodesis. Most of the surgical cases were treated using an anterior approach with discectomy and anterior cervical arthrodesis at a single level, with favorable outcomes.

**Keywords:** Facet fractures; cervical; trauma; floating lateral mass; F3.

**Level of Evidence:** IV

## Tratamiento de las fracturas cervicales aisladas de tipo “masa lateral flotante”: serie de casos

### RESUMEN

**Objetivo:** Presentar una serie de casos de pacientes con fracturas cervicales de tipo “masa lateral flotante” con énfasis en describir el rol de la lesión discal en la potencial inestabilidad segmentaria. **Materiales y Métodos:** Se realizó un estudio descriptivo y retrospectivo de una serie de pacientes con fracturas facetarias de tipo “masa lateral flotante”, aisladas, diagnosticadas entre el 1 de enero de 2016 y el 1 de enero de 2022. Se incluyeron pacientes con lesiones de tipo “masa lateral flotante” según la clasificación AO, diagnosticadas por tomografía computarizada y, al menos, 6 meses de seguimiento. Se excluyó a aquellos con fracturas patológicas, lesiones por fragilidad ósea y registros incompletos. **Resultados:** Se analizó a 16 pacientes (media de la edad 42.86; DE 12,396), con predominio del sexo masculino (81,25%). El 68,75% tenía una lesión del disco intervertebral en el segmento fracturado y el 18,75%, anterolistesis. A 11 pacientes se les propuso un tratamiento conservador durante 12 semanas. La fractura consolidó en el 45,4% y 6 (54,6%) evolucionaron con traslación. El fracaso del tratamiento conservador se asoció con lesión del disco intervertebral. Once pacientes fueron operados, en su mayoría, con artrodesis cervical anterior monosegmentaria.

**Conclusiones:** En esta serie de casos, la presencia de una lesión asociada del disco intervertebral fue más frecuente cuando el tratamiento conservador fracasó y cuando se decidió una artrodesis como tratamiento inicial. La mayoría de las cirugías se realizaron por vía anterior con discectomía y artrodesis cervical anterior en un único nivel, y se lograron buenos resultados.

**Palabras clave:** Fracturas facetarias; cervical; trauma; masa lateral flotante; F3.

**Nivel de Evidencia:** IV

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**How to cite this article:** Cirillo JI, Peña E, Ricciardi GA, Contreras M, Pons Belmonte R, Vía Dorado J, Carazzo C. Treatment of Isolated “Floating Lateral Mass” Fractures of the Cervical Spine: A Case Series *Rev Asoc Argent Ortop Traumatol* 2024;89(1):53-58. <https://doi.org/10.15417/issn.1852-7434.2024.89.1.1860>

## INTRODUCTION

*Floating lateral mass* facet fractures are a unique subset of cervical spine fractures and comprise approximately 10% of all subaxial fractures.<sup>1,2</sup> The AO classification system for subaxial cervical spine injuries groups facet injuries into four types (from F1 to F4).<sup>3</sup> Type F3 includes injuries called floating lateral mass, characterized by simultaneous fractures of the pedicle and lamina that result in the disconnection of the superior and inferior articular processes at a given level, posing the risk of mechanical instability, and their treatment is controversial.<sup>1,2,4</sup> These fractures often go unnoticed, because they are difficult to diagnose on simple radiographs and usually occur with minimal or no displacement.<sup>1-4</sup>

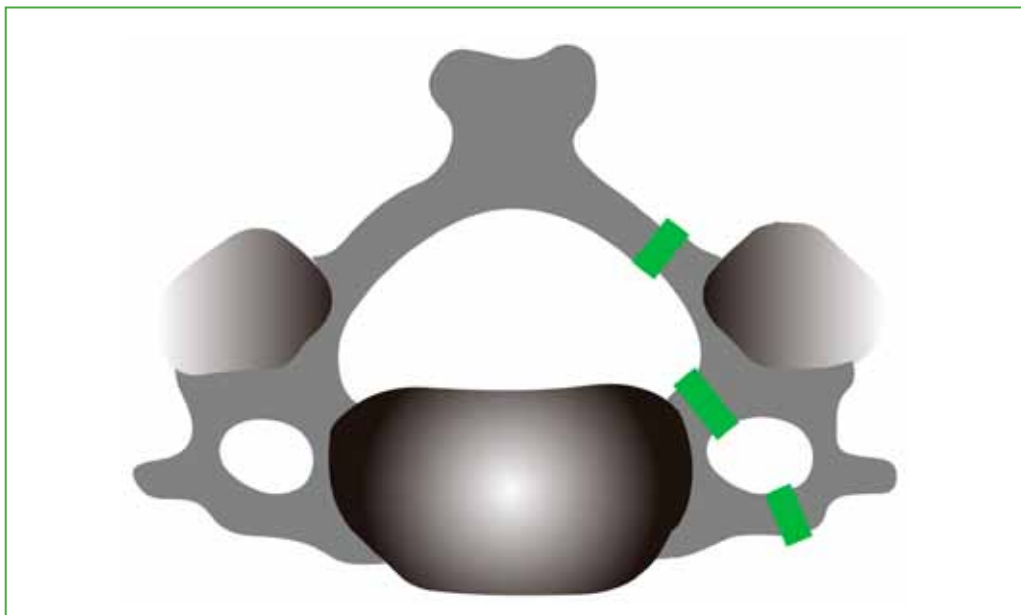
The treatment for this particular group of cervical injuries is still controversial.<sup>5</sup> The indications for orthopedic treatment are not yet clear, as are the factors associated with the failure of conservative treatment.<sup>1-7</sup> In published cases, anterior cervical discectomy and fusion of one or more levels and three-level posterior fusion have been described as possible surgical alternatives for these injuries.<sup>6</sup> Previous publications suggest that the state of the intervertebral disc of the injured segment is a key variable for decision-making.<sup>6</sup> In this way, when the disc is not injured, orthopedic treatment may be indicated. In addition, in surgical cases, the anterior fusion depends on the condition of the adjacent discs. When there is no additional disc involvement to the injured segment, single-level fusion is allowed, with good functional and radiological outcomes.<sup>6</sup>

The objective of this article is to report a series of patients with *floating lateral mass* cervical fractures with an emphasis on describing the role of disc injury in potential segmental instability.

## MATERIALS AND METHODS

A descriptive and retrospective study was conducted on a series of isolated cases of *floating lateral mass* facet fractures diagnosed between January 1, 2016 and January 1, 2022, at a single Center.

Patients with *floating lateral mass* injuries according to the AO classification ([Figure 1](#)), diagnosed by computed tomography (CT) and with at least six months of follow-up, were included.<sup>3</sup> Fractures of the subaxial cervical spine with simultaneous involvement of the pedicle and lamina, resulting in the disconnection of the superior and inferior articular processes at a given level, were classified as *floating lateral mass* or F3.



**Figure 1.** Graphic describing the characteristics that define type F3 fractures (or *floating lateral mass*) according to the AO classification. The green lines represent the topography of the fracture lines, where the lateral mass is disconnected from the rest of the vertebra, constituting a potentially unstable injury.

We only included isolated facet injuries without evidence of ligament injury or translation (type B or C of the AO classification, respectively) in the complementary images upon admission (radiographs, CT and magnetic resonance imaging [MRI]). Patients with pathological fractures, injuries due to bone fragility and incomplete medical records were excluded.

The following variables were recorded: age, sex, neurological status according to the ASIA disability scale (*American Spinal Injury Association Impairment Scale, AIS*),<sup>8</sup> type of treatment (orthopedic or surgical), number of segments operated, type of approach (anterior, posterior or combined anterior-posterior), disc injury (according to MRI), displacement (fractures with anterolisthesis >2 mm, according to CT) and fracture consolidation according to radiographs after six months.

Categorical variables are expressed in number and percentage; and numerical variables are expressed according to mean or median with their respective measures of dispersion, standard deviation (SD) and range. For the statistical description of the sample, the SPSS Statistics 25 program was used.

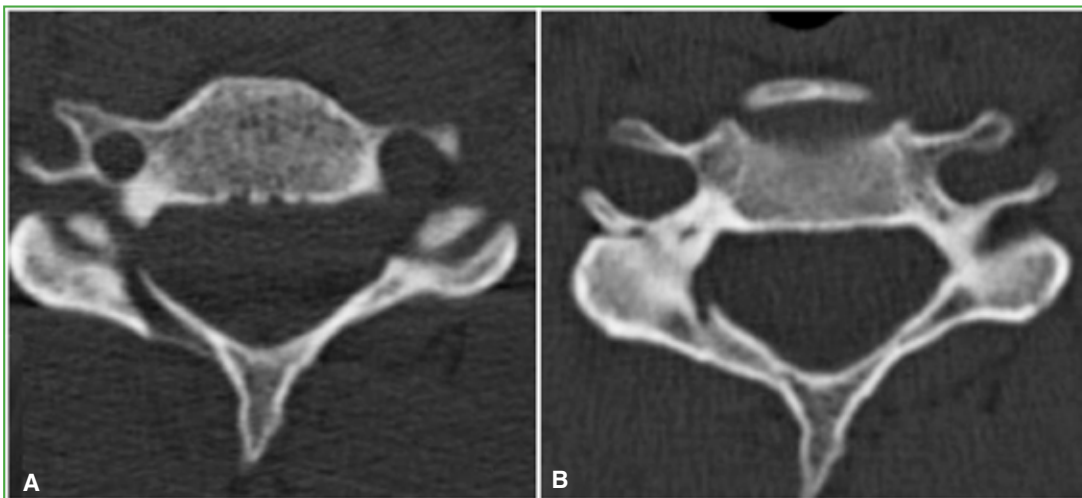
## RESULTS

16 patients were included, the average age was 42.86 (SD 12,396) years and the male gender predominated (n = 13; 81.25%). All patients were evaluated with CT and MRI. 68.75% (n = 11) had an intervertebral disc injury in the fractured segment (**Figure 2**) and 18.75% (n = 3) had tomographic evidence of anterolisthesis. None suffered an associated neurological injury (AIS E n = 16).



**Figure 2.** Computed tomography of the cervical spine. **A.** *Floating lateral mass facet fracture.* **B.** Intervertebral disc injury in the C5-C6 segment. **C and D.** Dynamic radiographs of the cervical spine. Signs of instability during image intensifier evaluation in the operating room.

Eleven patients (68.75%) were offered conservative treatment with a rigid cervical collar for 12 weeks. The fracture consolidated in five of them (45.4%) and six (54.6%) underwent translation during follow-up with definitive surgical treatment. It should be noted that all patients with successful conservative treatment did not present an intervertebral disc injury or tomographic evidence of translation (Figure 3). Conversely, unsuccessful cases had MRI evidence of disc injury (which was later hierarchized) or translation during follow-up.



**Figure 3.** An example of an isolated *floating lateral mass facet fracture*. Computed tomography of the cervical spine. **A.** Upon admission. **B.** After 6 months. Conservative treatment with a rigid collar for 12 weeks with fracture consolidation.

Finally, 11 patients underwent surgery (initial surgery:  $n = 5$ ; surgery as a rescue of failed conservative treatment:  $n = 6$ ) (Figure 4). Of this group, only one patient required a two-level anterior cervical discectomy and fusion procedure. The rest underwent anterior single-level cervical disc fusion. A complementary posterior arthrodesis was performed in only one case.



**Figure 4.** An example of an isolated *floating lateral mass facet fracture*. CT scan of the cervical spine, axial section (**A**), parasagittal sections (**B** and **C**). Magnetic resonance imaging suggests an associated intervertebral disc injury (**D**). Lateral radiograph of the cervical spine. Evidence of translation in the C5-C6 segment during follow-up (**E**). Surgical treatment with single-level anterior cervical discectomy and fusion (**F**).

After six months of follow-up, the consolidation rate was 93.75% (n = 15), regardless of the treatment initiated. Only one patient treated with anterior single-level cervical disc fusion had no consolidation on follow-up CT, with no clinical repercussions.

## DISCUSSION

F3 facet fractures are rare among cervical injuries, the current literature on this topic is scarce and the indications for orthopedic management are not yet clear.<sup>2</sup>

There is uncertainty regarding the risk factors for the displacement of facet fractures or the possible failure of conservative treatment. However, we can highlight some variables that arise from the analysis of the literature, such as a high body mass index, the degree of comminution of the fracture, the presence of radiculopathy as an initial clinical manifestation, tomographic evidence of listhesis >2 mm, involvement of more than 40% of the absolute height of the facet (compared to the contralateral facet), an articular fragment of the fractured facet >1 cm, and the injury of three of four ligaments including the joint capsule, the anterior longitudinal ligament, the posterior longitudinal ligament, and the interspinous ligament.<sup>1,2,4-6</sup>

Of the risk factors mentioned in the literature, in our series, intervertebral disc injury predominated as a risk factor for potential instability and failure of conservative treatment. Although evaluating the relative risk is beyond the scope of this study, since it is a description of a series of cases, we consider it relevant to support the authors' hypothesis that all patients in whom conservative management failed had signs of disc injury on MRI. At present, evidence is scarce on this relationship. Caravaggi et al. conducted an *in vitro* biomechanical study where they observed that a facet fracture associated with a concomitant disc injury generated a significant increase in the range of motion in flexion, lateral flexion and axial rotation, altering the intervertebral kinematics at the level of the injury.<sup>7</sup> As suggested in the literature, our findings of concomitant disc injury on MRI may indicate a greater likelihood of segmental instability in isolated facet fractures.<sup>6,7</sup>

It should be clarified that multicenter cohort studies are needed to obtain a representative number of patients for each predictive variable mentioned in the literature and thus estimate the relative risk between intervertebral disc injury, as well as other predictive factors, and conservative treatment failure. Our series did not include a significant number of patients with high body mass index, severe fracture comminution, or voluminous facet fragments that would allow for analysis.

There was great variability in the success rate of conservative treatment of isolated, *floating lateral mass* cervical facet fractures. According to Manoso et al., 75% of patients who received conservative treatment developed instability that led to definitive surgery.<sup>4</sup> Vedantam et al. reported a 33% failure rate for conservative treatment.<sup>9</sup> It should be noted that Prezelski et al. documented transient instability in 20% of the cases, although without the need for rescue surgery.<sup>10</sup>

Most of the surgeries were performed using single-level anterior cervical disc fusion without complementary posterior arthrodesis (9 cases) and the fracture healed in 90% of these cases. This adds to the existing evidence that supports this intervention as a viable treatment for isolated *floating lateral mass* facet fractures.<sup>1-8,10</sup>

The weaknesses of this study are its descriptive nature and the small number of patients; however, it represents a large series compared to other published international studies. It provides information that supports the hypothesis about disc injury as a risk factor for the failure of conservative treatment of *floating lateral mass* fractures. However, more research is needed to assess the above-mentioned relationship.

## CONCLUSIONS

Isolated *floating lateral mass* facet fractures may be treated with a rigid collar or require surgery because of their potential segmental mechanical instability. In our case series, the presence of an associated injury to the intervertebral disc was more common when conservative treatment failed or when arthrodesis was decided as the initial treatment. Most surgeries involved single-level anterior cervical discectomy and fusion, and good outcomes were achieved. The state of the adjacent discs in the MRI was used as the main criteria for selecting fusion levels.

## Acknowledgements

This study was organized by the AO Spine Latin America Trauma Study Group. AO Spine is a clinical division of the AO Foundation, which is an independent, physician-led, not-for-profit organization. Study support was provided directly through AO Spine Latin America with respect to data collection, data analysis and proofreading. The authors would like to thank Idaura Lobo and Carla Ricci (AO Spine) for their administrative assistance.

Conflict of interest: The authors have no conflicts of interest to declare.

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# Sacral Biopsy: Safe Working Channel by Tubular System

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## ABSTRACT

There is no standardized protocol for sacral biopsies, the choice of method and technique depends on the surgeon based on their experience and diagnostic suspicion. Preoperative planning is necessary to preserve the approach site and reduce complications of the technique such as insufficient specimen, neurovascular damage, or tumor seeding. The aim of our work is to present our experience performing a sacral tumor biopsy with a minimally invasive technique using a tubular system. We present a 34-year-old female patient with suspected primary sacral tumor (mainly giant cell tumor and chordoma). The approach for a fluoroscopy-guided core needle biopsy was planned, and a safe working channel was created using a tubular system. **Conclusion:** Bone biopsy, assisted by a tubular system to create a safe channel, is an option to consider in the case of suspected tumors at risk of seeding.

**Keywords:** Bone biopsy; biopsy; fine needle; primary sacral tumor; seeding.

**Level of Evidence:** IV

## Biopsia de sacro: canal de trabajo seguro mediante un sistema tubular

## RESUMEN

No existe un protocolo estandarizado para la toma de biopsias en el sacro. El cirujano, según su experiencia y la sospecha diagnóstica es quien elige el método y la técnica. Se necesita una planificación prequirúrgica para evitar comprometer el sitio de abordaje y disminuir las complicaciones de la técnica, como una muestra insuficiente, daño neurovascular o siembra tumoral. El objetivo de este artículo es comunicar nuestra experiencia en la toma de biopsia con una técnica mínimamente invasiva utilizando un sistema tubular en un tumor de sacro. Presentamos a una mujer de 34 años con sospecha de un tumor primario de sacro (tumor de células gigantes y cordoma principalmente), se planifica el abordaje y se crea un canal de trabajo seguro mediante un sistema tubular y se toman muestras con aguja gruesa guiada por radioscopia. **Conclusión:** La toma de biopsia ósea ayudada de un sistema tubular para crear un trayecto seguro es una alternativa para tener en cuenta ante la sospecha de tumores con riesgo de siembra.

**Palabras clave:** Biopsia ósea; biopsia con aguja fina; tumor sacro primario; siembra.


**Nivel de Evidencia:** IV

## INTRODUCTION

Bone tumors are diagnosed on the basis of a set of clinical data, imaging studies and histological analysis. Histological diagnosis requires the collection of samples, which can be performed openly or percutaneously, the latter including fine needle aspiration biopsies and core needle biopsies, which are the most commonly used for musculoskeletal tissue.<sup>1</sup>

The most common complications of biopsy collection include insufficient sample, tumor seeding in adjacent soft tissue, joint contamination, bleeding, neurological damage, and fractures.<sup>2,3</sup>

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**How to cite this article:** Bazán PL, Baudino Zoya F, Cinalli M. Sacral Biopsy: Safe Working Channel by Tubular System *Rev Asoc Argent Ortop Traumatol* 2024;89(1):59-63. <https://doi.org/10.15417/issn.1852-7434.2024.89.1.1838>

As there is no standardized protocol for sacral biopsies, the choice of the method and site of entry, and the number of samples are left to the surgeon's decision, according to his experience and diagnostic suspicion based on clinical data and complementary studies. However, pre-surgical planning is necessary to obtain a sufficient sample, avoid compromising the site of a future surgical approach and reduce complications, mainly tumor seeding.

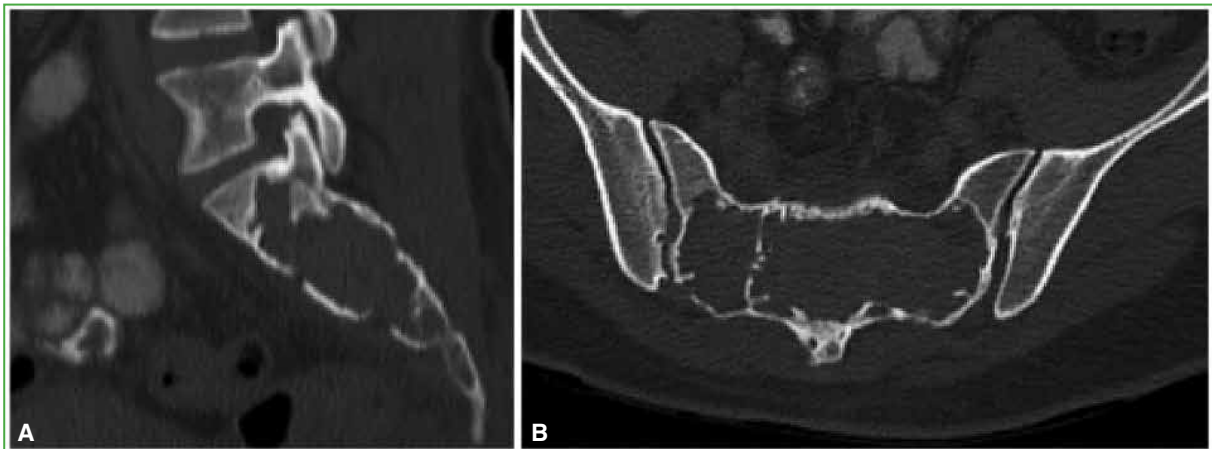
The aim of this article is to report our experience in taking a biopsy with a minimally invasive technique using a tubular system in a sacral tumor.

## CLINICAL CASE

A 34-year-old woman was referred to our Department in April 2023 by the Gastroenterology Department, where a pathological image in the sacrum had been detected in complementary studies, and she was being followed up for malaise that had progressed over a year and included weight loss, vomiting, and diarrhea.

On physical examination, she experienced incapacitating low back pain (visual analog scale 10/10), which persisted at night and did not respond to analgesics or position adjustments. Muscle strength and sensibility were preserved in all areas distal to the lesion, she had symmetrical tendon reflexes, with no pathological reflexes. Diuresis and catharsis were preserved.

Computed tomography showed a lytic image involving the entire sacrum, with bulging of the sacrum and thinned cortical bone, but without solution of continuity or invasion of adjacent tissues (Figure 1).

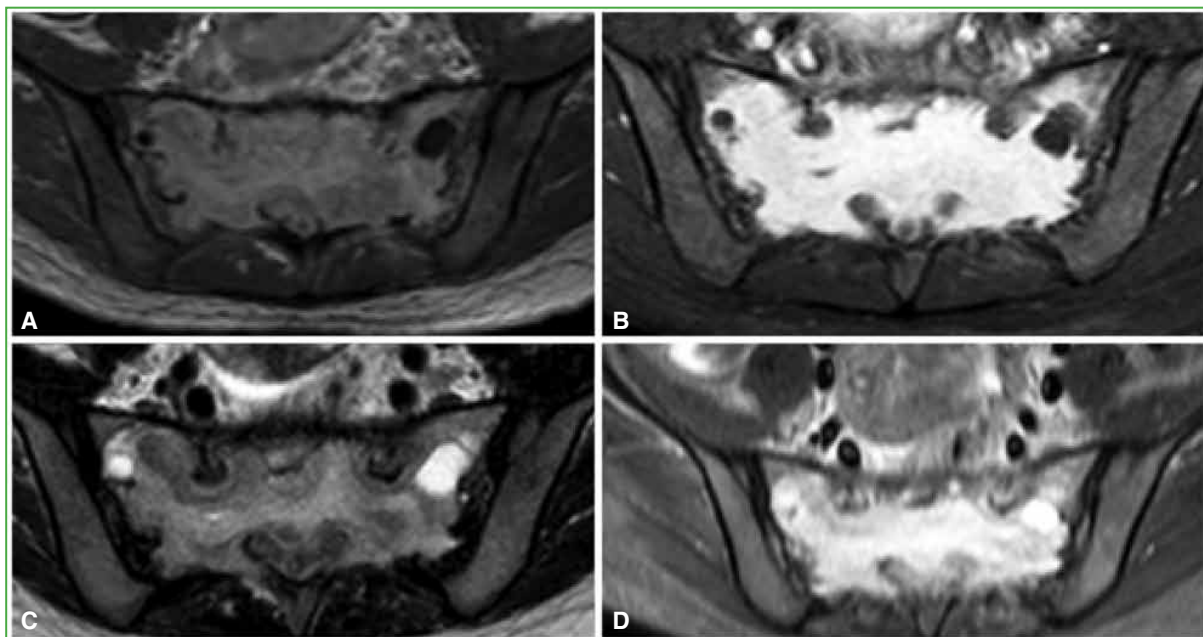


**Figure 1.** Sacral computed tomography, sagittal (A) and axial (B) slices. A lytic image is observed in the sacrum.

MRI revealed a lesion involving the sacrum diffusely, which was hypointense on the T1-weighted sequence (Figure 2A), with avid enhancement after injection of intravenous contrast medium (Figure 2B) and heterogeneous and hyperintense on T2-weighted and STIR sequences (Figure 2C and D).

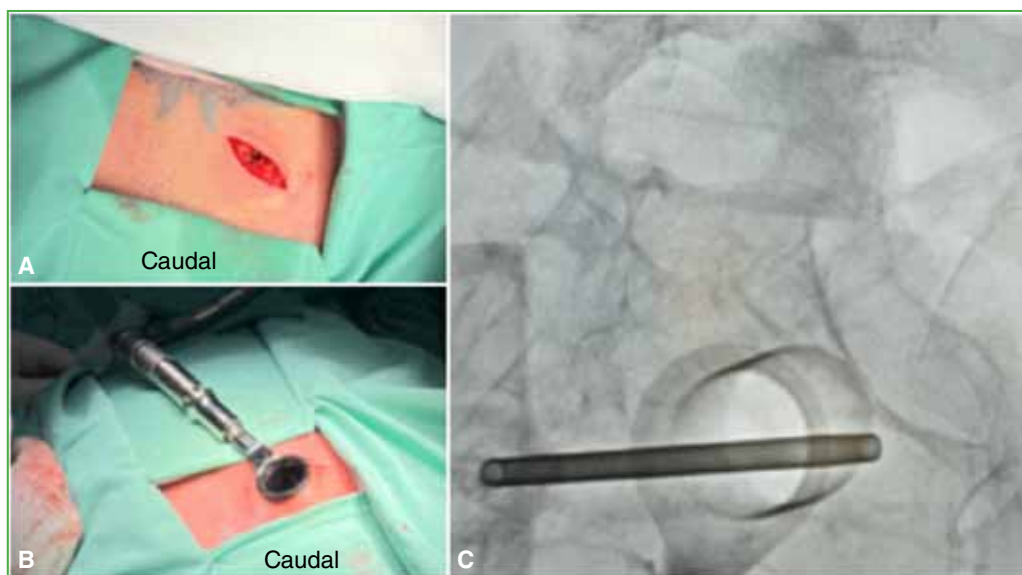
Based on these data, a primary tumor was suspected, and the two main differential diagnoses were sacral chordoma and giant cell tumor. Chordoma is the most frequent primary sacral tumor and has some imaging characteristics similar to those of our patient, such as bone expansion, osteolysis and hypersignal in the T2 sequence; on the other hand, giant cell tumor is the most frequent benign tumor in that region, it is locally aggressive, and the patient's age and sex matched its epidemiology.

A biopsy was essential for an accurate diagnosis and, considering the high risk of local seeding of the chordoma, a core needle biopsy was chosen using a minimally invasive approach with a visual field of view delimited by a tubular system. We did not have protection for the needle, so the tubular system would provide us with a safe working channel to avoid seeding and insufficient samples, as well as the ability to obtain several bone samples from the same entry point guided by fluoroscopy.



**Figure 2.** Magnetic resonance of the sacrum. The T1-weighted sequence shows a hypointense lesion that is diffusely involving the sacrum (A), with avid enhancement after injection of intravenous contrast medium (B). It is heterogeneous and hyperintense in T2-weighted (C) and STIR (D) sequences.

In planning the biopsy, the possible future surgery was taken into account, using an inverted Y approach as a guide. A 1.5 cm incision was made over a sector of the approach line (Figure 3A). Soft tissue dilators were used to create a safe working channel to the bone plane (Figure 3B). Four bone samples were obtained through the channel with a Jamshidi needle in different directions under fluoroscopic guidance (Figure 3C), using the same entry point. The wound was closed and the patient was discharged from the hospital the same day. The wound evolved without complications.



**Figure 3.** Intraoperative imaging. An inverted Y approach was planned and only a 1.5 cm incision was made (A). A tubular system (B) defines the field of vision and the safe working channel, and a fluoroscopy-guided core needle is used to collect samples (C).

One month later, the Pathology Service delivered the biopsy result, which reported a plasma cell neoplasm with lambda light chain restriction.

The patient was referred to the Oncohematology Department of our institution to receive the appropriate treatment.

## DISCUSSION

When a tumor is suspected, the main objective should be to provide a rapid and reliable diagnosis in order to plan treatment in a timely manner.<sup>4</sup>

Among the most commonly used methods in musculoskeletal tissue, core needle biopsy is more reliable than fine needle biopsy. It is often recommended because of the lower risk of complications, lower false negative rate, and lower cost, and shows no significant difference in the accuracy of incisional biopsy sampling.<sup>5,6</sup> However, the use of this method may result in a higher rate of repeat biopsies due to insufficient material and, if there is no adequate tissue, an open biopsy is recommended.<sup>4</sup>

Given the heterogeneity of musculoskeletal tumors, multiple samples are often necessary to obtain an accurate result. Assuming that the biopsy tract can be contaminated, the surgical incision site should be planned and the procedure should not disrupt other anatomical compartments or injure neurovascular structures.<sup>6</sup> In many articles, the risks of biopsy tract seeding are mentioned, but no recommendations on safe working channels are given. In our clinical case, the main differential diagnosis was sacral chordoma and, given the risk of seeding presented by these tumors,<sup>3,7,8</sup> biopsy collection was planned for a possible future inverted Y surgical approach.<sup>9</sup> A tubular system was used to delimit the visual field and a safe trajectory, and several samples were collected with a fluoroscopy-guided core needle from the same entry point.

In the literature, we found no other case report mentioning the use of this method. We recommend it for taking biopsies since it is simple, safe, and convenient, especially when a differential diagnosis may have a high seeding rate in the biopsy tract and no needle protection is available.

## CONCLUSIONS

The use of a tubular system could be considered a simple, convenient, and safe alternative to delimit the field of view and a safe path for bone sampling in order to avoid seeding and to obtain an adequate sample.

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Conflict of interest: The authors declare no conflicts of interest.

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# Symptomatic Triple-Region Spinal Stenosis: Case Report and Narrative Literature Review

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## ABSTRACT

Simultaneous spinal stenosis across all three regions of the spine is an uncommon condition that requires proper clinical and imaging assessment. There are currently no established guidelines for its diagnosis and treatment. The objective of this paper is to describe, based on a case report, the clinical presentation, treatment, and progression of triple stenosis in a patient and compare it with available evidence through a narrative literature review. A 69-year-old woman presented with progressive paraparesis associated with right sciatica and positive signs of upper motor neuron involvement. Imaging confirmed triple stenosis: cervical, thoracic, and lumbar. She underwent thoracic decompression and tumor resection, as well as conservative treatment for cervical and lumbar stenoses, and showed favorable progress one year after surgery.

Symptomatic triple-region spinal stenosis is an uncommon condition. Proper clinical and radiological assessments will enable an accurate diagnosis with appropriate and timely intervention.

**Keywords:** Symptomatic triple-region spinal stenosis; tandem spinal stenosis; cervical, thoracic, and lumbar stenosis.

**Level of Evidence:** IV

## Estenosis espinal de triple región sintomática: reporte de un caso y revisión narrativa de la bibliografía

## RESUMEN

La estenosis espinal de las tres regiones de la columna en simultáneo es un cuadro infrecuente que requiere una adecuada valoración clínica y de las imágenes. En la actualidad, no existen guías establecidas para su abordaje diagnóstico y terapéutico. El objetivo de este artículo es describir la presentación clínica, el tratamiento y la evolución en un paciente con triple estenosis y contrastarlos con la evidencia disponible a través de una revisión narrativa de la bibliografía. Se presenta a una mujer de 69 años de edad que consultó con un cuadro de paraparesia progresiva asociado a cialgia derecha y signos de motoneurona superior positivos. En los estudios por imágenes, se constató una triple estenosis: cervical, torácica y lumbar. Se procedió a la descompresión y la resección tumoral torácica asociadas al tratamiento conservador de las estenosis cervical y lumbar. La evolución era favorable al año de la cirugía. La estenosis espinal de triple región sintomática es una condición rara, las valoraciones clínicas y radiológicas adecuadas permitirán un diagnóstico correcto con un abordaje adecuado y oportuno.

**Palabras clave:** Estenosis espinal de triple región sintomática; estenosis espinal en tándem; estenosis cervical, torácica y lumbar.

**Nivel de Evidencia:** IV

## INTRODUCTION

Tandem spinal stenosis (TSS) is defined as synchronous narrowing of the diameter of the spinal canal in at least two regions of the spine, with a prevalence ranging from 0.2% to 11% in imaging studies.<sup>1,2</sup> Clinically, it manifests with associated upper and lower motor neuron symptoms. Dagi et al. described a typical triad characterized by: 1) claudication and loss of lower limb strength; 2) gait disturbance; and 3) upper motor neuron signs, such as hyper-reflexia, clonus, and positive Babinski sign.<sup>3</sup>

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**How to cite this article:** Latallade V, Pereira Duarte M, Gamsie S, Kido GR, Petracchi MG, Gruenberg MF. Symptomatic Triple-Region Spinal Stenosis: Case Report and Narrative Literature Review. *Rev Asoc Argent Ortop Traumatol* 2024;89(1):64-69. <https://doi.org/10.15417/issn.1852-7434.2024.89.1.1862>

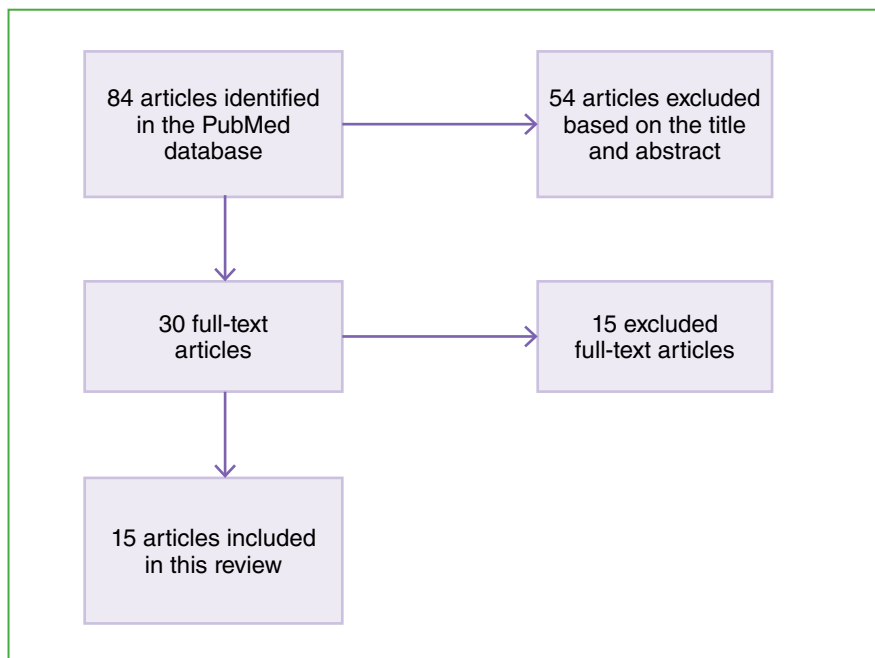
Evidence regarding the treatment of TSS is scarce and the casuistry is even more limited when the stenosis occurs in three segments synchronously, termed symptomatic triple-region spinal stenosis (TRSS). Its low frequency, combined with the variety of possible signs and symptoms, creates an extremely complex picture, making diagnosis and resolution challenging and presenting numerous therapeutic alternatives (single or multiple region decompression, in stages or simultaneously).<sup>4</sup>

The aim of this article is to describe the clinical presentation, treatment and evolution in a patient with triple stenosis and to contrast them with the available evidence by means of a narrative review of the literature.

This study had the prior approval of the Ethics Committee of our institution. A literature search was performed in PubMed, Web of Science, Scopus and Lilacs databases using the following terms: “Tandem spinal stenosis”, “Tandem stenosis” or “Cervical, thoracic and lumbar stenosis”.

All case reports, case-control studies, cohort studies, and reviews published in the last 10 years, evaluating adult patients with TSS and TRSS, and a minimum follow-up of one year, were included. No reports of similar cases were found in Latin American databases. Articles that did not evaluate spinal disease, included pediatric patients or disease of a single region were excluded.

Fifteen articles were selected for this narrative review. **Figure 1** shows the details of the literature search and the selection of articles.



**Figure 1.** Flow chart of the bibliographic search.

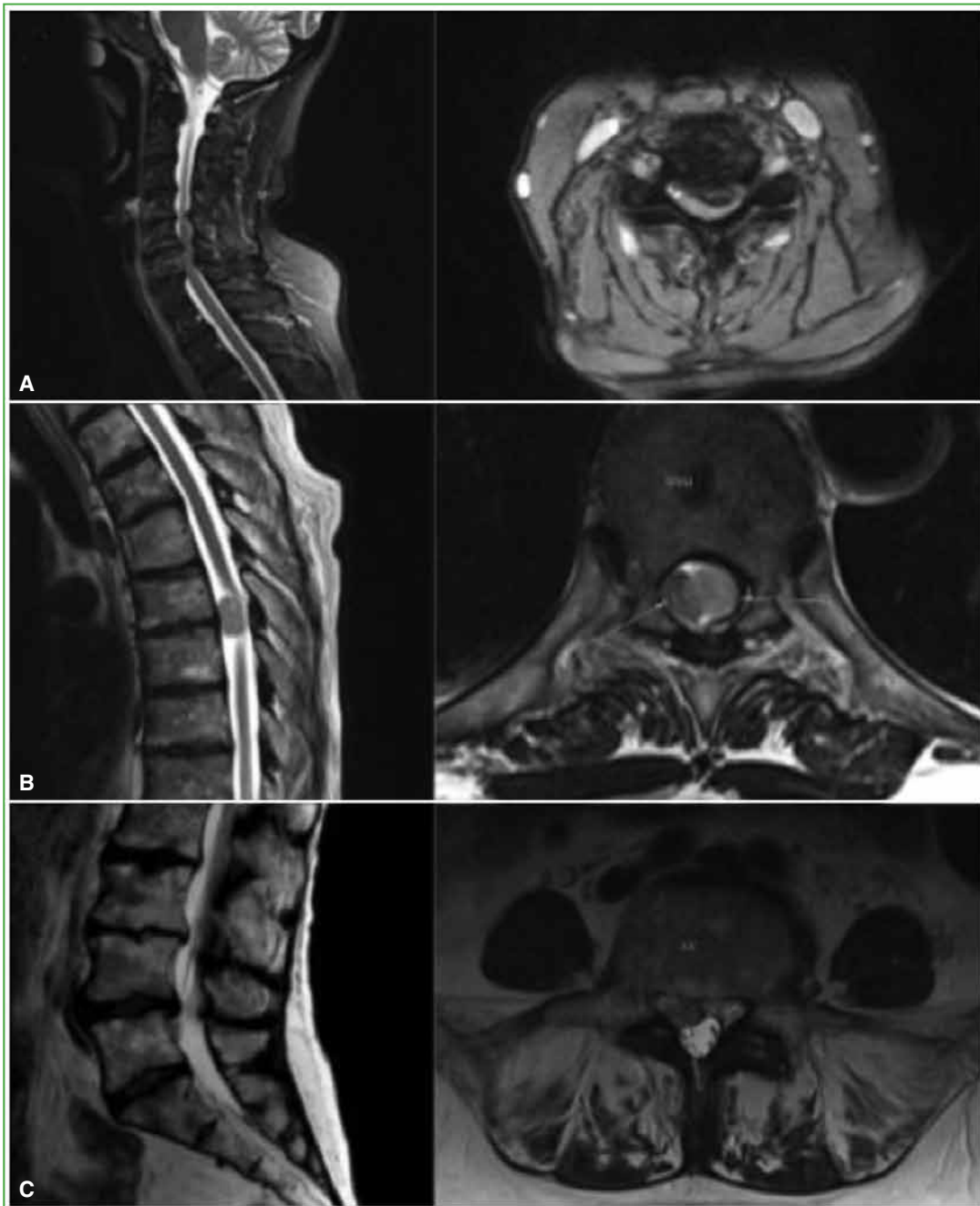
## CLINICAL CASE

A 69-year-old woman, with no relevant medical history, consulted the emergency room for progressive and incapacitating paraparesis (grade C on the ASIA scale,<sup>5</sup> score 5 on the Nurick scale<sup>6</sup>) of one year of evolution associated with right sciatica.

Physical examination revealed paraparesis with motor strength M3/5<sup>7</sup> in both lower limbs from L2 to S1, with bilateral patellar and achilles hyperreflexia, negative Hoffman sign, positive Babinski sign and clonus in the lower limbs, together with right sciatica of 9/10 intensity according to the visual analog scale in the territory of the L5 root, and positive Lasègue and Bragard signs. Cervical myelopathy scores were: 9/17 on the modified Japanese Orthopaedic Association scale<sup>8</sup> and 5 on the Nurick scale.

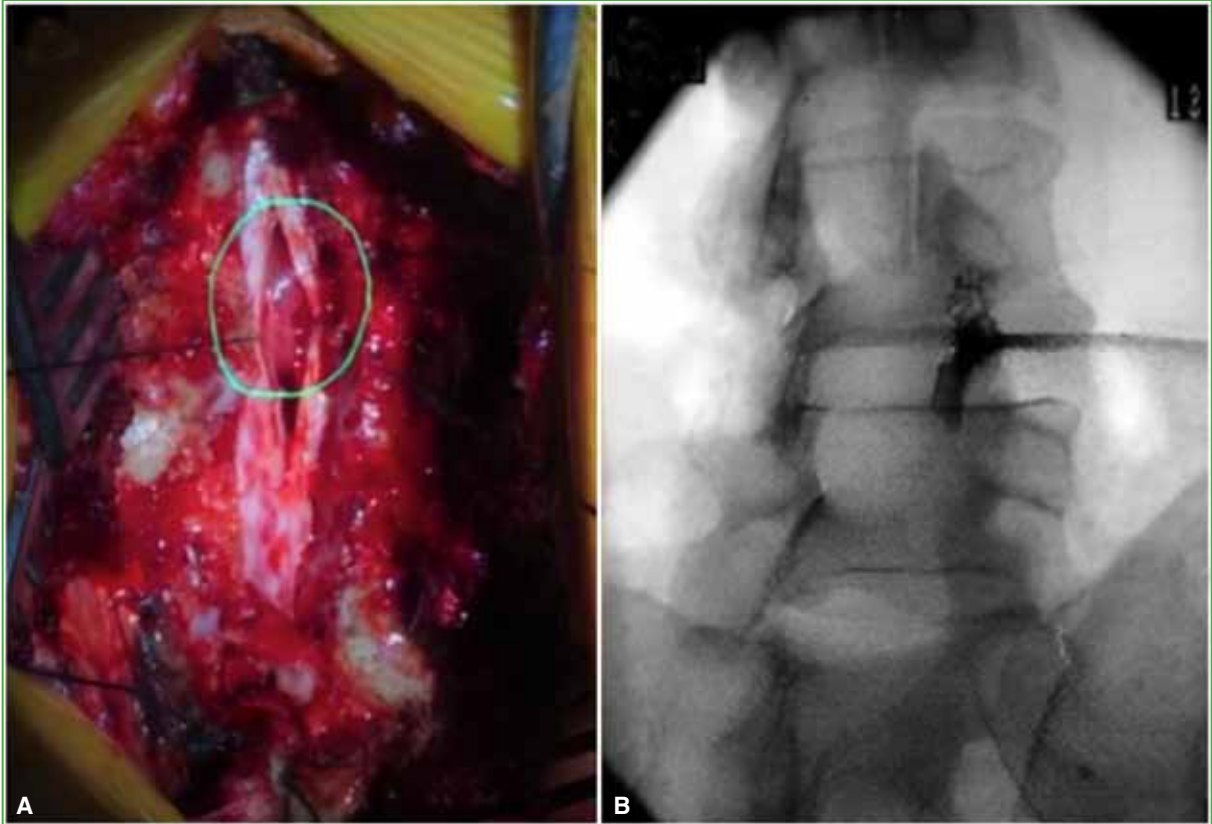
### Imaging studies

In an emergency MRI, three points of stenosis of the spinal canal were detected: 1) a degenerative narrow cervical canal at C5-C6 with focal myelomalacia; 2) an intradural extramedullary tumor at T6-T7 impacting the spinal cord, measuring 15 mm x 8 mm x 7 mm; and 3) a right posterolateral disc extrusion of L4-L5 (Figure 2).



**Figure 2.** Spinal MRI without contrast. **A.** Sagittal and axial slices of the cervical spine showing left posterolateral C5-C6 stenosis due to disc protrusion with signs of myelomalacia. **B.** Sagittal and axial slices of T6-T7 with an intradural-extramedullary tumor. **C.** Sagittal and axial lumbar slices with right posterolateral disc extrusion at L4-L5.

Once the diagnosis of TRSS was confirmed, after four days of hospitalization, it was decided to perform a posterior decompression of T6-T7 by laminectomy and excision of the thoracic intradural extramedullary tumor, and a right intraoperative block of L4-L5 (Figure 3).



**Figure 3.** **A.** Intraoperative image of the same patient. The opening of the dura mater with an intradural extramedullary dorsal tumor is observed through a central T6-T7 laminectomy. **B.** Intraoperative fluoroscopic image of the right L4-L5 periradicular block.

Surgery was performed under general anesthesia, with intraoperative monitoring of somatosensory and motor evoked potentials, and lasted 2 hours and 20 minutes. Pathological examination revealed a WHO grade I transitional meningioma.<sup>9</sup>

The evolution was favorable during the immediate postoperative period, with remission of the sciatica (3/4 on the visual analog scale). On the third day after surgery, the patient moved with a walker and was discharged.

At the day 7 and day 14 follow-up visits, there was a notable improvement in motor strength and a 2/10 level of sciatica; after one month, the patient was able to walk with a cane, and three months after surgery, she was no longer using it. One year after surgery, at the last follow-up, residual pain of 1/10 intensity was detected, with an M4 deficit for right L5, no gait instability and decreased upper motor neuron signs, with scores of 17/17 on the modified Japanese Orthopaedic Association scale, and 1 on the Nurick scale.

## DISCUSSION

We present the case of a patient who consulted for progressive spastic paraparesis associated with right sciatica and a TRSS diagnosis, and underwent surgery for one of the lesions, which resulted in a good postoperative evolution and almost complete remission of symptoms.

The term TSS was introduced by Dagi et al. in 1987 to describe concurrent symptomatic cervical and lumbar spinal stenosis.<sup>3</sup>

In 2016, Uehara et al. classified TSS into four subtypes according to region: cervicothoracic, thoracolumbar, cervico-thoraco-lumbar, and cervicolumbar.<sup>10</sup>

Our patient had a cervico-thoraco-lumbar TSS, a rare condition, as most reports address tandem stenosis with compression at two levels only.

The clinical manifestations of TSS are highly variable and depend on the location of the stenotic areas and their severity. LaBan et al. and Kenneth et al. reported difficulty in reaching a correct diagnosis due to the combined clinical presentation of upper and lower motor neuron symptoms.<sup>11,12</sup> In their series of 33 patients, Bhandutia et al. reported a late diagnosis rate of 45%, which had serious consequences on outcome.<sup>13</sup>

Epstein et al. noted that the correct order for surgical treatment of TSS depended on the severity of myelopathy and radiculopathy.<sup>14</sup> In their series, cervical decompression improved lumbar radicular symptoms. Similarly, in our patient, thoracic decompression may have favored symptomatic improvement associated with lumbar periradicular block. We hypothesized that cervical stenosis, as a chronic degenerative process, may have developed adaptive mechanisms that prevented it from manifesting clinically, but the tumor, with increased compression velocity, would have been responsible for nearly all upper motor neuron symptoms.

Most published reports address TSS with compression at the cervical and lumbar levels. We found few case reports of TSS involving the thoracic region, and none with an associated tumor. Chen et al. and Hu et al. published retrospective reviews of 15 and 16 cases, respectively, on cervicothoracic tandem ossification.<sup>15,16</sup> Both reported surgical resolution using a single posterior incision that achieved significant clinical improvements, but at the expense of a high intraoperative and postoperative complication rate.

Finally, Schaffer et al. published a case of TRSS treated with simultaneous surgery of the three regions, and warned that this may be associated with a prolonged hospital stay.<sup>17</sup> Jannelli et al. presented a patient with TRSS who underwent staged decompression, first cervical, then lumbar, and finally thoracic, with a final improvement of the paraparesis that was delayed by two and a half years.<sup>18</sup> In this last case, initially, only images of the cervical spine were taken. In our patient, however, due to the disparity between clinical and imaging findings, it was considered of vital importance to order an MRI of the complete spine.

Unlike what is described in the literature, in our case, we started with the thoracic region because the tumor was causing severe stenosis, which was compatible with the patient's symptoms. The results were an early hospital discharge and a very good postoperative evolution, with a significant improvement of the neurological deficit.

This article is a narrative review of the literature on triple tandem spinal stenosis based on a case report. Its limitations are mainly related to the low incidence of this disease, since almost all the bibliographic citations included are case reports and small series of patients, as well as its retrospective nature and low level of evidence. In addition, the modality of reporting of these cases and series of patients is very heterogeneous, each publication emphasizing a different aspect of the subject. Nevertheless, this is, to the best of our knowledge, the first narrative review on the subject and we believe we have developed each of the aspects inherent to this rare entity in a harmonious and engaging manner.

## CONCLUSIONS

We present a patient with TRSS and progressive neurological compromise, who required thoracic decompression, and had a favorable evolution. Although multiple stenosis is a rare condition, diagnostic suspicion through a correct clinical assessment allows for timely treatment and monitoring. TRSS should be considered within the differential diagnoses in patients with signs and symptoms of spinal and upper and lower motor neuron stenosis.

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Conflict of interest: The authors do not declare conflicts of interest.

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# Extraforaminal L5-S1 Disc Herniation Treated by Endoscopic Transfacet Approach. Case Report and Technical Note

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## ABSTRACT

Extraforaminal L5-S1 disc herniations are usually difficult to treat due to their complicated access and risk of nerve injury. We present the case of a patient with left L5-S1 disc disease who was treated by endoscopic discectomy using a transfacet Wiltse-like approach. This method provides safe access to L5-S1 extraforaminal herniations while avoiding manipulation and irritation of the L5 root.

**Keywords:** Endoscopy; minimally invasive; spine; lumbar; disc disease.

**Level of Evidence:** IV

## Hernia extraforaminal en el espacio L5-S1 tratada por abordaje transfacetario endoscópico. Presentación de un caso y nota técnica

## RESUMEN

Las hernias de disco extraforaminales en el espacio L5-S1 suelen ser difíciles de tratar por su complicado acceso y el riesgo de lesión nerviosa. Se presenta el caso de un paciente con discopatía en L5-S1 izquierda que fue tratado mediante discectomía endoscópica por abordaje símil Wiltse transfacetario. Este tipo de abordaje permite el acceso seguro a las hernias extraforaminales en el espacio L5-S1 evitando la manipulación e irritación de la raíz de L5.

**Palabras clave:** Endoscopia; abordaje mínimamente invasivo; columna vertebral; lumbar; discopatía.

**Nivel de Evidencia:** IV

## INTRODUCTION

Lateral disc herniations account for 1% to 12% of all lumbar herniations<sup>1</sup> and can be classified as intraforaminal or extraforaminal, according to their location with respect to the foramen.<sup>2</sup> The latter were first described by Abdullah et al. in 1974 and are more frequent in older patients, with L4-L5 often being the most affected level.<sup>3,4</sup>

Surgical treatment of these disc lesions is usually more difficult than that of central herniations, especially in the L5-S1 space, where access is more complex, mainly due to the height of the iliac crests and the volume of the L5 transverse process.<sup>5</sup> Currently, the surgical options for this type of lesions include the classic discectomy via the posterolateral Wiltse approach,<sup>6-10</sup> minimally invasive techniques, such as tubular microdiscectomy via a homolateral or contralateral approach,<sup>5,11</sup> and an increasing number of endoscopic discectomy techniques, such as the contralateral interlaminar approach and access to the foramen.<sup>12</sup>

Endoscopic surgery has several advantages over other techniques, including reduced bleeding, preservation of the paravertebral musculature, and shorter hospitalization.<sup>12</sup> There are several approaches to accessing the disc herniation in the L5-S1 space: contralateral extraforaminal, transiliac, and posterolateral, which can be performed with or without drilling the facet. The main complications of these techniques are postoperative pain, transient paresis, and nerve injury caused by manipulation of the L5 root.

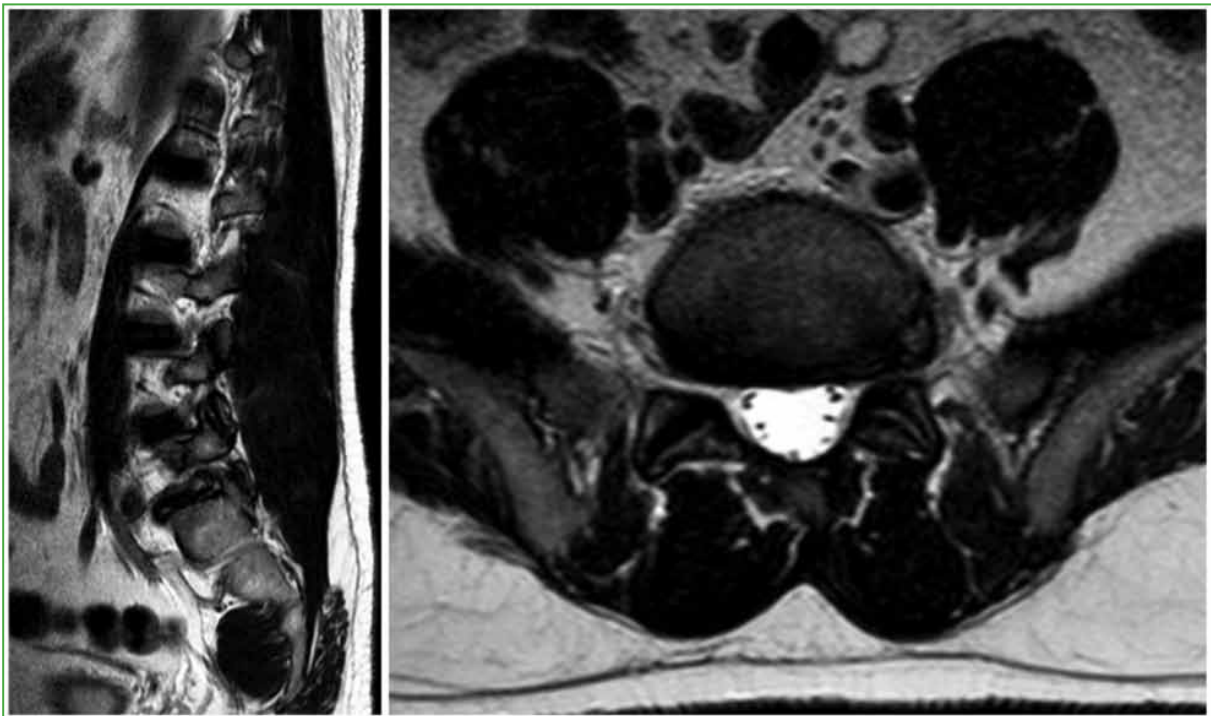
Received on November 27<sup>th</sup>, 2023 Accepted after evaluation on December 16<sup>th</sup>, 2023 • Dr. MÁXIMO DE ZAVALÍA • maximodezavalia@gmail.com  <https://orcid.org/0000-0002-4022-4100>

**How to cite this article:** de Zavalía M, Gobbi E, Yeregui S. Extraforaminal L5-S1 Disc Herniation Treated by Endoscopic Transfacet Approach. Case Report and Technical Note. *Rev Asoc Argent Ortop Traumatol* 2024;89(1):70-75. <https://doi.org/10.15417/issn.1852-7434.2024.89.1.1856>

We present the case of a patient who underwent endoscopic treatment for an extraforaminal herniation in the L5-S1 space via a posterolateral approach with facet drilling. Because experience and knowledge of this technique are limited in our country, a literature review was conducted.

## CLINICAL CASE

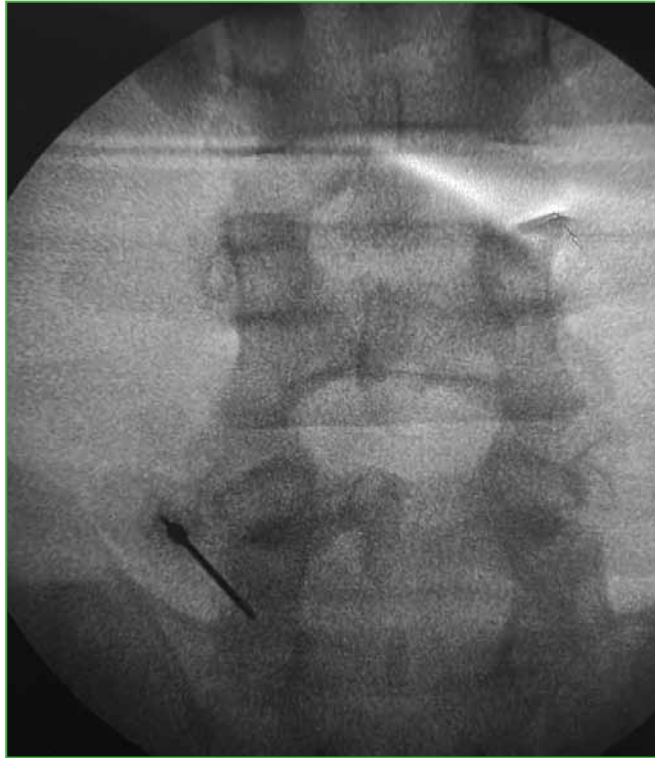
A 45-year-old man came in for a consultation due to a left radiculopathy of L5 that had been developing for seven months (visual analog scale 8/10). On physical examination, range of motion and strength were preserved, and there were no motor deficits. On MRI, an extraforaminal herniation was visualized in the L5-S1 space on the left side (Figure 1). The patient reported having undergone 20 sessions of physical therapy, two selective root blocks of L5-S1 and having received treatment with pregabalin 75 mg for three months, with improvement in symptoms, but of short duration. In the absence of a response to conservative treatment, an endoscopic discectomy was proposed.



**Figure 1.** Magnetic resonance imaging of the lumbosacral spine, sagittal and axial sections. An extraforaminal hernia is observed in the L5-S1 space on the left side.

## Surgical technique

Under general anesthesia, the patient is placed in the ventral decubitus position. Chlorhexidine is applied for skin asepsis before surgical fields are set up for the posterior lumbar approach. Using direct fluoroscopy in the antero-posterior position, the left tip of the superior articular facet of S1 is marked with a 16 G needle (Figure 2). An 8 mm skin incision is performed, followed by the opening of the lumbar fascia. The working cannula is then lowered together with an Elliquence® transforaminal endoscope with a 30° lens. The S1 facet is drilled laterally with an endoscopic drill bit. As space is created in the ventral direction, the working cannula is lowered. Once the anterior cortex of the facet is located, it is resected with 3 mm Kerrison Rongeur forceps. Then, a fluoroscopic control is performed to ensure the correct working direction (Figure 3).

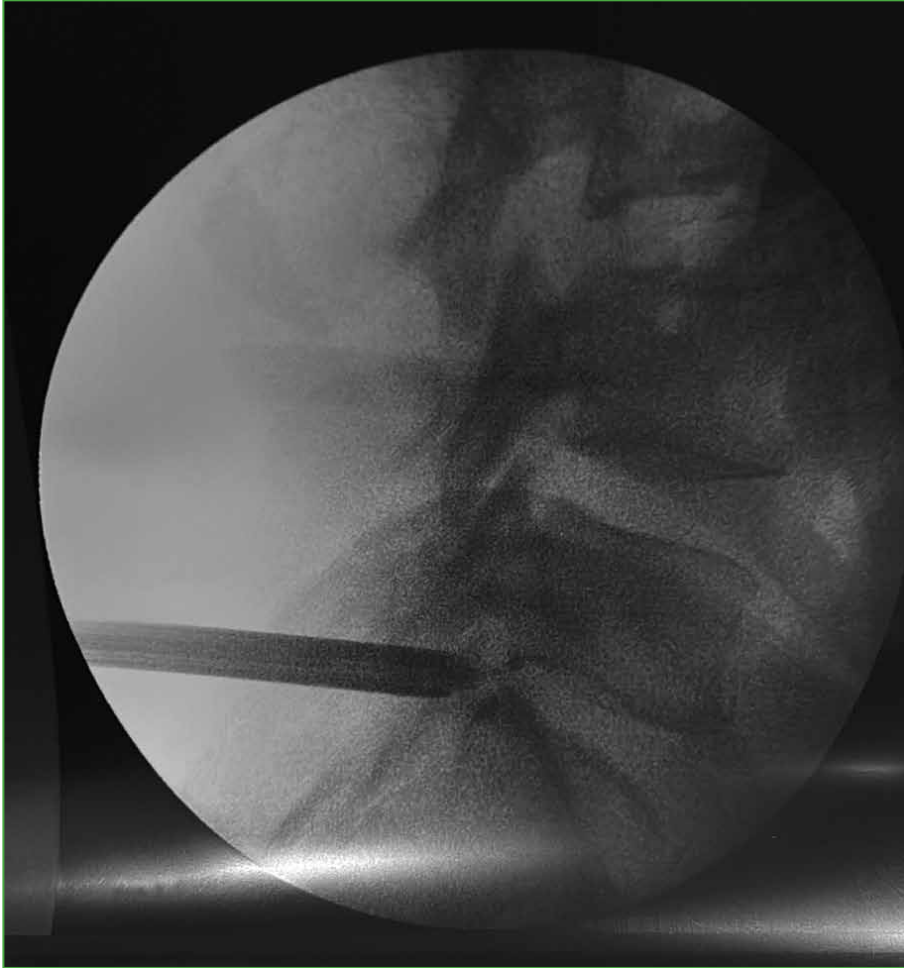


**Figure 2.** Fluoroscopic control of the left marking of the superior articular facet of S1 with a 16 G needle.



**Figure 3.** Fluoroscopy ensures the correct working direction.

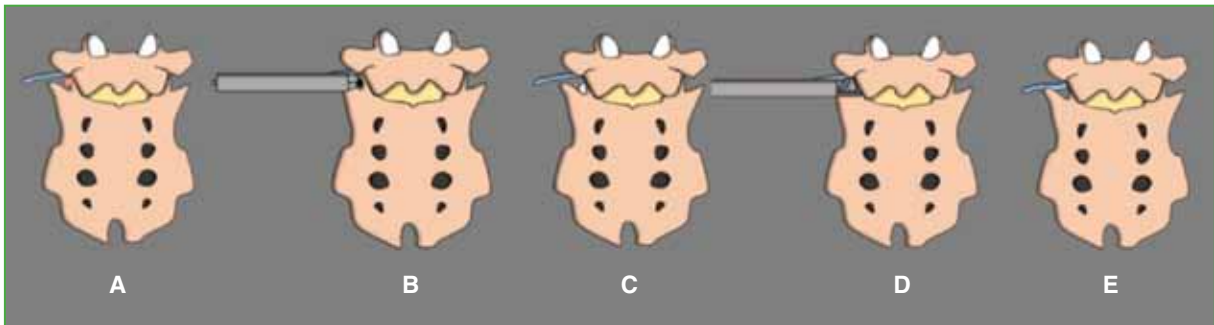
The extruded disc fragment is palpated in the extraforaminal space using a bone hook (Figure 4). The extruded fragment is excised with disc forceps (Figure 5) and the correct release of the L5 root is verified (Figure 6 and Video).



**Figure 4.** Fluoroscopy showing the palpation of the disc fragment.



**Figure 5.** Fragment of the extracted disc.



**Figure 6.** A. Lateral identification of the superior articular facet of S1. B. Drilling of the facet from lateral to medial and in the ventral direction. C. Visualization of the extruded disc fragment. D. Disc fragment excision. E. Free L5 root.

### Clinical evolution

The patient recovered from anesthesia without complications in the immediate postoperative period. Regarding pain, he reported the absence of radiculopathy immediately after surgery and was discharged 12 hours later. The radicular visual analog scale score was 1/10 after one month and 1/10 after three months. There was no recurrence of symptoms or low back pain five months after surgery.

### DISCUSSION

Foraminal and extraforaminal herniated discs have specific clinical manifestations that include, in particular, severe root pain.<sup>1</sup> The dorsal root ganglion has been identified as one of the causes of the above symptoms.<sup>13,14</sup> Treatment for herniated discs aims to achieve nerve decompression with as little trauma as possible. This objective can become challenging when dealing with foraminal or extraforaminal herniations, and it becomes even more difficult when the affected level is L5-S1, due to the anatomical particularities of the segment, such as the high iliac crest and frequent foraminal narrowing at that level.<sup>15</sup> Endoscopic discectomy by interlaminar approach is often a solution that allows for overcoming these anatomical barriers.<sup>16</sup> However, this approach is usually more appropriate for treating axillary disc herniations or migrated hernias. On the other hand, the transforaminal approach may be an option to treat foraminal or extraforaminal hernias; however, it is not easily accessible in patients with high iliac crests or transverse mega-apophysis (Castellvi 2, 3 and 4).<sup>17</sup> The conventional open transfacet approach has been widely used in spine surgery, because it is suitable for disc decompression involving the ventral dural sac and hypertrophic ligamentum flavum.<sup>18</sup> In our case, we used this approach endoscopically, which allowed us to access the hernia more easily.

The key to the success of this technique is to create a precise and adequate working space while keeping the segment mechanically stable. The use of the drill allows us to have more working space in an area without the risk of injuring nerve or vascular structures. However, care must be taken with bone resection to reduce the probability of segmental instability, which is avoided by carefully controlling the direction of work under fluoroscopy and attempting the smallest possible resection. In our case, we resected approximately 15% of the facet, which allowed us to generate a good working space without destabilizing the segment.

In a patient with an extraforaminal disc herniation in the L5-S1 space, we opted for an endoscopic discectomy via the posterolateral transfacet approach using a drill, and the postoperative outcome was satisfactory.

### CONCLUSIONS

The endoscopic approach allows safe access to extraforaminal hernias in the L5-S1 space, avoiding manipulation and irritation of the L5 root. Therefore, we believe this technique is a safe option to consider when treating this type of hernia.

Conflict of interest: The authors declare no conflicts of interest.

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# Complications of Lateral Lumbar Interbody Fusion (XLIF). Narrative Literature Review

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## ABSTRACT

**Introduction:** The lateral approach for lumbar interbody fusion has been described for the treatment of diverse pathologies. Although it is a safe procedure, its popularity has led to an increase in reports of complications associated with it. The objective of this work is to conduct a narrative review of the literature on the most frequently reported complications associated with this surgical approach. **Materials and Methods:** We performed a narrative review of the literature based on the publications obtained from the following databases: PubMed.gov, Web of Science, Scopus and Lilacs to identify published articles that detail complications related to the lateral approach to the lumbar spine. **Results:** After analyzing the results of the bibliographic search, 18 articles were selected to carry out this review. **Conclusions:** The most frequent complications directly related to this approach are thigh pain and motor deficit for hip flexion and/or leg extension, which are mostly temporary and reversible. Severe or fatal vascular injuries have rarely been reported.

**Keywords:** Lateral lumbar arthrodesis; spine surgery; complications; XLIF; LLIF; lateral approach to the lumbar spine.

**Level of Evidence:** III

## Complicaciones asociadas a la artrodesis intersomática lumbar por vía lateral. Revisión narrativa de la bibliografía

## RESUMEN

**Introducción:** El abordaje lateral de la columna lumbar en la artrodesis intersomática está descrito para tratar varias enfermedades. Si bien es un procedimiento seguro, a medida que la técnica ha ganado popularidad, se han publicado diversas complicaciones asociadas. El objetivo de este artículo es presentar una revisión narrativa de la bibliografía para proveer al lector de un resumen organizado de las complicaciones comunicadas más frecuentes relacionadas con esta técnica. **Materiales y Métodos:** Se llevó a cabo una revisión narrativa de la bibliografía obtenida en las bases de datos PubMed, Web of Science, Scopus y Lilacs para identificar artículos que detallen complicaciones relacionadas con el abordaje lateral de la columna lumbar. **Resultados:** Luego del análisis de los resultados de la búsqueda bibliográfica, se seleccionaron 18 artículos para esta revisión. **Conclusiones:** Las complicaciones más frecuentes directamente relacionadas con este abordaje son la cruralgia y el déficit motor para la flexión de la cadera o la extensión de la pierna que, en su gran mayoría, son transitorias y reversibles. Hay escasos reportes de lesiones vasculares severas o fatales.

**Palabras clave:** Artrodesis lateral; cirugía de columna; complicaciones; XLIF; LLIF; abordaje lateral de columna lumbar.

**Nivel de Evidencia:** III

## INTRODUCTION

The lateral approach to the lumbar spine for interbody fusion, commonly referred to as XLIF (extreme lateral interbody fusion) or LLIF (lateral lumbar interbody fusion), is a technique that emerged about 15 years ago and, according to most published series, the results are promising. It has been used to treat a variety of conditions, including degenerative, traumatic, oncological, and infectious.<sup>1</sup> It is a safe technique that provides adequate struc-

Received on December 1<sup>st</sup>, 2023 Accepted after evaluation on December 10<sup>th</sup>, 2023 • Dr. MATÍAS PEREIRA DUARTE • matiaspereiraduarte@gmail.com  <https://orcid.org/0000-0001-5652-2631>

**How to cite this article:** Pereira Duarte M. Complications of Lateral Lumbar Interbody Fusion (XLIF). Narrative Literature Review. *Rev Asoc Argent Ortop Traumatol* 2024;89(1):76-82. <https://doi.org/10.15417/issn.1852-7434.2024.89.1.1861>

tural support between the vertebral endplates, providing a larger contact surface for solid fusion, and allows the correction of deformities in the coronal and sagittal planes, as well as the indirect decompression of the spinal canal and foramina while sparing the posterior elements.<sup>2</sup>

Both the conventional lateral approach and minimally invasive approaches are promoted as techniques that have been successful in reducing vascular and visceral injury rates when compared to ALIF (anterior lumbar interbody fusion) while avoiding the trauma to the musculature, innervation, and paraspinal vasculature caused by posterior interbody fusion techniques such as TLIF (transforaminal lumbar interbody fusion) and PLIF (posterior lumbar interbody fusion). Potential benefits include smaller incisions, less blood loss, shorter surgical times, restoration of disc space height, reduced infection rates, shorter hospital stays, increased fusion rates, decreased subsidence rates, less postoperative pain, and lower reoperation rates.<sup>2</sup>

However, as this method and its variations have grown in popularity, associated complications have begun to be reported worldwide.

The objective of this article is to present a narrative review of the literature to provide the reader with an organized summary of the most frequently reported complications and to provide tools to avoid them.

## MATERIALS AND METHODS

A narrative review of the literature obtained from the analysis of the following databases was carried out: PubMed, Web of Science, Scopus and Lilacs, to identify articles detailing complications related to the lateral approach to the lumbar spine.

The following combined search terms were used: “(lateral lumbar interbody fusion OR extreme lateral lumbar interbody fusion OR XLIF OR LLIF) AND (complic\* OR complication OR adverse event)”.

The titles of the studies found in the databases were compared. Duplicate records were removed and the remaining articles were screened for inclusion according to title and abstract. In addition, the references of the included articles were reviewed to ensure that no relevant citations were missed. The author of this article conducted the eligibility assessments independently and in a standardized manner.

The selection criteria were as follows:

- Articles published in English or Spanish
- Articles published in a peer-reviewed scientific journal
- Prospective or retrospective, randomized or non-clinical trials
- Case-control or cohort studies (prospective or retrospective)
- Articles published in the last 20 years
- Articles that included a description and detail of the complications directly related to the lateral approach to the lumbar spine.

The exclusion criteria were:

- Other reviews, case reports, letters to the editor, animal studies, book chapters and commentaries
- Articles reporting no complications in the results
- Articles including approaches other than the lateral approach to the lumbar spine
- Articles in languages other than English and Spanish

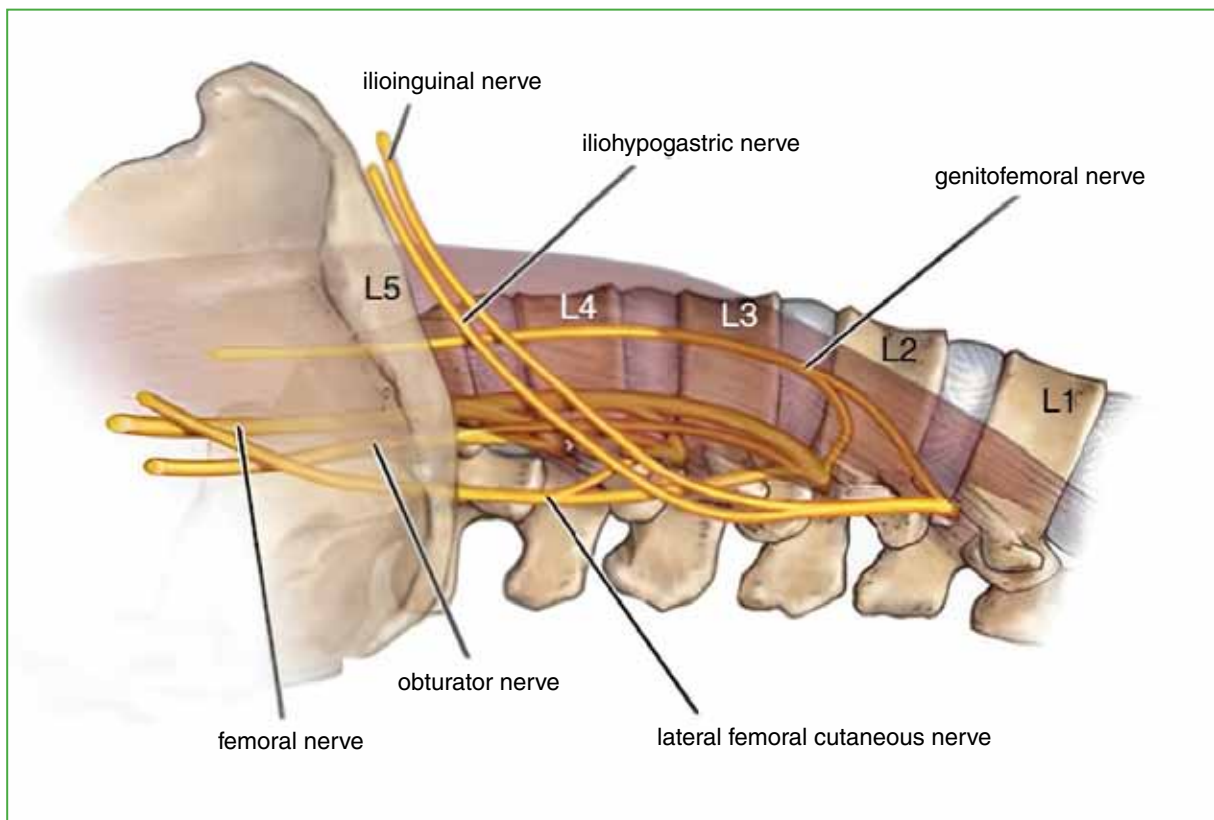
## RESULTS

A total of 1044 articles were identified in the four databases. After initial screening, application of inclusion and exclusion criteria, and elimination of duplicates, 18 studies were included and comprehensively evaluated.<sup>3-20</sup>

## DISCUSSION

In their first publication on this procedure in 2006, Ozgur et al.<sup>1</sup> reported no complications in the first 13 patients treated. However, they began to appear as the procedure gained popularity.

The most frequent complications after a lateral approach to the lumbar spine are anterior thigh pain or dysesthesia. Its etiopathogenesis involves irritation of the psoas muscle or neuropraxia of the genitofemoral nerve (branch of the lumbar plexus) during blunt dissection of this muscle, either due to retractor pressure, indirect ischemia or postoperative hematoma.<sup>1,3-5,21-25</sup> The rate of this complication ranges from 23%<sup>6</sup> to 39%<sup>7</sup>. However, Rodgers et al.<sup>3</sup> described a much wider range, from 0.7% to 62.7%. Most of the injuries occur when the psoas is split with the dilators or the retractor<sup>26</sup> and it has been shown that the time spent in the open position has a direct relationship with the rate of postoperative neurological injury.<sup>3,8-10,27</sup> The L4-L5 level is the most likely to suffer this injury, since, in approximately 44% of cases, nerve structures cross at the level of the theoretically ideal surgical field (Figure 1).<sup>23</sup> Pumberger et al.<sup>8</sup> evaluated 181 patients, and 38% of them presented with anterior thigh pain six weeks after surgery. However, this percentage gradually decreased to 11% at 12 weeks and 1% at 26 weeks. Other authors reported spontaneous recovery from this complication in 50% of the cases after three months and 90% after one year.<sup>28</sup>



**Figure 1.** Diagram showing the usual location of the roots that constitute the lumbar plexus and their relationship with the spine and the psoas muscle.

The second most frequent complication is the deficit in muscle strength for hip flexion, the rate of which varies from 1% to 36%.<sup>6,9,24,29,30</sup> In these cases, Pawar et al.<sup>31</sup> referred to a mechanical deficit due to direct injury to the psoas muscle and a neurological deficit due to irritation or injury to the intramuscular nerve plexus. According to these authors, the rate of mechanical deficit in hip flexion was 13.1% (n = 32) at 6 weeks, and decreased to 3.7% (n = 9) at 12 weeks; 2.9% at 6 months; and 1.6% at 12 months. Meanwhile, the motor deficit related to the lumbar plexus was lower, 4.9% (n = 12), 4.9% (n = 12), 2.9% (n = 7), and 2.9% (n = 7), respectively. Female sex and dura-

tion of surgery were independent risk factors for mechanical flexor deficit, while duration of surgery was the only independent risk factor for motor deficit related to lumbar plexus involvement. This variable is directly related to the time the gap remains open and the dilation as described above.

Sympathetic deafferentation is a neurological complication as well, with a frequency of 4% to 12%,<sup>19</sup> and is due to an injury to the lateral sympathetic trunk. Typically, patients report a slight increase in size and temperature in a limb that is ipsilateral to the injury, with more perspiration than in the contralateral limb. Nonetheless, the authors' clinical experience demonstrates that the coldness of the contralateral limb in comparison to the affected limb is what strikes the patient or evaluator the most.

The most feared complications during this procedure are major vascular injuries, which are extremely rare (0.4%)<sup>19</sup> or very rarely reported, but the consequences can be devastating, such as death.<sup>17</sup> There is a risk of injury to the venous component during right approaches,<sup>18</sup> while arterial injury is more likely in left approaches. Small vessel injuries are also included within vascular injuries. In a series of 181 patients, Pumberger et al.<sup>8</sup> reported one injury to the segmental lumbar artery (0.5%) and two (1%) injuries to the ascending iliolumbar vein.

Implant subsidence is the migration of the implant from its original location in any direction. This complication has a rate of 10-14%<sup>19,21</sup> and may or may not be associated with vertebral endplate fracture (Figure 2).<sup>12-14,25</sup> According to Essig et al.,<sup>15</sup> advanced age, osteoporosis and a sagittal orientation of the facets are risk factors for implant subsidence when this technique is used in isolation or *stand alone*. These authors suggest complementary posterior support when these conditions exist. Anterior implant subsidence is related to an unnoticed tear of the anterior longitudinal ligament during a very anterior discectomy or due to untimely dilatation of the disc space, as well as in ACR (anterior column realignment) procedures<sup>32</sup> with the use of hyperlordotic cages without self-retaining devices.



**Figure 2.** A. Immediate postoperative lumbosacral spine radiograph of a stand-alone L3-L4 interbody fusion by lateral approach. B. Radiographic control 15 days after surgery. Mobilization and rotation of the implant associated with subsidence of the superior vertebral endplate of L4 and inferior vertebral endplate of L3. C and D. Computed tomography of the lumbosacral spine, parasagittal slices, 15 days after surgery of the same patient. The above findings are observed. These studies show what is called implant subsidence.

Pseudarthrosis or consolidation failure is a late complication of the technique, but not so much of the approach. The rate varies between approximately 7.5%<sup>19</sup> and 19%<sup>30</sup>. This depends on the number of fused levels, the complementary posterior fixation, the thoroughness of the discectomy and the preparation of the endplates, as well as the patient's comorbidities (smoking, vascular disease, diabetes), among many other variables.

The surgical site infection rate is low compared to that of conventional posterior approaches to the lumbar spine (about 1-3%).<sup>3,20,33</sup> In addition, the vast majority of reported cases have been superficial wound infections.<sup>3</sup>

Among the specific complications of this approach, abdominal wall hernias due to denervation have been described very infrequently. Dakwar et al.<sup>11</sup> reported an asymmetry in the abdominal wall due to protrusion of the contents, related to the denervation of the internal oblique and transversus abdominis muscles due to injuries to the ilioinguinal and iliohypogastric nerve branches. Likewise, the subcostal nerve that emerges from T12 innervates the rectus femoris and external oblique muscles, so it must be identified and protected.<sup>34</sup> According to the available evidence, if this complication arises, the patient's discomfort will be more aesthetic than functional due to the asymmetry.

Other published perioperative complications of this technique are: postoperative ileus, intestinal perforations, arrhythmias, respiratory failure, gastric ulcer, acute urinary retention, and seromas or delayed wound healing. All with a rate of less than 1%.<sup>19,21</sup>

In 2019, Walker et al.<sup>33</sup> published a meta-analysis of complications of the lateral approach to the lumbar spine using prepsoas (1874 patients) and transpsoas (4607 patients) approaches. To the detriment of the prepsoas approach, they detected a higher incidence of sympathetic nerve lesions (5.4% prepsoas vs. 0% transpsoas) and more major neurovascular lesions (1.8% prepsoas vs. 0.4% transpsoas). Conversely, to the detriment of the transpsoas approach, they reported higher rates of temporary sensory deficits (21.7% vs. 8.7%), hip flexor weakness (19.7% vs. 5.7%) and infection (3.1% vs. 1.1%). Notably, the rates of urological, peritoneal and intestinal injuries, postoperative ileus, hematomas, subsidence (12.2% prepsoas vs. 13.8% transpsoas) and nonunion (9.9% prepsoas vs. 7.5% transpsoas) were similar in both groups.

It should be noted that, according to the available evidence, complication rates and severity have not been modified by obesity.<sup>16</sup> Therefore, obesity does not predispose to a higher complication rate, unlike in conventional posterior approaches.

## CONCLUSIONS

The most frequent complications directly related to the lateral approach to the lumbar spine are anterior thigh pain and motor deficits for hip flexion and leg extension, most of which are transient and reversible in the first six months. The prevalence of the rest of the complications varies according to the literature consulted, and reports of catastrophic vascular lesions are rare.

It should be noted that this approach requires careful and detailed imaging planning for each individual patient, along with knowledge of the anatomy and technique.

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Conflict of interest: The author declares no conflicts of interest.

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# Non-osteoporotic Loss of Spinal Bone. Denosumab as a Therapeutic Tool and its Implications

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## ABSTRACT

**Background:** Denosumab is a human monoclonal antibody that acts against RANKL, inhibiting bone destruction mediated by osteoclasts, thus avoiding bone loss. For this reason, it is used in the treatment of osteoporosis as an antiresorptive and is authorized for the treatment of giant cell tumor and multiple myeloma. Our objective is to understand its indications and contraindications for the treatment of non-osteoporotic bone loss. **Materials and Methods:** A systematic review of English-language articles published between 2009 and 2023, using PRISMA criteria. Articles indicating or contraindicating the use of denosumab were considered for inclusion. **Results:** From a total of 4306 articles, 18 articles were analyzed, which showed consensus on the dose and controls with tomography and indicated or contraindicated the use of denosumab. **Conclusions:** Denosumab is recommended as a primary therapeutic option for unresectable spinal tumors, to prevent recurrences or to delay the formation of metastases from primary tumors or solid tumors, primarily breast, prostate, and lung, as well as for multiple myeloma spinal involvement. Denosumab is currently contraindicated in infectious lesions.

**Keywords:** Spine; non-osteoporotic bone loss; tumor; infection.

**Level of Evidence:** III

## Pérdida de stock óseo no osteoporótico en la columna. Denosumab como herramienta de tratamiento e implicancia

### RESUMEN

**Introducción:** El denosumab es un anticuerpo monoclonal humano que actúa contra el RANKL, inhibiendo la destrucción ósea mediada por los osteoclastos, así evitando la pérdida del stock óseo; por este motivo, se lo utiliza en el tratamiento de la osteoporosis como agente antiresorptivo y está autorizado para el tratamiento del tumor de células gigantes y el mieloma múltiple. Nuestro objetivo fue conocer las indicaciones y contraindicaciones para la pérdida de stock óseo de causa no osteoporótica. **Materiales y Métodos:** Revisión sistemática de artículos en inglés publicados en el período 2009-2023. Se incluyeron artículos que indicaran o contraindicaran el uso del denosumab. **Resultados:** De un total inicial de 4306 artículos, se analizaron 18 artículos que mostraban consenso en la dosis y los controles con tomografía e indicaban o contraindicaban el uso del denosumab. **Conclusiones:** El denosumab está indicado como una buena opción de tratamiento preferente de tumores vertebrales primarios inoperables, para evitar recidivas o demorar las metástasis de tumores primarios o de tumores sólidos, principalmente de mama, próstata y pulmón, y para el compromiso vertebral del mieloma múltiple. El denosumab está contraindicado, por el momento, para las lesiones infecciosas.

**Palabras clave:** Columna; pérdida ósea no osteoporótica; tumor; infección.

**Nivel de Evidencia:** III

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**How to cite this article:** Bazán PL, Godoy Adaro A, Hernández Molina GL, Blanco Payano RÁ, Cinalli M. Non-osteoporotic Loss of Spinal Bone. Denosumab as a Therapeutic Tool and its Implications *Rev Asoc Argent Ortop Traumatol* 2024;89(1):83-89. <https://doi.org/10.15417/issn.1852-7434.2024.89.1.1802>

## INTRODUCTION

Denosumab is a human monoclonal antibody that acts against the receptor activator of nuclear factor kappa B ligand (RANKL), which promotes osteoclastic activity through the RANK-RANKL interaction, thereby inhibiting osteoclast-mediated bone destruction.<sup>1</sup> For this reason, it is administered as a treatment for osteoporosis in doses of 60 mg, subcutaneously, every 6 months, associated with vitamin D and calcium. Increased osteoclastic activity is evident in many osteopenic disorders, including infections, Paget's disease, bone metastases or osteolytic primary tumors, and rheumatoid arthritis, which increase bone resorption and destruction.<sup>2</sup>

Since the second decade of this millennium, the U.S. Food and Drug Administration has approved the use of denosumab in patients with mature skeletons and giant cell tumors (GCT),<sup>3</sup> which has been validated by numerous oncological management guidelines, with a dose of 120 mg administered subcutaneously, monthly, along with vitamin D and calcium.<sup>4</sup> Its use in the management of aneurysmal bone cysts and chordoma is being studied as well.

The objective of this review was to determine the indications and contraindications to the use of denosumab in patients with bone loss of non-osteoporotic causes, specifically in those with primary spinal tumors or infections.

## MATERIALS AND METHODS

The study was conducted in accordance with the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA 2020).

A systematic literature search of full articles in English was carried out in the PubMed, LILACS and SciELO databases, using the MeSH terms: Bone loss NOT osteoporotic AND Spine AND Denosumab AND Tumor OR Infection. Duplicates, unpublished studies, books, letters, and other documents were excluded. Publications between January 2009 and March 2023 were included.

We selected laboratory studies, randomized clinical trials, systematic and narrative reviews, and case reports that justified or contraindicated the use of denosumab for patients with bone loss related to spinal tumors or infections.

Within the inclusion criteria, we selected relevant studies on the use of denosumab for the treatment of bone defects associated with a bone tumor or spinal infection in humans, which justified or contraindicated its use, dosage, and controls.

Articles related to the management of osteoporosis or traumatic fractures and post-surgical bone defects were excluded.

## RESULTS

The initial search yielded 4306 articles in PubMed and three in LILACS from 2009 to 2023.

A second review was conducted after reading the titles and abstracts of each, after which 70 studies were selected and 18 of them were included for final data analysis (Figure).

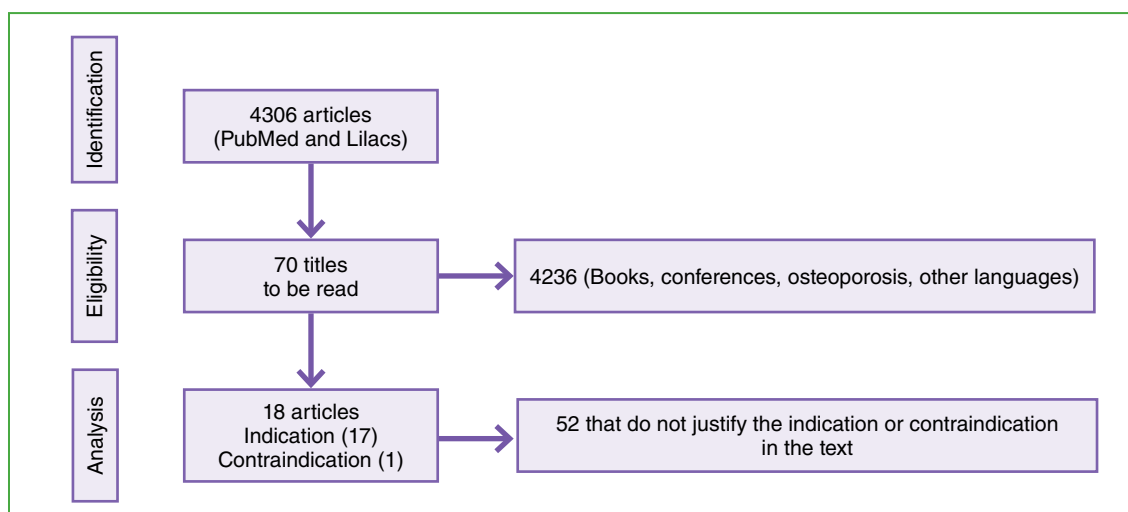


Figure. PRISMA 2020 flowchart.

Since 2013, the *Food and Drug Administration* has authorized the use of denosumab in patients with tumors, such as unresectable, relapsed or metastasized GCTs, and therefore it is now a consensual tool.<sup>4</sup> The dose is 120 mg/month, administered subcutaneously along with vitamin D (400 IU/month) and calcium (500 mg/day). For a loading dose, 120 mg/week is suggested for the first month.<sup>3-8</sup> There is no consensus on the duration of treatment, although it is at least 12 months.<sup>4</sup> In patients with large tumors,<sup>1</sup> it can be administered for six months to reduce size and facilitate resection, and thereafter to decrease recurrence,<sup>3,9</sup> as well as in those cases where the morbidity of resection does not warrant surgery.<sup>9</sup>

In cases of aneurysmal bone cyst, it is administered in the same way as for GCT, for unresectable or recurrent cases.<sup>10-13</sup>

In 2017, Kushlinskii et al.<sup>14</sup> pointed to the possibility of use for chordoma recurrences.

The administration of denosumab to patients with metastases from solid tumors, mainly breast, prostate, and lung,<sup>15-22</sup> such as multiple myeloma lesions, is safe and cost-effective.<sup>23,24</sup>

Its administration to patients with bone loss due to an infectious process has been investigated. In a literature review, Ohnishi et al.<sup>2</sup> contraindicated denosumab for this condition (Table).

**Table.** Indication or contraindication of denosumab in patients with non-osteoporotic bone defects.

Authors (year)	Use	Condition	Control	Evidence
Chawla et al. (2013)	Yes	GCT	CT	III
Ford et al. (2013)	Yes	Metastasis of any type of tumor	CT	III
Sun and Yu (2013)	Yes	Metastasis of any type of tumor	CT	III
Sohn et al. (2014)	Yes	Metastasis of any type of tumor	CT	III
Ng et al. (2014)	Yes	GCT	CT	II
Skubitz et al. (2015)	Yes	ABC	CT	III
Dubory et al. (2016)	Yes	GCT & ABC	CT	II
Kumar et al. (2017)	Yes	GCT	CT	III
Roitman (2017)	Yes	GCT	CT	II
van der Heijden et al. (2017)	Yes	GCT	CT	III
Kurucu et al. (2018)	Yes	ABC	CT	IV
Kushlinskii et al. (2017)	Yes	Chordoma	CT	II
Way (2018)	Yes	GCT	CT	III
Raje et al. (2018)	Yes	MM	CT	III
Rusin (2019)	Yes	GCT	CT	IV
Bukata et al. (2021)	Yes	GCT	CT	IV
Bazán et al. (2020)	Yes	GCT	CT	III
Diel et al. (2020)	Yes	Breast, prostate, and lung metastases	CT	II
Stopek (2020)	Yes	Metastasis of any type of tumor	CT	III
Lanari et al. (2021)	Yes	ABC	CT	IV
Ohnishi et al. (2021)	No	Infection	CT	II
Chen et al. (2021)	Yes	Metastasis of any type of tumor and MM	CT	II
Cadieux et al. (2022)	Yes	MM	CT	III
Li et al. (2022)	Yes	Small cell metastases from lung cancer	CT	III
Li et al. (2022)	Yes	Metastasis of any type of tumor	CT	II

Use: Yes = indicated, No = contraindicated; GCT = giant cell tumor; ABC = aneurysmal bone cyst; MM = multiple myeloma.

## DISCUSSION

Vertebral tumors have a very low frequency and make up 4% of all spinal tumors.<sup>25</sup> Currently, the use of denosumab for the initial treatment and recurrence of tumor conditions, in addition to infectious diseases, is being discussed; additionally, it may be a therapeutic alternative for tumors located in areas of difficult surgical access.<sup>10</sup>

In 2013, the Food and Drug Administration approved denosumab for the treatment of skeletally mature adults and adolescents with unresectable GCTs or the potential for severe morbidity due to resection. In 2017, the Clinical Practice Guidelines in Oncology (NCCN Guidelines®) also recommended the administration of denosumab in cases of axial lesions (spine, pelvis and sacrum) and metastatic lesions.<sup>3</sup> Short-term (six-dose) preoperative administration of denosumab to patients with unresectable or recurrent GCT improved clinical symptoms, decreased tumor size, and increased tumor density. The changes in the tumors, in turn, simplified the manipulation of the tumor for removal and subsequently reduced the local recurrence of resection surgery.<sup>3</sup> In a prospective multicenter series of five patients with spine GCT, the following radiographic findings were observed after treatment with denosumab: tumor size decreased by at least 10% and tumor calcification was a consistent finding in all patients; in addition, a stronger pseudocapsule was observed during surgery.<sup>26</sup> A systematic review concluded that denosumab is indicated for patients with advanced GCT in the sacrum. The goals are to achieve local control and create an optimal surgical situation. It is recommended to administer a dose of 120 mg, subcutaneously, every 7 days, for the first month and then administer it every 4 weeks, for 2.5 to 13 months. After the use of denosumab, resection surgery should encompass the entire original tumor to reduce the risk of recurrence.<sup>4</sup> When the resection is without tumor-free margins, the risk of recurrence is much higher. Although studies are needed to confirm the following theory, in patients with GCT who do not receive a neoadjuvant, this risk of recurrence after resection surgery is greater when the dose of denosumab as an adjuvant is decreased or discontinued, which is controlled once the dose of 120 mg/month is restarted.<sup>9</sup> Denosumab may be used as a stand-alone treatment in patients with GCT.<sup>27</sup> In a published case of an 18-year-old woman, complete histologic remission was achieved after treatment with denosumab, histopathologic analysis of the surgical specimen revealed absence of GCT cells.<sup>28</sup> Over the past five years, the development of denosumab as adjuvant therapy in patients with GCT has had a profound impact on the surgical resection of this tumor. The ability to reduce tumor size and induce consolidation through cortical bone formation has facilitated both intralesional and total en bloc spondylectomy of affected vertebrae and improved its effectiveness.<sup>29</sup> Further research will be required to determine the efficacy and safety of denosumab as a stand-alone long-term treatment for GCT, as there is currently no consensus on its appropriate duration.<sup>29,30</sup> Denosumab therapy has had effects on bone and surrounding tissues, including a case report of a 58-year-old female patient with GCT in the lumbar spine, in whom histopathologic findings of sections resected after 10 courses of denosumab revealed the presence of RANK-positive cells around bone tissue.<sup>31</sup>

Denosumab is a therapeutic option available for recurrences, unresectable or intralesionally resected aneurysmal bone cysts. Clinical and radiological results of calcification and remission of the tumor lesion have been observed.<sup>10</sup>

Denosumab is useful in the management of bone tumors, such as chordomas. In one study, 12 chordomas out of a total of 199 primary bone tumors were evaluated, with determination of RANK and RANKL. Chordoma has high RANK and low RANKL levels, making the use of denosumab possible.<sup>14</sup>

Some drugs to treat osteoporosis are considered potentially therapeutic for bone loss secondary to infection, as they are given for bone loss in other diseases. Agents for osteoporosis include anabolics (teriparatide, romosozumab) and antiresorptives (bisphosphonates, denosumab, and romosozumab).<sup>2</sup> Denosumab is a human monoclonal antibody against RANKL that inhibits the differentiation of osteoclast precursors into mature osteoclasts. However, since its receptor, RANK, is also expressed by monocytes/macrophages and dendritic cells, it highlights the importance of this pathway in the development and maturation of the immune system. This means that there is no evidence for the administration of denosumab to patients with active infection, as it has been shown that it could increase the deficiencies of the immune system to fight these infectious processes. Therefore, denosumab may worsen the infection when administered to patients with pyogenic osteomyelitis, although it is effective for suppression of osteolysis.<sup>2</sup> Further studies are also needed to clarify the efficacy of denosumab in the treatment of this condition.

Long-term use of denosumab is not harmless and complications or adverse events have been reported, such as osteonecrosis of the jaw (6%), hypocalcemia (5%), and atypical femur fractures (4%). Calcium and vitamin D supplementation is recommended, in addition to radiological monitoring of the jaw.<sup>30,32</sup> Osteonecrosis is more frequent in the lower jaw than in the upper jaw and not in other bones, this is due to its embryonic origin (ectomesenchymal origin), its vascular irrigation, and bone remodeling, which are altered by different drugs, such as denosumab at high doses, but especially in patients receiving bisphosphonates.<sup>33</sup> A dental diagnosis should be made to differentiate infectious processes from osteoradionecrosis associated with head and neck radiation therapy, especially in patients with dental trauma due to loose dental prostheses.<sup>33</sup>

Tumor recurrence has been reported after discontinuation of this drug. We report the case of a 25-year-old man with C2 GCT who underwent surgical resection and was treated with long-term denosumab and discontinued the drug. Discontinuation of denosumab resulted in rapid recurrence of the tumor. There is still no consensus on the dosage and duration of denosumab treatment after GCT resection.<sup>34</sup> In conclusion, the efficacy and safety profiles of denosumab in patients with GCT of the spine, including the sacrum, appear to be consistent with those of denosumab in the general population with GCT and in other advanced bone neoplasms, such as aneurysmal bone cyst, chordoma, and bone metastases. The results of the analysis suggest that treatment with denosumab is potentially useful for patients with GCT of the spine, including the sacrum.<sup>5,35</sup>

## CONCLUSIONS

Denosumab is indicated because it is a good preferential treatment option for unresectable primary vertebral tumors, it is a good option to avoid recurrences or to delay metastases of primary tumors or solid tumors, mainly of the breast, prostate and lung, and for the vertebral involvement of multiple myeloma. Denosumab would be contraindicated, for the time being, in patients with infectious lesions.

Conflict of interest: The authors declare no conflicts of interest.

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# Dr. Iván Ayerza (1943-2023)



**D**r. Iván Ayerza was born on November 1, 1943. He completed his primary and secondary studies at Colegio Champagnat in Buenos Aires. He studied medicine at the University of Buenos Aires, and obtained his medical degree in 1966.

He came from a family with strong medical roots and tradition. His father, a prominent orthopedist, was Chief of the Orthopedics and Traumatology Service at Hospital Fernández.

In 1967, he joined the orthopedics residency at Hospital Italiano de Buenos Aires and later became Head and Instructor of Residents at the institution. He was therefore directly influenced by his teacher and mentor Carlos Ottolenghi.

In 1974, he joined Hospital Fernández, and finished his hospital activity in charge of the Spine Surgery Sector.

He was highly involved in professional societies. He was a founding member of the *Asociación Argentina de Artroscopia* (Argentine Arthroscopy Association) and an active member of the *Sociedad Argentina de Columna* (Argentine Spine Society). He exhibited exceptional performance and influence within the *Asociación Argentina de Ortopedia y Traumatología* (AAOT - Argentine Association of Orthopedics and Traumatology). He served as treasurer, vice president and president of the AAOT. Finally, he presided over the *Argentine Congress*, which was held in Salta, resuming the organization of our Association's greatest scientific event in cities in the interior of the country. He received awards from the *Asociación Argentina de Ortopedia y Traumatología* and the *Academia Nacional de Medicina* (National Academy of Medicine).

He was a man of universal culture with a strong inclination towards the arts, predominantly the opera and visual arts. His frequent trips related to his profession were always complemented by visits to centers of musical and visual arts, which honed his natural talent for painting.

He possessed the necessary characteristics of a physician: prioritizing the patient, astute observation and interpretation of the clinical examination, an intense capacity for learning and innovation, and surgical proficiency. He had a natural manual dexterity applied to surgery that distinguished him from his peers.

Perhaps his Basque heritage, which he cherished, imbued him with a passionate, dynamic spirit oriented toward noble attitudes and feelings, as well as a sense of camaraderie beyond borders. His generosity and dedication had a profound influence on the assistants and disciples who followed him in both his hospital activity and his vast and intense private practice.

He died on December 8, 2023 at the age of 80, accompanied by a strong religious conviction.

Nevertheless, for those who have accompanied him in his many years of medical practice and have received his boundless friendship, a desolate feeling remains.

I believe, however, that the many disciples he leaves behind will consider it an honor to have shared our fascinating and demanding profession with him.

*Prof. Dr. D. Luis Muscolo  
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**How to cite this article:** Muscolo DL. Obituary. Dr. Iván Ayerza. *Rev Asoc Argent Ortop Traumatol* 2024;89(1):90. <https://doi.org/10.15417/issn.1853-7434.2024.89.1.1916>

# Dr. Fernando Pablo Degrossi



On December 20, 2023, we received heartbreaking news that a great person had died. Dr. Fernando Pablo Degrossi left us at the early age of 64. Fernando was a renowned orthopedic surgeon of our association and also a member of the Asociación Argentina de Artroscopía.

He was, for many years, head of the Orthopedics and Traumatology Service of Hospital Argerich of the Autonomous City of Buenos Aires, head of the Orthopedics and Traumatology Service of Sanatorio Modelo de Quilmes and Director of Hospital Oller of San Francisco Solano de Quilmes.

He was an avid enthusiast of sports, particularly soccer, which prompted him to become a doctor for the professional team Quilmes Atlético Club and a member of the board of directors for many years.

But above all, Fernando was a good person. I highlight his humble nature, respect for his colleagues, and unwavering dedication and professionalism towards his patients.

I have had the opportunity to perform several solidarity surgeries at Hospital Argerich with his totally selfless support.

A great person has left us, but we will always remember the friend who prioritized solidarity above all else.

Our Association extends its heartfelt condolences to all of his family, friends, and colleagues, who will surely miss him very much.

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**How to cite this article:** Gallucci GL. Obituary. Dr. Fernando Pablo Degrossi. *Rev Asoc Argent Ortop Traumatol* 2024;89(1):91. <https://doi.org/10.15417/issn.1852-7434.2024.89.1.1912>