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Artificial Intelligence Is Here to Stay: Benefits and Risks

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Artificial intelligence (AI) is no longer a promise for the future: it is an everyday reality in medical practice. It is integrated into electronic health records, diagnostic support systems, and conversational assistants.

The question today is not whether we should use it, but how to use it responsibly.

In information management, AI makes it possible to process volumes of data that exceed human capacity. It can reduce clinical documentation time by 20-30% and assist in diagnostic decision-making.[1]

However, these systems are probabilistic, not infallible. They can generate errors and biases and produce opaque decisions. The abundance of information calls for rigorous quality control and validation of AI-generated content.

In medical education, AI offers simulations of complex scenarios and personalized learning. It can generate diagnoses, interventions, and assessments that students must then analyze, correct, and justify.

However, it also introduces a documented risk: the erosion of skills when reliance on technology precedes independent reasoning. Physicians in training may come to rely on AI before fully developing their core competencies, leaving them without a solid foundation if the technology fails and limiting the learning experiences needed to develop clinical intuition and sound judgment (Figure).

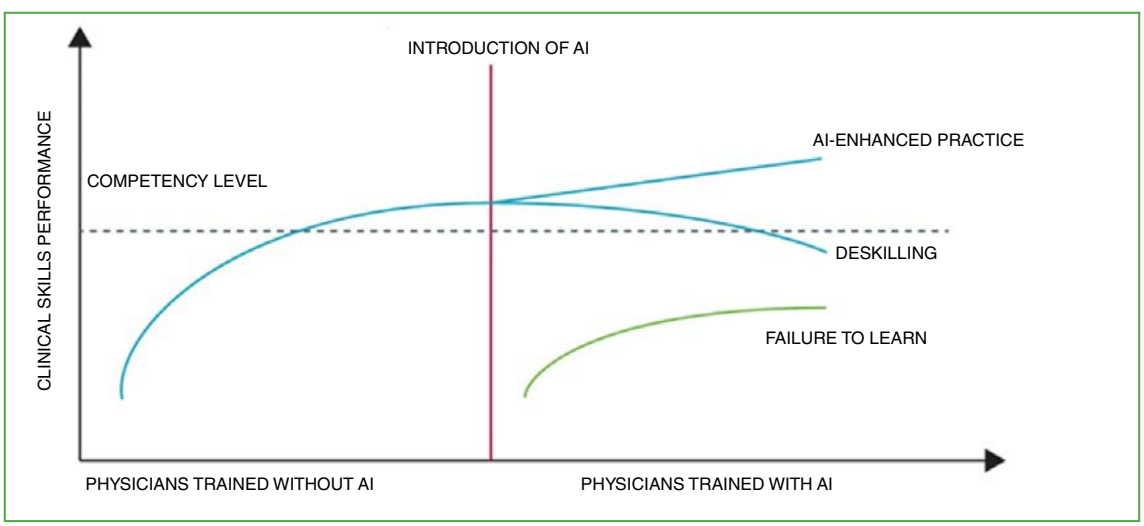

Figure. Clinical skills vs. AI performance. Modified from Berzin TM, Topol EJ. Preserving clinical skills in the age of AI assistance. *Lancet* 2025;406:1719-21. https://doi.org/10.1016/S0140-6736(25)02075-6

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These risks can be mitigated if AI is used only after physicians have made and recorded their own observations. These "sessions" should be repeated systematically and periodically even after basic training has been completed, just as pilots undergo recurrent flight simulator training.[2]

AI should be used after independent clinical analysis, not before.

In the physician-patient relationship, AI is changing expectations. Many patients arrive at the consultation with algorithm-generated diagnoses expressed with an air of certainty. Others arrive with treatments suggested by a system that does not disclose the level of evidence supporting them.

This apparent certainty gives the system an authority that people perceive as trustworthy. Apparent coherence can prevail over evidence.[3]

The challenge is not to compete with technology, but to strengthen clinical listening: the *escuchatorio*, the practice of truly listening to the patient. When the healthcare system does not provide enough time for listening, patients seek answers from algorithms that are available 24/7.

The implementation of voice-based communication that allows AI to participate as an interlocutor during the consultation continues to advance. Conversational AI promises to alleviate the administrative burden, but it introduces risks related to the accurate interpretation of language and the secondary use of clinical data.[4]

At the ethical level, crucial questions arise:

- Who is responsible for an AI-assisted error?

- How is privacy protected?

- Should the use of AI be included in informed consent?5

- Could failure to use AI be considered negligence if it becomes standard?

Conclusion

The conclusion is clear: AI does not replace the physician, but it does redefine the physician's responsibility. Integrating it critically, with continuous human oversight and appropriate regulation, is the challenge facing our generation of medical professionals. The greatest risk: confusing algorithmic coherence with scientific evidence.

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Surgical Timing in Patients with Vertebral Metastases and Neurological Impairment in the Public Health System: A Case Series and Literature Review

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ABSTRACT

Introduction: Vertebral metastases account for 40% of all bone metastases and are often complicated by spinal cord compression, which constitutes an emergency. Decompression surgery within the first 48 hours has been proposed as the most effective strategy. In the public health system of the Autonomous City of Buenos Aires (CABA), Argentina, the care of these patients is affected by the heterogeneity of the healthcare system and the resources available. **Materials and Methods**: A retrospective, descriptive case series study was conducted at a public hospital in CABA between 2018 and 2023. Patients aged >18 years with vertebral metastases and neurological deficits who underwent surgery were included. Patients with incomplete data or no neurological deficits were excluded. Clinical, functional, and prognostic variables were analyzed using descriptive statistics. **Results:** Fourteen patients were included (12 women and 2 men; median age, 59 years). The main causes of surgical delay were a lack of surgical supplies, delayed diagnosis, and poor treatment adherence. **Conclusions:** Problems related to surgical delays in patients with vertebral metastases and neurological impairment were documented to raise awareness of this issue. A lack of surgical supplies and delayed diagnosis were identified as the main areas requiring improvement.

Keywords: Spinal neoplasms; spinal cord compression; neurological deficits; spine; surgery; access to health services.

Level of Evidence: IV

Oportunidad quirúrgica en pacientes con metástasis vertebrales y lesión neurológica en el ámbito público de la salud: serie de casos y revisión bibliográfica

RESUMEN

Introducción: Las metástasis vertebrales representan el 40% de todas las metástasis óseas y, a menudo, se complican con la compresión del neuroeje, lo que representa una urgencia. La cirugía de descompresión dentro de las primeras 48 h se postula como la estrategia más eficaz. En el sistema público de la Ciudad Autónoma de Buenos Aires (CABA), Argentina, la atención de estos pacientes está condicionada por la heterogeneidad del sistema de salud y los recursos disponibles. **Materiales y Métodos:** Se realizó un estudio retrospectivo, descriptivo de una serie de casos en un hospital público de la CABA, entre 2018 y 2023. Se incluyó a pacientes >18 años con metástasis vertebral y déficit neurológico, tratados con cirugía. Se excluyó a los pacientes con datos incompletos y sin déficits neurológicos. Se analizaron variables clínicas, funcionales y pronósticas mediante estadística descriptiva. **Resultados:** Se incorporó a 14 pacientes (12 mujeres, 2 hombres, mediana de edad: 59 años). Las causas principales de la demora quirúrgica fueron la falta de materiales quirúrgicos, el diagnóstico tardío y la falta de adherencia al tratamiento. **Conclusiones:** Se documentaron conflictos en la demora quirúrgica de pacientes con metástasis vertebrales y daño neurológico, con el objetivo de visibilizar esta problemática, y se destaca la falta de material quirúrgico y el diagnóstico tardío como las principales causas por mejorar.

Palabras clave: Neoplasias espinales; compresión de la médula espinal; déficits neurológicos; columna vertebral; cirugía; accesibilidad a los servicios de salud.

Nivel de Evidencia: IV

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INTRODUCTION

Vertebral metastases are the most common secondary skeletal oncologic lesions and account for approximately 40% of bone metastases. Compression of the neuraxis is the most severe complication and occurs in 5-10% of patients.[1–3]

Neurological involvement is common in patients with advanced cancer and delayed diagnosis.[3] Progressive neurological deficit is a surgical emergency, and decompression surgery within 48 hours of the onset of neurological deficit is considered the safest and most effective strategy.[4–13] However, the optimal timing of surgery in patients with vertebral metastases and neurological deficits remains controversial.

It is estimated that diagnosis is delayed by two months from the onset of the first significant symptom until the neurological deficit is adequately documented.[1] Most patients experience pain before the onset of neurological symptoms, make multiple visits to the emergency department, and, in some cases, have no previous diagnosis of the primary malignancy. Other factors reported in the literature include delays in referral to a specialized center and limited availability of imaging studies.[1–7]

In our setting, the care of these patients may be affected by the heterogeneity of the healthcare system and the resources available, making it difficult to implement evidence-based recommendations in daily practice. In the authors' experience, issues related to the availability of appointments, diagnostic studies, operating room time, anesthesia, intensive care unit beds, and surgical implants are among the difficulties faced by spine surgeons when attempting to treat these patients within the optimal therapeutic window.

We present a series of patients with vertebral metastases and neurological deficits who underwent surgery at a public hospital and analyze surgical delays and their associated causes.

MATERIALS AND METHODS

A descriptive, retrospective case-series study was conducted in patients with vertebral metastases and neurological deficits who underwent surgery at a single public hospital in the Autonomous City of Buenos Aires between January 2018 and January 2023. Patients were selected according to the following criteria: adults of both sexes with pathological vertebral fractures due to metastatic disease and clinical and imaging evidence of neuraxis compression. Impairment was assessed using the *American Spinal Injury Association* (ASIA) Impairment Scale, and patients with grades A, B, C, and D were included.[14,15]

Data were obtained from the medical records for the following variables: age, sex, neurological deficit according to the ASIA scale, comorbidities, underlying malignancy, general condition according to the Karnofsky Performance Status, survival score according to the Tokuhashi score, mechanical instability determined by the *Spine Instability Neoplastic Score* (SINS), and surgical delay (calculated as the time from the onset of neurological deficit, according to the medical records, to decompression surgery). In addition, factors contributing to surgical delay after surgery was indicated were recorded. These factors were grouped into the following categories: clinical instability, implant-related delays, intensive care unit bed availability, anesthesiologist availability, operating room availability, and other factors.

Statistical Analysis

Categorical variables are expressed as numbers and percentages and were analyzed using the χ^2 test. Numerical variables are presented as means or medians and were analyzed using Student›s *t*-test or the Mann-Whitney U test according to whether their distribution was normal or nonparametric, respectively. A p value <0.05 was considered statistically significant.

Statistical analyses were performed using SPSS version 25. The principles of the Declaration of Helsinki for research involving identifiable patient data were followed. Confidential, anonymized records were used.

RESULTS

Twenty patients with vertebral metastases and neurological deficits who underwent surgery and were hospitalized at our center during the study period were identified. Six were excluded because of missing data. The final sample consisted of 14 patients, 12 women (85.7%) and two men (14.3%), with a median age of 59 years (range, 36-69). The most common primary tumor was breast cancer (35.7%), followed by lung cancer (21.4%) and prostate cancer (21.4%) (Figure 1).

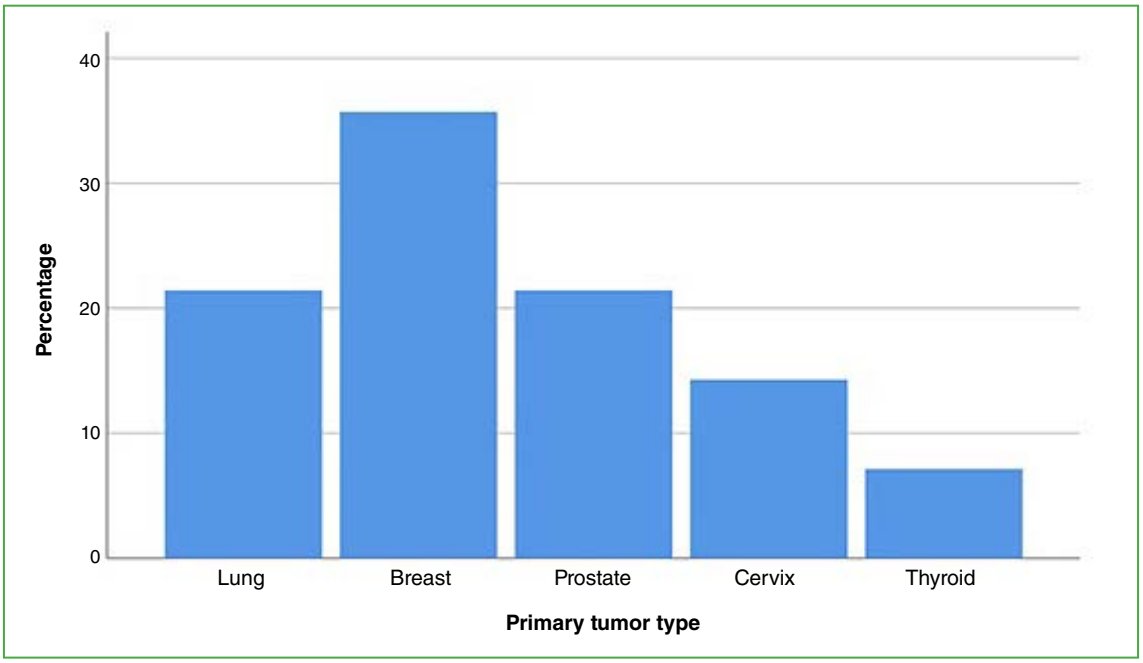

Figure 1. Distribution of primary tumor types: breast cancer (35.7%), lung cancer (21.4%), prostate cancer (21.4%), cervical cancer (14.3%), and thyroid cancer (7.1%).

Neurological status was assessed using the ASIA scale. Grade D accounted for 57.1% of patients, grade C for 28.6%, and grade B for 14.3%. According to the Karnofsky score, 35.7% were able to work and care for themselves, 35.7% were unable to work and required some assistance, and 28.6% required extensive care.

According to the SINS, 28.6% of patients were classified as unstable and 71.4% as potentially unstable. Figure 2 shows the Tokuhashi scores for patient prognosis.

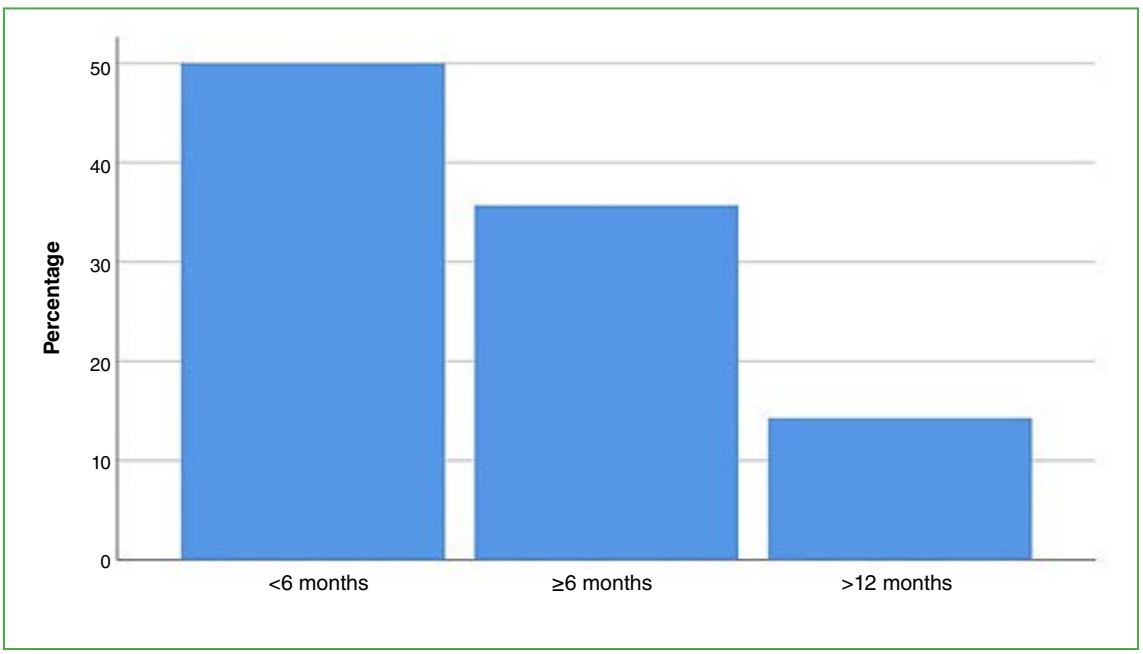

Figure 2. Distribution of prognosis according to the Tokuhashi score.

The underlying disease progressed in 28.5% of patients; three patients (21.4%) had progression of metastatic disease, and one (7.14%) sustained a pathological hip fracture due to disease progression.

The median surgical delay from diagnosis of the neurological deficit to surgery was 28 days (range, 4-90).

The most common location of metastases was the thoracic spine (50%), followed by the lumbar spine (28.6%). Two patients (14.3%) had thoracolumbar involvement, and one (7.1%) had involvement of the entire spine. No cervical or sacral metastases were detected.

Patients were assessed using the ASIA scale at the time of consultation with the spine specialist. Two (14.3%) had preserved sensation but no motor function (ASIA B); eight (57.1%) had some degree of incomplete motor impairment (ASIA C and D); and four (28.6%) had no neurological deficits at the initial assessment (ASIA E).

Regarding access to the healthcare system, three patients (21.4%) presented through the emergency department, six (42.9%) were referred from other specialties, and five (35.7%) were diagnosed directly by the spine specialist.

The documented causes of surgical delay were delays in obtaining surgical implants (100%), delayed diagnosis with an established neurological deficit (42.8%), and lack of adherence, including treatment discontinuation by the patient or failure to attend scheduled follow-up visits (21.4%). No issues related to intensive care unit bed, operating room, or anesthesiologist availability were documented. Figure 3 shows an illustrative case.

Given the small sample size of this case series (n = 14), the statistical analysis was limited to descriptive statistics. In this context, inferential statistical methods would not be appropriate and would not yield robust conclusions.

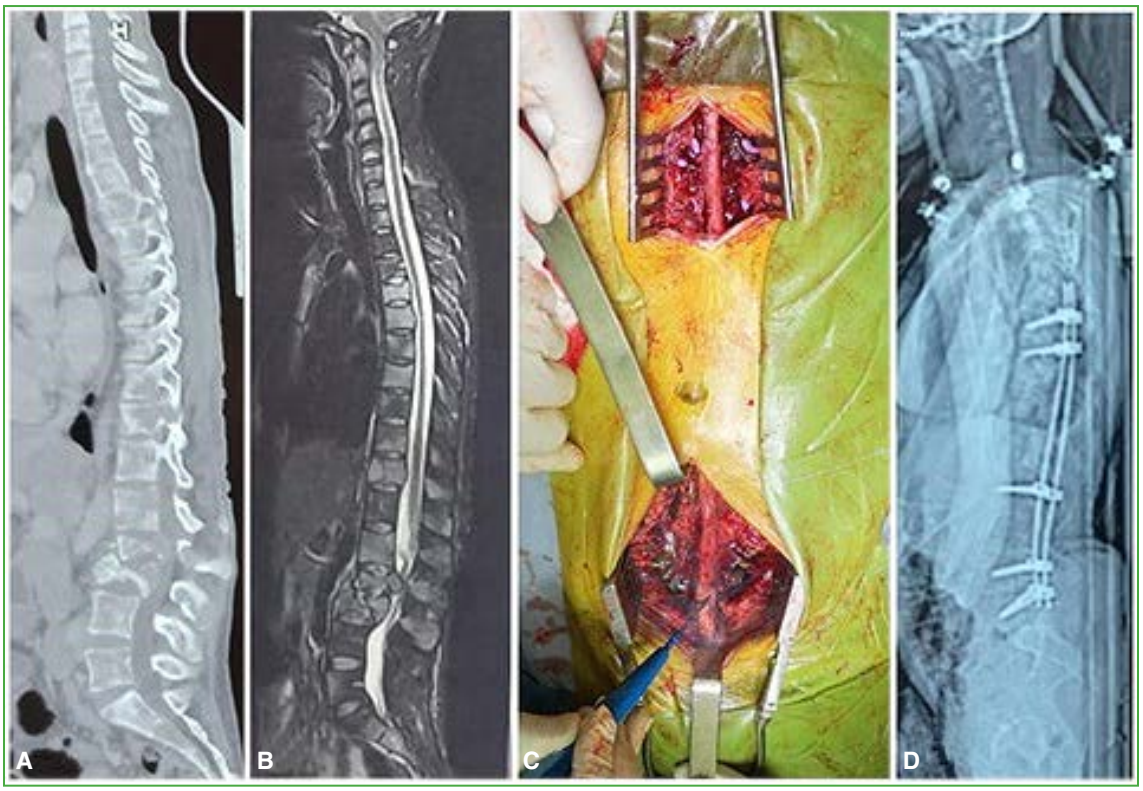

Figure 3. Representative case. A 36-year-old woman presented to the emergency department with a 2-month history of mechanical low back pain and lower extremity weakness (ASIA D). She had had multiple previous consultations, and the primary tumor was unknown. Advanced disease with multiple skeletal metastases and diffuse spinal involvement. **A and B.** Cauda equina syndrome due to L2 and L3 metastases. **C and D.** Surgical decompression with long-segment stabilization.

DISCUSSION

The "optimal" therapeutic window for early decompression in patients with vertebral metastases and neurological involvement has been estimated to be within the first 48 hours after the onset of neurological symptoms.[9–13] However, the optimal timing of surgery remains controversial. Most of the available evidence is based on retrospective cohorts, and patients with cancer represent a clinically heterogeneous population in whom the risk-benefit balance of surgical decompression depends on multiple clinical and prognostic variables. Meyer et al. reported one of the largest cohorts to date of patients with vertebral metastases and acute neurological involvement and suggested that early surgery within 16 or even 12 hours appears to substantially increase the likelihood of functional recovery without increasing the risk of serious perioperative and postoperative complications.[4] Based on a synthesis of data from seven retrospective studies, Bresolin et al. identified the first 48 hours as a safe and effective therapeutic window, although with a low level of certainty.[13] In our case series, no patient underwent surgery within the first 48 hours. Delays in obtaining surgical materials within the first 48 hours (100%), delayed diagnosis (42.8%), and lack of treatment adherence (21.4%) were the predominant causes of untimely surgical delay.

In our setting, Landriel et al. published a retrospective study of patients with documented vertebral metastases and reported a mean delay of 83.5 days in surgical referral for potentially unstable or unstable lesions. The authors noted that 25% of patients had their first surgical consultation more than three months after undergoing computed tomography.[1] In our experience, all patients had sought care at emergency departments or from physicians in other specialties before their metastatic spinal disease was identified, and surgical consultation was documented only after neurological deficits had developed.

Timely diagnosis requires a high degree of clinical suspicion by physicians evaluating patients with axial spinal pain, assessment of red flags, knowledge of the clinical and epidemiological profile of patients at risk for vertebral metastases, an appropriate neurological and orthopedic examination, and sensitive and specific imaging studies, with magnetic resonance imaging playing a central role.[1,3,4,8,13] In this context, the documented Karnofsky score likely reflects both the systemic disease burden and local vertebral involvement. Notably, all lesions were classified as at least potentially unstable according to the SINS; therefore, the functional deterioration observed in these patients may be interpreted as resulting from the interaction between advanced systemic disease and structural involvement of the spine. Based on our experience, efforts should focus on achieving an accurate diagnosis of vertebral metastatic disease and neurological involvement so that appropriate treatment can be established to minimize sequelae while keeping the risk of complications as low as possible. This also requires an effort involving not only healthcare professionals, but all stakeholders involved in the care process to facilitate early availability of the necessary surgical implants and resources.

This study has limitations that preclude generalization of its conclusions. Its retrospective, descriptive design and small sample size are its main limitations. The small sample size and heterogeneity of the primary tumors do not allow a conclusive analysis of a potential association between the spinal location of the lesions and the primary tumor. Nevertheless, this study reflects the experience of a public institution and highlights the need to establish an appropriate protocol to facilitate timely referral and specialized treatment of patients with vertebral metastases and neurological involvement.

CONCLUSIONS

Factors contributing to untimely delays in the care of patients with vertebral metastases and neurological impairment were documented in the public healthcare setting. The predominant factors were delays in obtaining surgical materials and delayed diagnosis of the complication.

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

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Functional Outcomes in Patients with Acromioclavicular Dislocation Treated with Coracoclavicular Stabilization and Acromioclavicular Cerclage

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ABSTRACT

Introduction: The treatment of acromioclavicular dislocations using a coracoclavicular stabilization system with high-strength sutures achieves reduction of the dislocation and maintains acromioclavicular joint stability. However, some modifications incorporate additional surgical techniques, such as acromioclavicular cerclage, to provide stabilization in different planes. **Objective:** To evaluate functional outcomes, functional scores, and complications in patients with acromioclavicular dislocations treated with coracoclavicular stabilization and acromioclavicular cerclage. **Materials and Methods:** Forty-two patients with traumatic type IIIb, IV, or V acromioclavicular dislocations of less than 2 weeks' duration were prospectively evaluated. Patients with associated fractures or glenohumeral instability were excluded. The Visual Analog Scale and the Constant-Murley score were used. **Results:** The mean age was 31.26 ± 10.7 years, and most patients were female (54.8%). After surgery, 71.4% of patients went from experiencing severe pain (7-10 points) to no pain (0 points). The Constant-Murley score improved from 1.17 ± 0.37 before treatment to 3.88 ± 0.32 after treatment, reflecting an improvement in the patients' clinical condition. **Conclusions:** Coracoclavicular stabilization with acromioclavicular cerclage is a valid treatment option that provides good functional outcomes and improved scores in patients with acute type IIIb, IV, or V acromioclavicular dislocations.

Keywords: Acromioclavicular dislocation; functional scores; coracoclavicular stabilization; acromioclavicular cerclage.
Level of Evidence: IV

Resultados funcionales en pacientes con luxación acromioclavicular tratada con estabilización coracoclavicular y cerclaje acromioclavicular

RESUMEN

Introducción: El tratamiento de las luxaciones acromioclaviculares con un sistema de estabilización coracoclavicular con suturas de alta resistencia logra reducir la luxación y mantener estable la articulación acromioclavicular, aunque existen modificaciones que suman otras técnicas quirúrgicas (cerclaje acromioclavicular) para estabilizar en diferentes planos. **Objetivo:** Evaluar los resultados funcionales, las escalas funcionales y las complicaciones en pacientes con luxaciones acromioclaviculares tratadas con estabilización coracoclavicular y cerclaje acromioclavicular. **Materiales y Métodos:** Se evaluó prospectivamente a 42 pacientes con luxación acromioclavicular tipos IIIb, IV y V, con menos de 2 semanas de evolución y traumáticas. Se excluyó a pacientes con fracturas asociadas e inestabilidad glenohumeral. Se utilizaron la escala analógica visual y la escala de Constant-Murley. **Resultados:** La edad de los pacientes era de 31.26 ± 10.7 años, y predominaba el sexo femenino (54,8%). El 71,4% pasó de tener dolor intenso (7-10 puntos) a no sentir dolor (0 punto) después del procedimiento quirúrgico. El puntaje de la escala de Constant-Murley (1,17 ± 0,37) antes y (3,88 ± 0,32) después del tratamiento mejoro la condición clínica del paciente. **Conclusiones:** La técnica de estabilización coracoclavicular con cerclaje acromioclavicular se considera una opción válida que permite obtener buenos resultados funcionales en pacientes con luxaciones acromioclaviculares tipos IIIb, IV y V agudas, con mejoría de los puntajes.

Palabras clave: Luxación acromioclavicular; puntajes funcionales; estabilización coracoclavicular; cerclaje acromioclavicular.
Nivel de Evidencia: IV

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INTRODUCTION

The ability to classify acromioclavicular dislocations, identify the structures involved, and characterize the different patterns of displacement makes it possible to select the appropriate surgical treatment to reduce and control vertical, horizontal, and rotational instability.[1,2] The various surgical techniques used to treat acromioclavicular dislocations have proven effective and provide stable reduction.[3-6]

Surgical treatment of this condition aims to achieve anatomic reduction of the acromioclavicular dislocation and repair the injured structures. For type IIIb (ISAKOS Upper Extremity Committee) and types IV, V, and VI (Rockwood classification) dislocations,[1] dynamic stabilization techniques for the acromioclavicular joint are used, involving sutures, grafts, tapes, screws, anchors, or suture buttons. These procedures may be performed arthroscopically and provide reliable stabilization.[3–6]

The addition of shoulder arthroscopy to acromioclavicular dislocation repair allows associated glenohumeral joint pathology to be identified and treated.[7–9] Coracoclavicular stabilization with high-strength sutures can reduce the dislocation and maintain acromioclavicular joint stability, although some modifications incorporate additional surgical techniques (acromioclavicular cerclage) to provide multiplanar stabilization.[3,8,10]

One of the surgical alternatives proposed for the management of patients with acromioclavicular dislocation is coracoclavicular stabilization combined with acromioclavicular cerclage. This technique has yielded good results in type IIIb, IV, and V dislocations by providing vertical, horizontal, and rotational stability and reducing the risk of instability and loss of reduction.[3,8,11,12]

The objective of this study was to evaluate functional outcomes, scores, and complications in patients with acromioclavicular dislocations treated with coracoclavicular stabilization and acromioclavicular cerclage.

MATERIALS AND METHODS

A prospective explanatory study was conducted. Patients with acromioclavicular dislocation underwent coracoclavicular stabilization combined with acromioclavicular cerclage. The sample consisted of 42 patients. Diagnostic shoulder arthroscopy was performed in all cases. All patients with type IIIb, IV, or V acromioclavicular dislocations resulting from a traumatic event were included. Two patients were excluded because of associated fractures, glenohumeral instability, and incomplete clinical and radiographic evaluations at the end of follow-up.

This study was approved by the hospital's ethics committee.

Functional Assessment

Patients were evaluated before and after surgery. During history taking, data were collected on age, sex, sports activity, acromioclavicular dislocation classification, and complications. On physical examination, patients had shoulder pain and a positive piano key sign for acromioclavicular dislocation. The diagnosis was confirmed with anteroposterior shoulder radiographs and Alexander views. The rotator cuff and long head of the biceps tendon were evaluated by ultrasound to identify associated lesions. The Visual Analog Scale (VAS) and Constant-Murley score were also administered.

Surgical Procedure

The patients provided informed consent. They were placed in the beach-chair position. Aseptic and antiseptic preparation was performed, and sterile drapes were applied. Then, they underwent ultrasound-guided interscalene brachial plexus block and general anesthesia.

The procedure was performed by a shoulder surgeon. Diagnostic shoulder arthroscopy was performed to identify associated lesions. The coracoid process was then skeletonized from lateral to medial, preserving the conjoint tendon, and a 2-mm-wide, high-strength polyethylene tape was passed through the subcoracoid region from medial to lateral.

A superior shoulder approach of approximately 4 cm was performed over the acromioclavicular joint. Two 2.7-mm clavicular tunnels were created in an anteroposterior direction under direct visualization, at 2 and 4 cm from the lateral margin of the clavicle, respectively. The medial end of the tape was retrieved through the lateral clavicular tunnel and the lateral end through the medial clavicular tunnel, creating a figure-of-eight configuration. The acromioclavicular dislocation was manually overreduced through the supraclavicular approach, with fluoroscopic confirmation, and the tape was tied over the posterior aspect of the clavicle (Figure).

The acromion was then tunneled from lateral to medial under fluoroscopic guidance. One end of the tape was passed from medial to lateral using a PDS suture and then tied, achieving acromioclavicular stabilization (Figure). The wound was closed in layers. Patients were immobilized in a sling for 21 days and then began passive exercises, which continued until the sixth week.

Postoperatively, VAS scores were <3, and Constant-Murley scores were >80 points, indicating excellent outcomes, at 3, 6, 9, 12, and 24 months. Radiographic follow-up with anteroposterior shoulder views was also performed at 3, 6, 9, 12, and 24 months, with no loss of reduction.

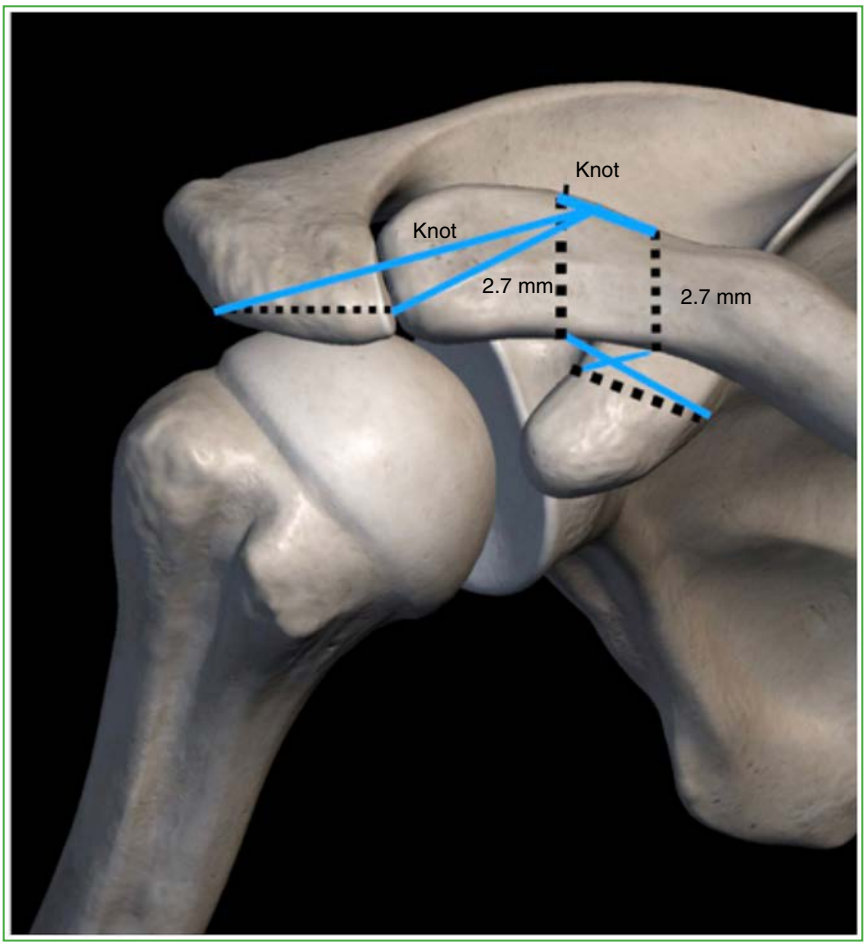

Figure. Two 2.7-mm clavicular tunnels are shown, created in an anteroposterior direction at 2 and 4 cm from the lateral margin of the clavicle. The medial end of the tape is retrieved through the lateral clavicular tunnel and the lateral end through the medial clavicular tunnel, creating a figure-of-eight configuration. The acromion is tunneled from lateral to medial, and one end of the tape is passed from medial to lateral and tied.

Statistical Analysis

The data were summarized in statistical tables using absolute and relative frequencies, the latter expressed as percentages. Descriptive statistics were used, with means and standard deviations calculated for scale variables. Inferential statistics were used to test the research hypothesis, using the paired Student's *t*-test and 99% confidence intervals. Statistical analyses were performed using SPSS version 25 and Excel for Windows.

RESULTS

Table 1 shows the general characteristics of patients with acromioclavicular dislocation who underwent coracoclavicular stabilization and acromioclavicular cerclage. This type of injury was more common in women (54.8%) and among patients who participated in sports (cycling, 40.5%; soccer, 9.5%).

Table 1. Data on patients who underwent coracoclavicular stabilization and acromioclavicular cerclage.

	Number	%
Age (mean ± SD)	(31.26 ± 10.7)	
18-30	26	61.9
31-57	16	38.1
Gender		
Female	23	54.8
Male	19	45.2
Sports activity		
Cycling	17	40.5
Soccer	4	9.5
Baseball	2	4.8
Other	1	2.44
None	18	42.8
Total	42	100

The most common type of acromioclavicular dislocation was type V (54.8%). All patients underwent open reduction with coracoclavicular stabilization and acromioclavicular cerclage assisted by shoulder arthroscopy (Table 2). Most patients (88.1%) had no complications. Suture dehiscence occurred in 9.5% and surgical site infection in 2.4%.

Table 2. Clinical characteristics of patients who underwent coracoclavicular stabilization and acromioclavicular cerclage.

Characteristic	Number	%
Classification of acromioclavicular dislocation		
IIIb	11	26.2
IV	8	19.0
V	23	54.8
Surgical treatment used		
Open reduction + CC stabilization and AC cerclage + shoulder arthroscopy	42	100
Surgical complications (follow-up at 3, 6, 9, 12, and 24 months)		
Suture dehiscence	4	9.5
Surgical site infection	1	2.4
None	37	88.1
Total	42	100

CC = coracoclavicular; AC = acromioclavicular.

Before surgery, 83.3% of patients had a Constant-Murley score <50 (poor), whereas after surgery, 88.1% had a score of 88-100 (excellent). Of note, 71.4% improved from <50 points (poor) to 88-100 points (excellent), with follow-up assessments at 3, 6, 9, 12, and 24 months (Table 3).

Table 3. Constant-Murley Score before and after treatment.

Constant-Murley Score Before	Constant-Murley Score After (follow-up at 3, 6, 9, 12, and 24 months)				Total	
	65-79 points (Good)		88-100 points (Excellent)		Number	%
	Number	%	Number	%		
<50 points (Poor)	5	11.9	30	71.4	35	83.3
50-64 points (Fair)	0	0.0	7	16.7	7	16.7
Total	5	11.9	37	88.1	42	100.0

Surgical treatment resulted in a change in clinical assessment based on the Constant-Murley scale, from 1.17 ± 0.37 before treatment to 3.88 ± 0.32 at 3, 6, 9, 12, and 24 months after surgery. Analysis of this change showed that surgical treatment significantly improved the patients' clinical condition (p <0.001) (Table 4).

Table 4. Constant-Murley Score before and after treatment.

Mean score	Before	After (follow-up at 3, 6, 9, 12, and 24 months)	p (99%) Student's t-test for paired samples	Confidence interval	
				Lower	Upper
	1.17 ± 0.37	3.88 ± 0.32	0.000	-2.85	-2.57

Another outcome measure used to evaluate the effectiveness of surgical treatment was the VAS. Pain intensity was compared before and after treatment. Before treatment, severe pain (7–10 points) was predominant, occurring in 83.3% of patients, whereas after treatment, one patient reported no pain. Of note, 71.4% of patients improved from severe pain (7–10 points) to no pain (0 points) during follow-up at 3, 6, 9, 12, and 24 months (Table 5).

Table 5. Visual Analog Scale (VAS) scores before and after treatment.

Pain intensity assessment Before	VAS After (follow-up at 3, 6, 9, 12, and 24 months)				Total	
	0 (No pain)		1–3 (Mild pain)		Number	%
	Number	%	Number	%		
4-6 (Moderate)	7	16.7	0	0.0	7	16.7
7-10 (Severe)	30	71.4	5	11.9	35	83.3
Total	37	88.1	5	11.9	42	100.0

VAS: no pain (0); mild (1-3); moderate (4-6); severe (7-10).

A change in pain intensity before (1.12 ± 0.32) and after (3.38 ± 0.37) surgical treatment was demonstrated using the VAS to assess changes in pain over the 24-month postoperative period (Table 6).

Table 6. Visual Analog Scale (VAS) scores before and after treatment.

	Before	After (follow-up at 3, 6, 9, 12, and 24 months)	p (99%) Student's t-test for paired samples	Confidence interval	
Mean score				Lower	Upper
	1.12 ± 0.32	3.88 ± 0.37	0.000	2.57	2.85

VAS: no pain (0); mild (1-3); moderate (4-6); severe (7-10).

DISCUSSION

In this study, the mean patient age was 31.26 ± 10.7 years, with a predominance of women (54.8%) and patients who participated in cycling. Type V acromioclavicular dislocation was the most common (54.8%). These results differ from those reported by Boström et al., who included 124 patients with a mean age of 40 years (range, 18–64), 91% of whom were men; 61 patients had an acromioclavicular dislocation.[13] These findings indicate that acromioclavicular dislocations can occur in both male and female adults.

In this study, all patients were treated with open reduction, coracoclavicular stabilization, and acromioclavicular cerclage assisted by shoulder arthroscopy. Complications included suture dehiscence (9.5%) and surgical site infection (2.4%). Saier et al. biomechanically demonstrated that only combined acromioclavicular and coracoclavicular reconstruction could adequately restore physiological horizontal stability of the acromioclavicular joint, which is consistent with the technique used in our study.[4] In contrast, Gaytán et al. reported no complications when using a double-button fixation system for acromioclavicular dislocations. The complications observed in our study may have been related to some patients not attending postoperative wound-care visits as scheduled.[14]

In a study by Natera-Cisneros et al., 10 patients with acromioclavicular dislocation were evaluated, and significant improvements from preoperative values were observed in the VAS (from 5.2 ± 2.40 to 1.7 ± 2.07) and Constant-Murley scores (95.6 ± 3.28 and 9.2 ± 0.67, respectively).[9]

Similarly, Pan et al. analyzed 179 patients and found that the use of tape was associated with a significantly lower VAS pain score, with no significant differences in Constant-Murley scores.[15] This is consistent with the findings of our study, in which 71.4% of patients improved from severe pain (7-10 points) to no pain (0 points) after surgery, while 71.4% improved from a Constant-Murley score of <50 points (poor) to 88-100 points (excellent).

The limitations of this study include the short follow-up period and the lack of a control group treated with a different surgical technique for comparison.

CONCLUSIONS

Coracoclavicular stabilization with acromioclavicular cerclage is a valid treatment option that provides good functional outcomes and improved scores in patients with acute type IIIb, IV, and V acromioclavicular dislocations.

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

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Midterm Results of Total Trapeziectomy and Suture-Button Suspensionplasty for Trapeziometacarpal Osteoarthritis

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ABSTRACT

Objective: To retrospectively analyze the results of total trapeziectomy and suture-button suspensionplasty for trapeziometacarpal osteoarthritis at a minimum follow-up of 2 years. **Materials and Methods:** Twelve patients who underwent this procedure were evaluated at least 2 years after surgery. Range of motion and metacarpal height were assessed. All patients completed the QuickDASH questionnaire and the Visual Analog Scale (VAS). **Results:** Eight women and four men (mean age, 63 years) were evaluated at a mean follow-up of 75 months. Adequate opposition was achieved in all patients, with a mean radial abduction of 59.8° and palmar abduction of 61.9°. The mean QuickDASH score was 21%, and the mean VAS score was 1.55. The mean distance between the first metacarpal and the scaphoid was 5.86 mm. There were no major complications. **Conclusions:** The favorable results of total trapeziectomy and suture-button suspensionplasty support its use in the treatment of trapeziometacarpal osteoarthritis, with an acceptable risk of complications. Subjective and objective outcomes are similar to those of other techniques; however, the benefit of this procedure lies in the initial stability provided by the implant, which does not depend on tissue healing. Therefore, rehabilitation can begin 10 days after surgery. At a time when total joint arthroplasty for trapeziometacarpal osteoarthritis is increasingly used, this technique could provide a simple and safe salvage option after failed total joint arthroplasty.
Keywords: Trapeziometacarpal osteoarthritis; suture-button suspensionplasty.
Level of Evidence: IV

Resultados a mediano plazo de la trapecectomía total y la suspensoplastia con botón para la rizartrosis

RESUMEN

Objetivo: Analizar retrospectivamente los resultados de la trapecectomía total y la suspensoplastia con botón para la rizartrosis en un seguimiento mínimo de 2 años. **Materiales y Métodos:** Se evaluó a 12 pacientes operados con esta técnica durante 2 años o más después de la cirugía. Se determinaron el rango de movilidad y la altura metacarpiana. Todos completaron el cuestionario QuickDASH y la escala analógica visual. **Resultados:** Se evaluó a 8 mujeres y 4 hombres (edad promedio 63 años) con un seguimiento promedio de 75 meses. En todos, se obtuvo una adecuada oposición, con una abducción radial promedio de 59,8º y una abducción palmar de 61,9º. El puntaje QuickDASH promedio fue del 21%, y el de la escala analógica visual, de 1,55. El espacio promedio entre el primer metacarpiano y el escafoides fue de 5,86 mm. No hubo complicaciones mayores. **Conclusiones:** Los resultados favorables de la trapecectomía completa y la suspensoplastia con botón alientan su utilización para tratar la rizartrosis, con un riesgo de complicaciones aceptable. Los resultados subjetivos y objetivos son similares a los de otras técnicas, pero el beneficio de este procedimiento consiste en la estabilidad inicial brindada por el implante, que no requiere tiempo de cicatrización; por lo tanto, la rehabilitación se inicia a partir de los 10 días de la cirugía. En el auge de las prótesis totales para rizartrosis, esta técnica podría ser una alternativa sencilla y segura para el rescate de la artroplastia total fallida.
Palabras clave: Rizartrosis; suspensoplastia con botón.
Nivel de Evidencia: IV

INTRODUCTION

Trapeziometacarpal osteoarthritis is a common condition that can significantly impair activities of daily living. The articular surfaces of the two bones involved are saddle-shaped and articulate perpendicularly to each other, allowing a wide range of motion but also increasing joint stress and instability. Biomechanically, generating 1 kg

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of pinch force at the tip of the thumb results in a load 10 times greater at the trapeziometacarpal joint.[1,2] Degeneration and laxity of the carpometacarpal ligaments contribute to dorsal subluxation and subsequent joint damage.[2] When nonoperative treatment fails, surgical intervention should be considered, with multiple options available. In cases of early-stage disease, characterized primarily by instability and minimal or no osteoarthritis, dorsal capsulodesis, volar ligament reconstruction, or extra-articular osteotomy of the first metacarpal may be indicated. In cases of advanced joint involvement and substantial damage to the articular surface, treatment options include trapeziometacarpal joint arthrodesis, total joint arthroplasty, suspensionplasty with tendon interposition, partial or complete trapeziectomy, or a combination of these procedures. These techniques yield similar outcomes at different stages of trapeziometacarpal osteoarthritis.[3] However, trapeziectomy alone has the lowest complication rate and shortest operative time, although its main drawback is the frequent proximal migration of the first metacarpal, with consequent functional impairment.[4] Partial or complete trapeziectomy can be temporarily stabilized with Kirschner wires placed from the first metacarpal to the second metacarpal or the distal pole of the scaphoid (or to the remaining trapezium in a hemitrapeziectomy) to reduce the tendency toward proximal migration of the first metacarpal.[2] This fixation requires prolonged immobilization and a second procedure to remove the wires, while providing no structural support during the rehabilitation period once the wires have been removed. When post-trapeziectomy stabilization is achieved by placing a button between the first and second metacarpals, early mobilization can be initiated because the construct provides firm support throughout the rehabilitation period and does not require a second procedure for implant removal.

This article describes the results of a retrospective review of complete trapeziectomy with button suspensionplasty in patients with more than 2 years of follow-up.

MATERIALS AND METHODS

The study protocol was approved by the institution's Ethics Committee, and all patients provided written informed consent to participate in the study.

Over a five-year period (2017-2022), 17 patients underwent complete trapeziectomy and button suspensionplasty performed by the same surgeon. Patients with persistent symptoms of trapeziometacarpal osteoarthritis despite nonoperative treatment and radiographic evidence of trapeziometacarpal osteoarthritis were included. According to the Eaton-Littler classification,[5] the cases were distributed as follows: stage II (3 patients), stage III (8 patients), and stage IV (1 patient). Five patients were excluded because of inadequate follow-up, as they had not attended the scheduled appointments for evaluation. The study group therefore consisted of eight women and four men, with a mean age of 63 years. 66.6% underwent surgery on their dominant hand (8 cases). The mean follow-up was 6.2 years (Table 1).

Table 1. Demographic data of the patients.

Study population	8 women	4 men	Total: 12 patients
	Mean	Range	Standard deviation
Age (years)	62.9	52-78	8.3
Follow-up (months)	75.25	43-94	16.22

Evaluation

Subjective outcomes were assessed using the QuickDASH, a validated questionnaire that measures patient-reported upper extremity disability on a scale from 0 to 100.[6] Maximum pain during activity was also assessed using the visual analog scale (VAS) for pain.[7]

Thumb range of motion was assessed by goniometry, with photographic documentation of opposition, radial abduction, and palmar abduction (Figure 1). Trapezial height was measured as the distance from the most distal aspect of the distal pole of the scaphoid to the base of the first metacarpal on a Roberts-view radiograph (Figure 2).

Medical records were also reviewed to document operative time and identify any surgical or postoperative complications.

Figure 1. Photographic documentation of thumb opposition to the distal palmar crease, radial abduction, and palmar abduction.

Figure 2. Roberts view used to measure metacarpal-scaphoid distance.

Surgical Technique

The procedure was performed on an outpatient basis under regional anesthesia using the Gedda and Moberg approach.[8] The Mini-TightRope® suspension button (Arthrex, USA) was placed immediately before trapeziectomy to preserve the trapezial space. The entry point for the system's suture-passing pin was located immediately volar to the insertion of the abductor pollicis longus tendon at the base of the first metacarpal. This maintains an appropriate line of pull and allows the button to be positioned radial to the abductor pollicis brevis tendon, thereby reducing the risk of postoperative button prominence.[9] The pin was directed from its entry point at the base of the first metacarpal toward the ulnar cortex in a distal and slightly volar direction, aiming toward the proximal metaphyseal-diaphyseal junction of the second metacarpal. A longitudinal dorsal incision was then made over the second metacarpal, through which the sutures attached to the proximal button were retrieved. A transverse tunnel was then drilled through the second metacarpal at the proximal metaphyseal-diaphyseal junction using the system's suture-passing pin, and the suture was passed through it. We find this additional step easier than passing through both metacarpals in a single step; furthermore, it allows the button on the second metacarpal to be positioned deeper and with less prominence. The resulting oblique orientation of the suture provides a tension vector that more effectively prevents proximal migration of the first metacarpal than a transverse orientation.

Once the system had been passed, the button at the level of the second metacarpal was secured with a simple knot (to allow readjustment if necessary), and the trapezium was then resected. An H-shaped capsulotomy was performed on the radiopalmar aspect of the trapeziometacarpal joint, raising one flap proximally and another distally, which remained attached to the distal pole of the scaphoid and the base of the first metacarpal, respectively. Although a periosteal elevator may be used, we find a curved bone gouge (or Smith-Petersen bone gouge) to be the most useful instrument for complete release of the trapezium. If the trapezium could not be resected in a single piece, the remaining fragments were removed with a rongeur.

After removal of the trapezium, manual axial compression of the first metacarpal was performed, and adequate stability without proximal migration was confirmed by direct visualization and fluoroscopy (Figure 3). Once stability had been confirmed, the system was definitively secured with multiple knots. The trapezial space was then filled with a resorbable spacer (Spongostan®), the capsule and skin were closed, and a thumb spica cast was applied for 10 days.

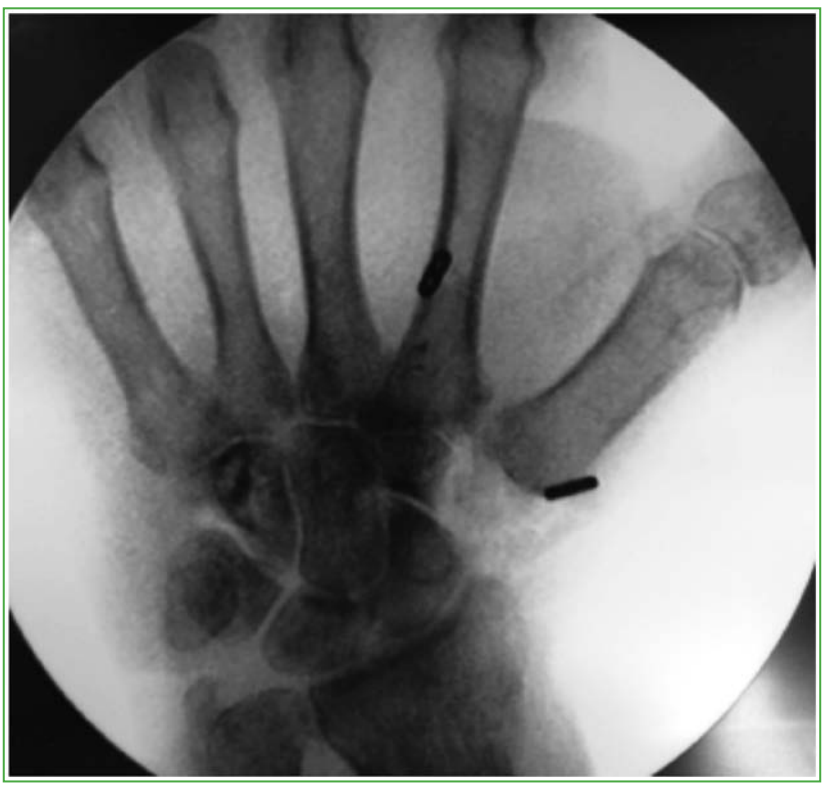

Figure 3. Intraoperative fluoroscopic image showing adequate button position and first metacarpal height.

Rehabilitation

Ten days after surgery, the cast and sutures were removed, and patients began range-of-motion exercises as part of occupational therapy. They were allowed to use the hand for activities of daily living (eating, personal hygiene, computer use, and driving), while manual sports and strenuous activities were restricted. At 6 weeks, strengthening with resistance exercises was initiated, and unrestricted activity was resumed at 12 weeks.

RESULTS

Range of motion was satisfactory in all 12 cases, with adequate thumb opposition to the distal palmar crease, a mean radial abduction of 59.9° (range, 50-75°), and a mean palmar abduction of 61.9° (range, 50-75°) (Figure 1).

The mean QuickDASH functional score was 21 (range, 2.3-54.5). The mean visual analog scale score for pain during strenuous use of the hand was 1.55/10 (range, 0-5) (Table 2). All patients resumed their previous activities and were cleared for strenuous activities at 3 months.

Table 2. Outcomes for the 12 patients evaluated.

	Mean	Range	Standard deviation
Range of motion			
Radial abduction (°)	59.89	50-75	8.7
Palmar abduction (°)	61.9	50-75	9.4
Functional Assessment			
QuickDASH	21	2.27-54.5	19
Visual Analog Scale	1.55	0-5	1.63
Radiological evaluation			
MTC-S distance (mm)	5.86	5-7.5	1.05

MTC-S distance = the distance from the scaphoid to the base of the first metacarpal on a Roberts radiograph.

The mean distance between the scaphoid and the base of the first metacarpal on Roberts-view radiographs was 5.86 mm (range, 5-7.5 mm) (Figure 2).

The mean duration of the procedure, from skin incision to sling application, was 116.8 min (range, 85-180; standard deviation, 28.4).

Two complications occurred. One patient with rheumatoid arthritis had mild residual pain (1/10 on the visual analog scale) in the diaphyseal region of the second metacarpal, probably associated with overall involvement of the hand and poor soft-tissue quality resulting from chronic corticosteroid therapy. She declined further procedures on the hand because she did not have significant pain or functional limitation. The second complication occurred in a patient who developed symptoms of complex regional pain syndrome, which resolved after one year of multidisciplinary management including rehabilitation, psychotherapy, and medication prescribed by the pain management team.

DISCUSSION

In this study, after a minimum follow-up of 2 years, subjective outcomes, as assessed using the QuickDASH and visual analog scale scores, and objective outcomes (range of motion) were favorable, as was the time to return to previous activities. Although some proximal migration of the first metacarpal was observed on radiographs obtained after more than 2 years of follow-up, a mean distance of 6 mm between the first metacarpal and the scaphoid was maintained. This collapse did not result in significant functional impairment, as 11 of the 12 patients achieved

excellent outcomes in terms of range of motion and subjective scores. Other studies support our experience, with results similar to those observed in our case series.[10,11]

There was one case of residual pain at the site of the second metacarpal tunnel in a patient with rheumatoid arthritis and one case of reflex sympathetic dystrophy that responded to medical treatment after one year. There were no injuries to the radial artery, the sensory branches of the radial nerve, or the nerve to the first dorsal interosseous muscle, and cadaveric studies have confirmed that these structures are located away from the surgical site.[12] No metacarpal fractures occurred with the use of the system's suture-passing pin, without the need to drill holes with a drill bit.

Hemitrapeziectomy or complete trapeziectomy with temporary stabilization using Kirschner wires and immobilization for 4 weeks provides good long-term outcomes. In the study by Hofmeister et al., hemitrapeziectomy with thermal capsular shrinkage and temporary pin fixation resulted in complete recovery of pinch strength, grip strength, and range of motion, with a mean proximal migration of 2 mm at a mean follow-up of 7.6 years.[13] Although some proximal migration of the first metacarpal was observed in our series at follow-up beyond 2 years, it was less pronounced than that reported after isolated trapeziectomy.[3,4] The most common complications of pin fixation are infection (8%) and pin migration. Similarly, the classic ligament reconstruction and tendon interposition technique provides good outcomes but also requires 4-6 weeks of immobilization to allow soft-tissue healing.[3,4,11,14,15] The technique used in our series simplifies and shortens the procedure and reduces morbidity compared with ligament reconstruction using a tendon autograft.

The main advantage of button suspensioplasty is the possibility of initiating thumb mobilization soon after the initial postoperative pain period (10 days). This technique would provide stabilization to prevent proximal migration of the first metacarpal without requiring prolonged immobilization. Ten days after surgery, immobilization is discontinued and rehabilitation is initiated. The implant maintains the position of the first metacarpal as range-of-motion exercises are initiated, followed by strengthening exercises.

Regarding button position, two technical steps may reduce its prominence, thereby decreasing the likelihood of irritation and the need for implant removal. At the base of the first metacarpal, the area immediately volar to the insertion of the abductor pollicis longus tendon is recommended as the entry point for the system's suture-passing pin. This maintains an appropriate line of pull and allows the button to be positioned radial to the abductor pollicis brevis tendon.[9] At the proximal metaphyseal-diaphyseal region of the second metacarpal, we drill transversely to the axis of the second metacarpal using the system's suture-passing pin, in an additional step separate from passage through the first metacarpal. This allows the button to be positioned deeper within the second intermetacarpal space. Although there are no significant differences in clinical or biomechanical outcomes,[9] placement of the second metacarpal button at the proximal metaphyseal-diaphyseal junction rather than at the mid-diaphysis is recommended, as this tends to provide a range of motion closer to normal, less proximal migration, and greater distance from the nerve to the first dorsal interosseous muscle.[9,12]

There is a clear difference in cost between the button suspensioplasty device and the Kirschner wires used for temporary stabilization or the simple sutures used for tendon ligament reconstruction. However, we believe that the shorter immobilization period and abbreviated rehabilitation afforded by this device represent an important benefit that patients should be made aware of when deciding on their treatment.

The limitations of this study include its retrospective design, the absence of a control group, and the lack of preoperative scores for comparison with postoperative outcomes. In addition, pinch strength was not measured as an objective outcome. The strengths of our case series include the description of a simple technique that would allow early mobilization for a common condition and the long follow-up period (mean, 75 months).

The encouraging results achieved with the button suspensioplasty device, the high level of patient satisfaction, favorable QuickDASH and visual analog scale scores, and excellent range of motion after a minimum follow-up of 2 years suggest that button suspensioplasty may be a useful option for the surgical treatment of trapeziometacarpal osteoarthritis. Because it does not require a prolonged healing period, it shortens overall recovery and allows patients to return sooner to work and activities of daily living. It is a relatively quick, minimally invasive technique that could also have a role when total prosthetic thumb carpometacarpal arthroplasty fails and requires removal of the prosthesis.

Multicenter, randomized studies with larger sample sizes will be needed to more accurately determine the benefits of this technique.

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

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Epidemiology of Surgically Treated Clavicle Fractures in Our Setting

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ABSTRACT

Introduction: Clavicle fractures account for 2.6–10% of all skeletal fractures and occur predominantly in young adults. In recent years, indications for surgery have expanded, driven by advances in implant technology. **Objective:** To conduct an updated epidemiological analysis of surgically treated clavicle fractures at a referral center in a large metropolitan area. **Materials and Methods:** This retrospective, descriptive, observational study included 451 adults who underwent surgery between January 2010 and December 2024. Demographic variables, mechanism of injury, anatomical location, fracture type according to the modified Edinburgh classification, associated injuries, time to surgery, time to union, and complications were analyzed. **Results:** Eighty-four percent of the patients were men (mean age, 29.8 years). The most affected age group was 18–29 years (32%). Most fractures involved the midshaft (84%), and the 2B1 pattern was the most common. The most frequent mechanism of injury was a motorcycle or all-terrain vehicle accident (24%), followed by sports-related injuries (23%). Associated injuries occurred in 14% of patients. The mean time to surgery was 11.6 days, the mean time to union was 12.5 weeks, and the overall complication rate was 10%. **Conclusions:** Surgically treated clavicle fractures are more common in young men, with a predominance of midshaft fractures caused by high-energy mechanisms. Two new descriptive patterns were added to the Edinburgh classification. The rate of surgery-related complications was low.

Keywords: Clavicle fractures; epidemiology; surgical treatment; osteosynthesis; classification; traumatology.
Level of Evidence: IV

Epidemiología de las fracturas de clavícula tratadas con cirugía en nuestro medio

RESUMEN

Introducción: Las fracturas de clavícula representan el 2,6-10% de todas las fracturas del esqueleto, y predominan en adultos jóvenes. En los últimos años, la indicación de cirugía se ha incrementado impulsada por la evolución de los implantes. **Objetivo:** Realizar un análisis epidemiológico actual de las fracturas de clavícula tratadas quirúrgicamente en un centro de derivación de una gran metrópoli. **Materiales y Métodos:** Estudio observacional retrospectivo descriptivo que incluyó a 451 adultos operados entre enero de 2010 y diciembre de 2024. Se analizaron las siguientes variables: demográficas, mecanismo lesional, localización anatómica, tipo de fractura según la clasificación de Edimburgo modificada, lesiones asociadas, tiempo hasta la cirugía y la consolidación, y complicaciones. **Resultados:** El 84% de los pacientes eran hombres (media de la edad 29.8 años). El grupo etario más afectado fue el de 18 a 29 años (32%). La localización predominante fue el tercio medio (84%), y el patrón 2B1, el más frecuente. El mecanismo lesional más común fue el accidente en motocicleta o cuatriciclo (24%), seguido de traumatismos deportivos (23%). El 14% sufrió lesiones asociadas. El tiempo promedio hasta la cirugía fue de 11.6 días; el de consolidación, de 12,5 semanas y la tasa global de complicaciones fue del 10%. **Conclusiones:** Las fracturas de clavícula tratadas con cirugía son más frecuentes en hombres jóvenes, y predominan las fracturas mediodiafisarias por mecanismos de alta energía. Se incorporaron dos nuevos patrones descriptivos a la clasificación de Edimburgo. La tasa de complicaciones por la cirugía fue baja.

Palabras clave: Fracturas de clavícula; epidemiología; tratamiento quirúrgico; osteosíntesis; clasificación; traumatología.
Nivel de Evidencia: IV

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INTRODUCTION

Clavicle fractures are among the most common fractures of the skeleton, accounting for 2.6% to 10% of all fractures, and occur predominantly in young adults.[1-4] Most clavicle fractures can be treated conservatively.[5] Surgery is reserved for fractures with multiple fragments, marked displacement, or significant deformity.[6,7] Currently, there is a trend toward surgical fixation owing to advances in implant design, which allow early recovery, with low complication rates and excellent functional outcomes, in contrast to the long-term outcomes reported with conservative treatment.[7-9]

The objective of this study was to perform a current epidemiological analysis of surgically treated clavicle fractures at a single hospital, a referral center serving a large metropolitan area, determining their frequency by age group, mechanism of injury, fracture type, associated injuries, and postoperative complications.

MATERIALS AND METHODS

The study was approved by the institution's Ethics Committee. A retrospective, descriptive observational study was conducted including all patients who underwent surgery for an isolated clavicle fracture at a single surgical center between January 2010 and December 2024. The series comprised 451 patients (379 men and 72 women). Before surgery, all patients underwent comparative radiographic evaluation with the contralateral unaffected side (anteroposterior and 45° cephalic tilt anteroposterior views), as well as computed tomography with 3D reconstruction. Exclusion criteria were age <18 years, open fractures, pathological fractures, fractures associated with other injuries of the shoulder girdle, previous surgery on the ipsilateral clavicle, and conservative treatment.

Fracture type was determined according to the Edinburgh classification.[1] For midshaft fractures (type 2) in this classification, a descriptive modification was introduced for epidemiological purposes, adding two new fracture patterns: fractures with a vertical fragment oriented at 90 ± 30° relative to the clavicular axis were classified as type 2C, whereas fractures with a midshaft fragment combined with a lateral or medial avulsion fracture involving the sternoclavicular or acromioclavicular joint, respectively, were classified as type 2D (Figures 1 and 2). This modification was not intended to validate a new classification but rather to describe morphological patterns observed in routine clinical practice.

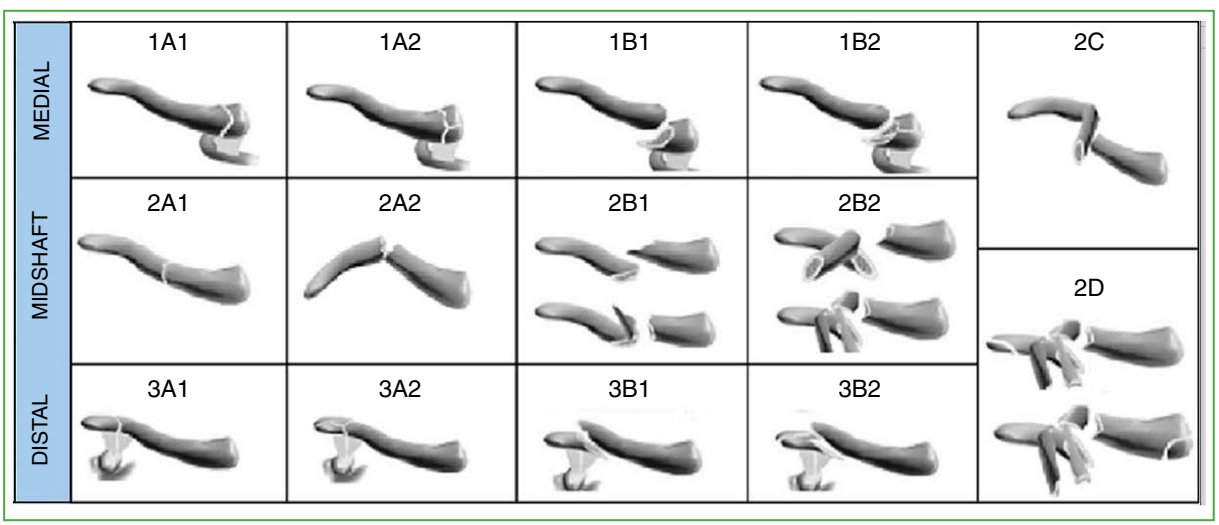

Figure 1. Clavicle fracture types according to the modified Edinburgh classification: 1A1. Medial, nondisplaced, extra-articular. 1B1. Medial, displaced, extra-articular. 1A2. Medial, nondisplaced, intra-articular. 1B2. Medial, displaced, intra-articular. 2A1. Midshaft, nondisplaced. 2A2. Midshaft, angulated. 2B1. Midshaft, displaced, simple or with a wedge fragment. 2B2. Midshaft, displaced, segmental or comminuted. 2C. Midshaft, displaced, with a third fragment oriented at 90° ± 30°. 2D. Midshaft fracture associated with a medial or distal intra-articular fracture. 3A1. Distal, nondisplaced, extra-articular. 3B1. Distal, displaced, extra-articular. 3A2. Distal, nondisplaced, intra-articular. 3B2. Distal, displaced, intra-articular.

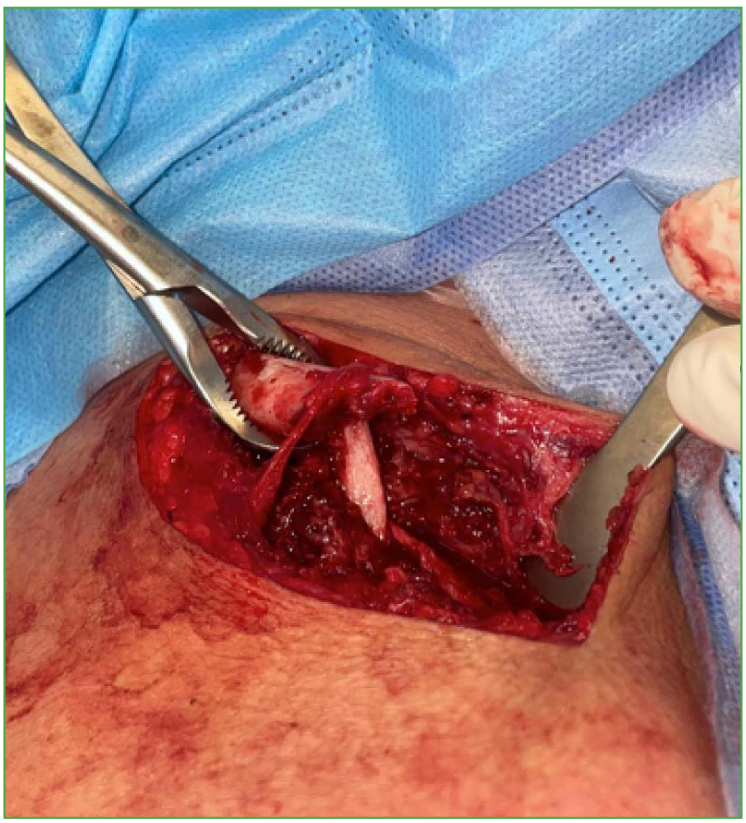

Figure 2. Intraoperative image of a type 2C clavicle fracture with a vertical fragment in a 23-year-old man.

Anatomical location was defined as medial, midshaft, or distal, using the lateral border of the first rib and the conoid tubercle as landmarks. Fractures located medial to the lateral border of the first rib were considered medial fractures; those located between this anatomical landmark and the conoid tubercle were classified as midshaft fractures; and those lateral to the conoid tubercle were classified as lateral or distal-third clavicle fractures (Figure 3).[1]

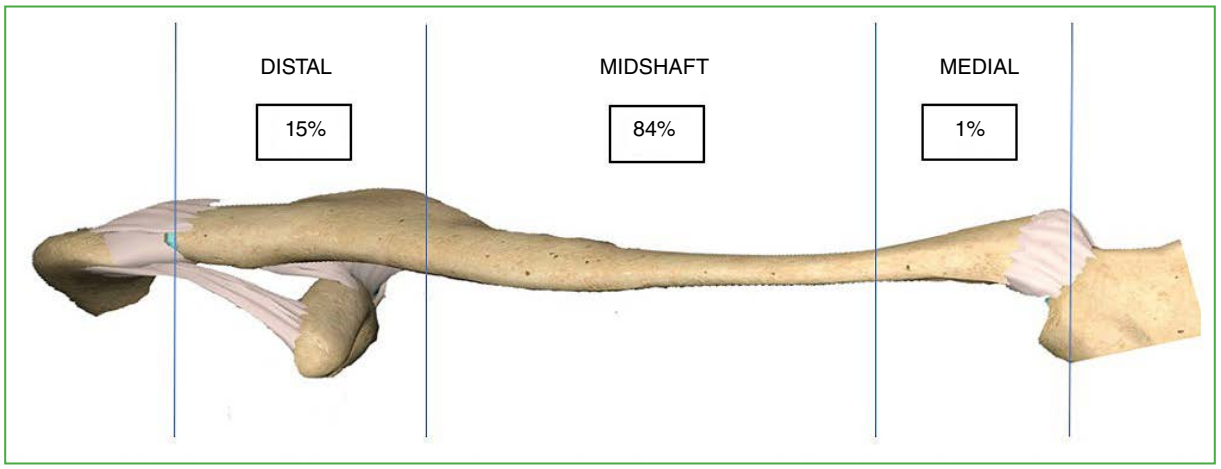

Figure 3. Anatomical distribution of clavicle fractures: midshaft fractures, 84% (n = 380); distal fractures, 15% (n = 67); and medial fractures, 1% (n = 4).

Surgical Technique and Postoperative Protocol

The surgical technique consisted of a modified Coupe infraclavicular approach[10] for medial and midshaft fractures and a supraclavicular approach for most distal fractures, with fixation using precontoured locking anatomical plates. In selected cases of comminuted fractures or significant instability, interfragmentary screws, high-strength sutures, or suture anchors were additionally used for ligament stabilization.

In the immediate postoperative period, patients were immobilized in a Velpeau-type sling for 4-6 weeks, depending on fracture complexity (degree of comminution and ligament involvement). Rehabilitation began during the first postoperative week and was structured into two main phases over the first three weeks: an initial protection and control phase focused on pain management, protection of the capsulolabral complex, and restoration of scapular control through isometric activation and co-contraction exercises, followed by a mobilization phase involving assisted scapulohumeral motion in the supine position, prioritizing glenohumeral stability over range of motion and remaining within pain limits. Beginning in the fourth week, isometric and progressive strengthening exercises were introduced, with resisted exercises allowed from the sixth week onward. Return to sports was permitted from 12 weeks onward, provided that complete bone union had been achieved.

Union was defined as disappearance of the cortical discontinuity at the fracture site due to callus formation. A time to union of <16 weeks was considered "normal," 16-24 weeks was considered "delayed union," and lack of union beyond 24 weeks was considered "nonunion."[1]

Demographic and temporal variables, mechanism of injury, fracture type, time to surgery and union, associated injuries, and complications were analyzed.

Statistical Analysis

Continuous variables (age, time to surgery in days, and time to union in weeks) are expressed as mean ± standard deviation and median with interquartile range (IQR). Categorical variables are expressed as absolute frequencies and percentages.

RESULTS

Of the 451 patients in the series, 379 (84%) were men and 72 (16%) were women. The mean age was 29.8 ± 13.3 years (median, 29; IQR, 8.5). Patients were grouped by age (18-29, 30-39, 40-49, 50-59, 60-69, and 70-79 years). Figure 4 shows the incidence of fractures by age group.

Most fractures involved the middle third of the clavicle (380 patients, 84%), followed by distal (67 patients, 15%) and medial fractures (4 patients, 1%). According to the modified Edinburgh classification, the most common fracture patterns were simple type 2B1 (120 patients, 27%), type 2B2 (110, 24%), and type 2B1 with a wedge fragment (76, 17%) (Table).

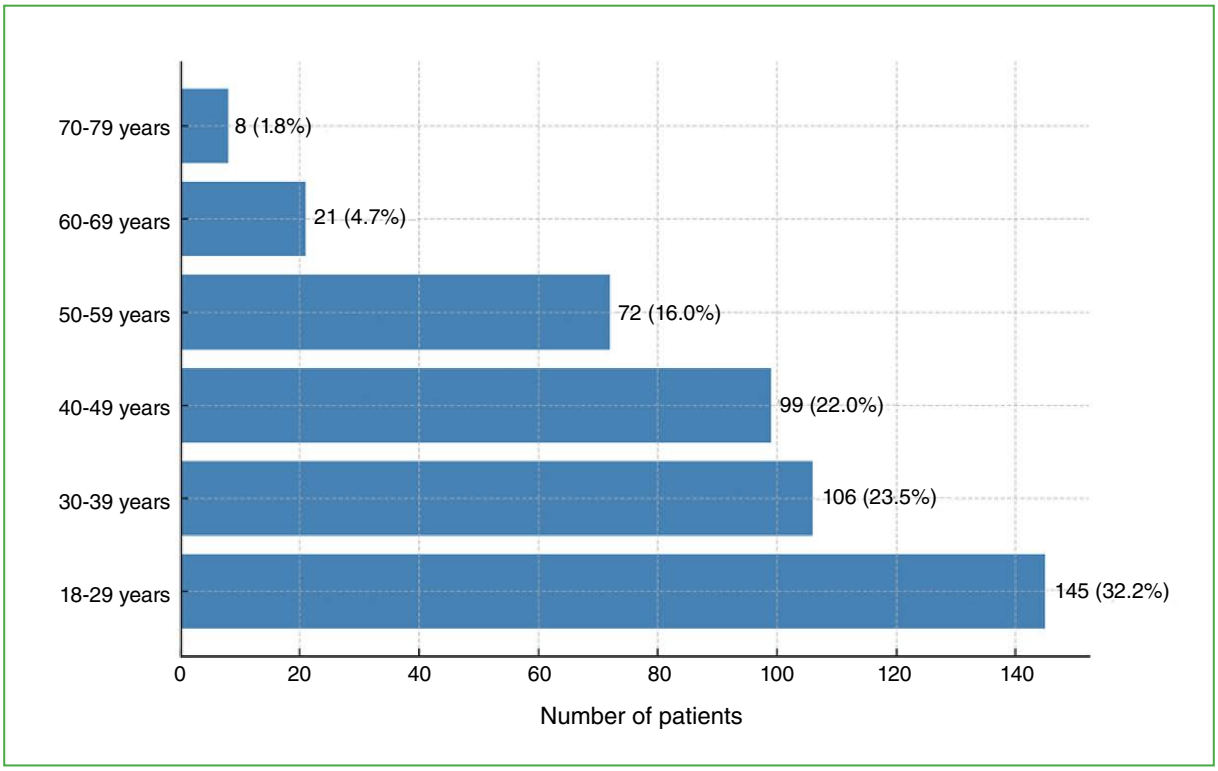

Figure 4. Distribution of clavicle fractures by patient age.

Table. Distribution of clavicle fractures according to the modified Edinburgh classification and anatomical site.

	Medial fractures				Mid-diaphyseal fractures							Distal fractures			
	1% (n = 4)				84% (n = 380)							15% (n = 67)			
Modified Edinburgh Classification	1A1	1A2	1B1	1B2	2A1	2A2	2B1 single	2B1 wedge	2B2	2C	2D	3A1	3A2	3B1	3B2
Number of patients	0	0	4	0	5	31	120	76	110	36	2	1	4	40	22
Percentage of patients	0	0	1	0	1	7	27	17	24	8	0	0	1	9	5

The most common mechanism of injury was motorcycle or ATV accidents, followed by sports-related injuries (most commonly soccer and rugby). Bicycle falls ranked third (18%), while falls from standing height and falls from horses each accounted for 10%. The least common mechanisms were falls from a height and motor vehicle accidents (Figure 5).

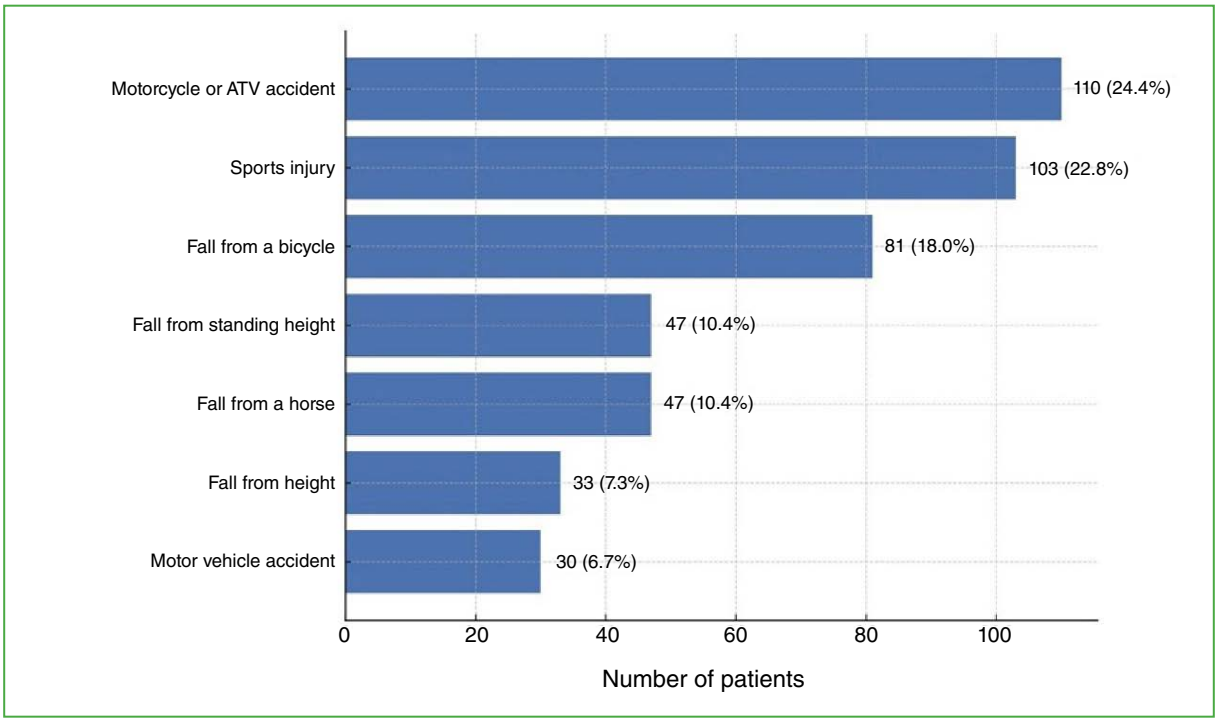

Figure 5. Main mechanisms of injury causing clavicle fractures.

The seasonal distribution showed the highest incidence in August (68 patients, 15%), followed by December (10%), and March and July (40 patients each, 9%). Fractures occurred most frequently on weekends: Saturday (97 patients, 22%) and Sunday (90 patients, 20%). They were less frequent on weekdays (Tuesday, 52 patients, 12%; Thursday, 41 patients, 9%) (Figures 6 and 7).

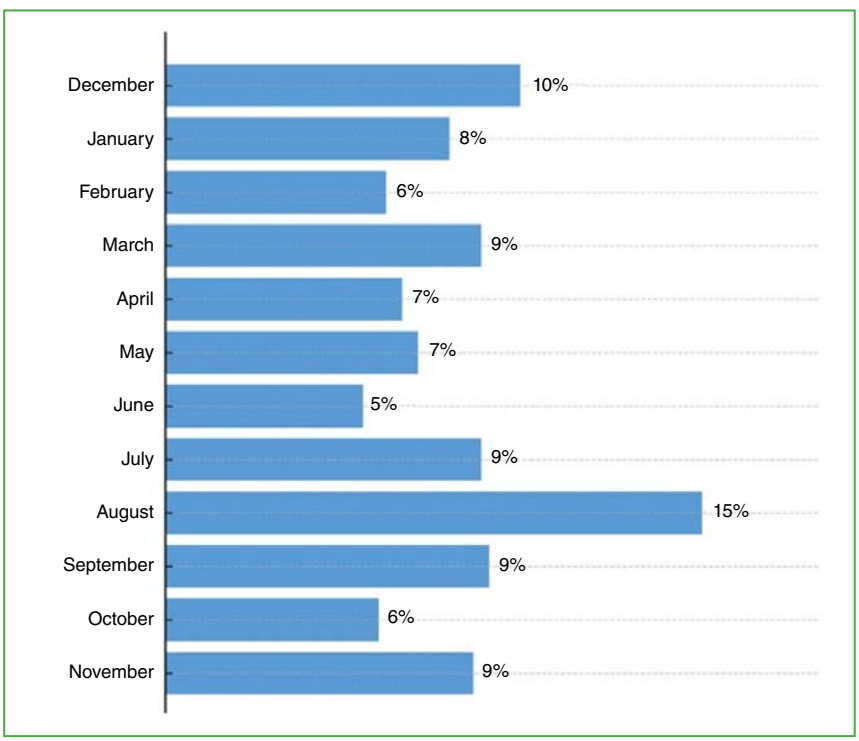

Figure 6. Seasonal distribution of clavicle fractures.

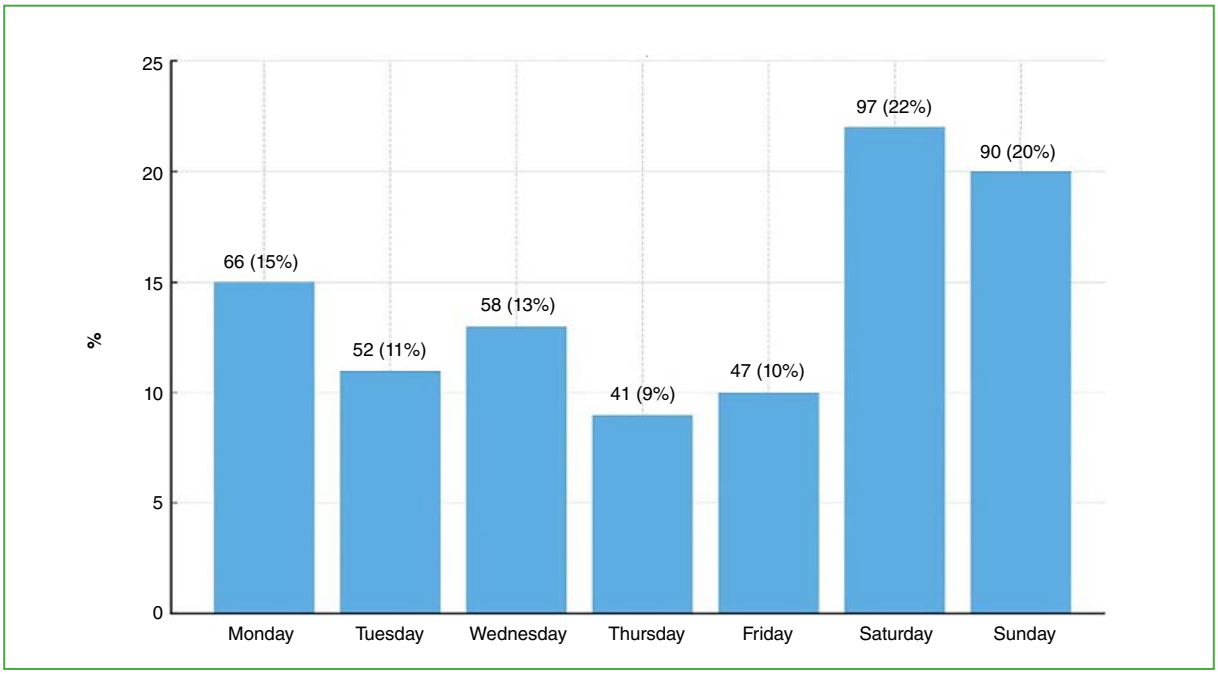

Figure 7. Distribution of clavicle fractures by day of the week.

Fifty-seven percent of patients had a left clavicle fracture and 43% had a right clavicle fracture. Of the 451 patients, 86% had no associated injuries, whereas 14% (n = 61) had at least one additional injury. Rib fractures were the most common associated injury (n = 20), followed by traumatic brain injuries (n = 13). In addition, 12 patients had upper-extremity fractures and six had lower-extremity fractures. Eleven patients sustained a pneumothorax or hemothorax, five of whom required emergency treatment. Two patients had lumbar vertebral fractures and two had orbitozygomatic fractures. Fifty-five percent of patients with concomitant injuries had a combination of at least two different types of injury.

The mean time to surgery was 11.6 ± 3.6 days (median, 13.5; IQR, 6.5), and the mean time to union was 12.5 ± 2.1 weeks (median, 12; IQR, 0.75). Ten percent of patients (n = 45) experienced complications. Fourteen patients required hardware removal because of pain or implant fatigue. Thirteen developed nonunion, six of whom had an infection. Six patients developed a surgical site infection; three required surgical debridement and targeted antibiotic therapy, whereas the remaining three were treated with empirical antibiotic therapy alone, with complete resolution. Five patients sustained a refracture following a new traumatic event and required repeat fixation. Four developed adhesive capsulitis of the shoulder, two developed neuritis at the surgical scar, and one developed anesthetic-induced chemical injury to the brachial plexus, which resolved spontaneously, with complete recovery at one year.

DISCUSSION

The incidence of clavicle fractures in our series showed a marked predominance in men (84%), higher than that reported in previous studies.[1,3,4] Clavicle fractures are considered common injuries in young patients, with a peak incidence before 30 years of age.[1,11,12]

Robinson and Nordqvist described a decreasing incidence of fractures from adolescence to 35 years of age, followed by a relatively stable incidence up to 75 years and an increase thereafter.[1,3] In contrast, Herteleer et al. reported a peak incidence of clavicle fractures between 41 and 50 years of age.[13] In our sample, the highest incidence occurred in the 18-29-year age group (32%), with a progressive decline with increasing age, consistent with the series by Nowak et al.[4] Regarding seasonal distribution, most studies report a higher incidence of fractures during the summer.[2,4,13] Although the incidence in our sample was also high during the summer, August was the month with the highest number of clavicle fractures (15%). As in other studies,[2,4,13] fractures occurred more frequently on weekends (Saturday and Sunday).

The most common mechanism of injury was a motorcycle or ATV accident (24%), followed by sports-related trauma (23%). Bicycle falls ranked third (18%). This was the most common mechanism of injury in European studies, particularly in the Nordic countries.[1-3] Falls from horses ranked fourth (10%), a mechanism not reported in the other studies analyzed. This finding may be influenced by the large number of competitive and therapeutic equestrian activities in this region.

Clavicle fractures have traditionally been considered common injuries in polytrauma patients. Robinson reported that 96 of 1000 patients evaluated (9.6%) required hospitalization for treatment of associated injuries: 75 had injuries requiring orthopedic treatment, 29 had cranial or facial injuries, 27 had severe chest trauma, and 4 had severe abdominal trauma.[1] Following a review of 321 clavicle fractures at Uppsala University Hospital in Sweden, Kihlström et al. reported that 21% of patients had associated fractures, most commonly vertebral, scapular, skull, and forearm fractures.[14] In another Swedish study, associated injuries were identified in 36% of 185 patients; however, 40% consisted of superficial abrasions of the upper extremity or face and 20% were rib fractures, whereas only 5% involved an extremity fracture.[4] In our study, associated injuries (14%) were less frequent than in other series, and the most common were traumatic brain injuries and rib fractures.

In Robinson's study, medial or type 1 fractures were the least common (2.8%). Midshaft or type 2 fractures were the most common (69.2%), and most were displaced. Among these, type 2B1 fractures with a simple fragment predominated. Type 3 fractures accounted for 28% of the total, with nondisplaced fractures predominating.[1] In a Swedish study, 80% of surgically treated fractures were midshaft fractures, and 73% of these were displaced type 2B1 and 2B2 fractures. Fewer than 20% of all surgically treated fractures were displaced lateral fractures (3B1–3B2). Very few nondisplaced midshaft and lateral fractures (2A1, 2A2, 3A1, and 3A1) and no medial fractures required surgical fixation.[14]

Although our study included only surgically treated clavicle fractures, the distribution of fracture patterns was consistent with that reported in the literature. In our population, 84% of patients had midshaft fractures, with a predominance of the simple type 2B1 pattern. For descriptive and epidemiological purposes, the classic Edinburgh classification was modified by adding two additional fracture patterns. Previous studies have shown that midshaft clavicle fractures with a vertically oriented third fragment are associated with higher rates of symptomatic nonunion and cosmetic skin compromise; in the literature, these are considered more complex fracture patterns and a potential indication for surgery.[15] In our series, these fractures were classified as type 2C, whereas midshaft fractures associated with a medial or distal fracture were classified as type 2D because of their greater morphological complexity.

Left clavicle fractures were more frequent in our study (57%), as also reported in retrospective studies by other authors. Nordqvist and Petersson reported an incidence of left clavicle fractures of 52%, as did Kihlström et al.[14] Hill et al. reported a rate of 63.5%[16] and Postacchini et al., a rate of 61%.[2]

A predominance of the nondominant side has also been described for other upper-extremity fractures, such as distal radius fractures.[17,18]

The mean time from fracture to surgery was 11.6 days, and the mean time to fracture union was 12 weeks (range, 8-24). Retrospective studies have reported low complication rates after surgery for clavicle fractures, with nonunion and infection rates <10%.[7,18] Most complications associated with surgical treatment appear to be implant-related, with reported rates of hardware irritation or failure ranging from 9% to 64%.[7,18-20] The complication rate in our study was 10%.

The limitations of this study include its retrospective design and the fact that it was conducted at a single referral center, which may limit the generalizability of the results to other populations or healthcare settings. In addition, the absence of a control group precludes direct comparison with conservative treatment.

The strengths of this study include providing a contemporary epidemiological overview of surgically treated patients in our setting, particularly considering that most large-scale epidemiological studies of this condition come from European countries, mainly the Nordic region. Additional strengths include the sample size (451 patients), the homogeneity of the series, with all patients treated by the same surgical team using the same technique, and the follow-up period of more than 10 years, which allowed long-term assessment of a large number of patients.

CONCLUSIONS

In our setting, clavicle fractures are common and predominantly affect young men, often in the context of polytrauma or one or more associated injuries. They generally occur on nonworking days and during vacation periods. Current surgical treatment is safe and effective and has a low complication rate.

Prospective, multicenter studies with long-term functional follow-up are needed to validate the fracture patterns described, analyze functional outcomes according to fracture type, and assess surgical indications in specific patient subgroups.

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Treatment of Solitary Enchondromas of the Hand with Curettage Alone: A Multicenter Study and Case Series of 10 Patients

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ABSTRACT
Introduction: Enchondroma is the most common benign bone tumor of the hand. Intralesional curettage is the standard treatment, although the use of bone grafting remains controversial because of its associated morbidity. **Objective:** To evaluate the safety and effectiveness of intralesional curettage alone, without bone grafting, in patients with solitary enchondromas of the hand. **Materials and Methods:** This retrospective multicenter study included 10 patients with solitary enchondromas of the hand treated with curettage alone. Demographic data, lesion location, time to radiographic healing, and functional outcomes assessed using the DASH questionnaire were analyzed. **Results:** The mean age was 34.6 years. Complete radiographic healing was achieved at a mean of 4.4 months. The mean DASH score was 4.9. No recurrences, postoperative fractures, or complications were recorded. **Conclusions:** Intralesional curettage alone is a safe and effective treatment for enchondromas of the hand, providing predictable bone healing and excellent functional outcomes while avoiding the morbidity associated with bone grafting.
Keywords: Enchondroma; hand; curettage; bone graft; DASH.
Level of Evidence: IV

Tratamiento de los encondromas solitarios de la mano con curetaje exclusivo: estudio multicéntrico y serie de 10 casos

RESUMEN
Introducción: El encondroma es el tumor óseo benigno más frecuente de la mano. El curetaje intralesional es el tratamiento estándar, aunque el uso de injerto óseo continúa siendo controvertido por la morbilidad asociada. **Objetivo:** Evaluar la seguridad y eficacia del curetaje intralesional exclusivo, sin relleno óseo, en pacientes con encondromas solitarios de la mano. **Materiales y Métodos:** Estudio retrospectivo multicéntrico que incluyó a 10 pacientes con encondromas solitarios de la mano tratados con curetaje exclusivo. Se analizaron las siguientes variables: datos demográficos, localización, tiempo de consolidación radiológica y resultados funcionales usando el cuestionario DASH. **Resultados:** La edad promedio era de 34.6 años. La consolidación radiológica completa se logró en un promedio de 4.4 meses. El puntaje DASH promedio fue de 4,9. No se registraron recurrencias, fracturas posoperatorias ni complicaciones. **Conclusiones:** El curetaje intralesional exclusivo es un tratamiento seguro y eficaz para los encondromas de la mano, la consolidación ósea es predecible y se logran excelentes resultados funcionales, evitando la morbilidad del injerto óseo.
Palabras clave: Encondroma; mano; curetaje; injerto óseo; DASH.
Nivel de Evidencia: IV

INTRODUCTION

Enchondroma is the most common benign bone tumor of the hand, accounting for approximately 47% of all bone tumors at this site.[1,2] It is most commonly located in the phalanges and metacarpals. Intralesional curettage is the standard surgical treatment for enchondroma.[3]

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Controversy persists regarding the management of the residual bone cavity after curettage. Traditionally, the defect has been filled with autologous bone graft or allograft with the theoretical aim of promoting bone healing and reducing the risk of postoperative fracture; however, this practice remains a matter of debate.[4] Autologous bone grafting entails donor-site morbidity and increased operative time, whereas allografts and bone substitutes increase costs and carry inherent risks.

We present a series of 10 patients with solitary enchondromas of the hand treated with intralesional curettage alone, without bone grafting or bone substitutes, to demonstrate the rapid and predictable bone healing and excellent functional recovery achieved with this approach.

MATERIALS AND METHODS

A multicenter retrospective study was conducted. Our working hypothesis was that intralesional curettage alone, without bone grafting, is a safe and effective treatment for solitary enchondromas of the hand, achieving adequate bone healing and good functional outcomes without graft-related morbidity.

Patients were consecutively included. The inclusion criteria were a clinical and radiographic diagnosis of solitary enchondroma of the hand and an indication for surgical treatment. The exclusion criteria were lesions >3 cm, extensive articular involvement requiring reconstruction, multiple lesions (Ollier disease or Maffucci syndrome), and follow-up <12 months. Ten patients with solitary enchondroma of the hand were included. All underwent intralesional curettage alone (without bone grafting), performed by two upper-extremity surgeons at two different centers between 2020 and 2024. The diagnosis was confirmed by imaging studies and histopathological examination.

Surgical Technique

The procedure was performed with the patient in the supine position, with the spine aligned and bony prominences protected, under regional anesthesia and sedation. The affected upper extremity was placed on a radiolucent hand table to allow adequate fluoroscopic control.

A standard approach was used, and a cortical window was created to access the lesion. Meticulous curettage was then performed. The residual cavity was not filled with any material. In cases of pathological fracture, bone stability was assessed; additional internal fixation was not required in any case. Three of the 10 patients presented with a pathological fracture (two involving the fifth metacarpal and one the proximal phalanx). All patients, both with and without pathological fractures, were immobilized for the same 5-day period. No additional restrictions were imposed between removal of the immobilization and complete radiographic healing, and progressive use of the hand was allowed as tolerated.

Postoperative Management

The rehabilitation protocol consisted of immobilization with a forearm-based palmar plaster splint, with the hand in a functional position, for the first 5 days to protect the surgical site and allow adequate soft-tissue healing. Limb elevation was recommended during the first 48-72 hours to reduce edema. After the first 5 days, early active finger mobilization was initiated to restore normal hand function, regain joint range of motion, and prevent stiffness.

RESULTS

The study included 10 patients (4 men and 6 women) with a mean age of 34.6 years (range 27-50). The most common locations were the fifth metacarpal (4 cases) and the phalanges (6 cases). The patient with distal phalanx involvement underwent surgery because of persistent pain and an imminent risk of pathological fracture due to severe cortical thinning.

The mean follow-up was 12.8 months. The following parameters were evaluated: 1) radiographic healing, defined as the time to complete filling of the residual cavity with trabecular bone; serial radiographs were obtained every 4 weeks; 2) functional outcome using the *Disabilities of the Arm, Shoulder and Hand* (DASH) questionnaire at 12 months; and 3) complications, including tumor recurrence, postoperative fracture, and infection.

Detailed data for the series are summarized in the Table.

The mean time to radiographic healing was 4.4 months (mean 4.4, range 2-6).

The mean DASH score at the final follow-up was 4.9 (range 0.8-7.3), reflecting minimal residual functional impairment and satisfactory clinical recovery.

Table. A series of 10 cases of enchondromas of the hand treated with curettage alone.

Case	Sex	Age	Location	Classification by Takigawa	Healing (months)	DASH
1	M	27	Fifth metacarpal, left hand	Type 1 (central)	4.0	0.8
2	F	32	Distal phalanx, right index finger	Type 1 (central)	4.6	1.7
3	F	45	Middle phalanx, right little finger	Type 2 (eccentric)	5.3	2.5
4	M	30	Proximal phalanx, right index finger	Type 1 (central)	4.2	3.2
5	F	39	Fifth metacarpal, right hand	Type 1 (central)	4.8	4.0 .
6	M	28	Fifth metacarpal, right hand	Type 1 (central)	6.0	5.4
7	F	50	Left index finger, proximal phalanx	Type 2 (eccentric)	6.0	6.1
8	F	40	Fourth metacarpal, left hand	Type 2 (eccentric)	3.0	7.3
9	F	34	Middle phalanx, right middle finger	Type 1 (central)	4.0	3.2
10	F	29	Fifth metacarpal, right hand	Type 1 (central)	2.0	6.1

DASH = *Disabilities of the Arm, Shoulder, and Hand.*

No complications, including tumor recurrence, postoperative fractures, or infections, were recorded in this series. Figures 1–3 show clinical cases 3, 4, and 5, respectively.

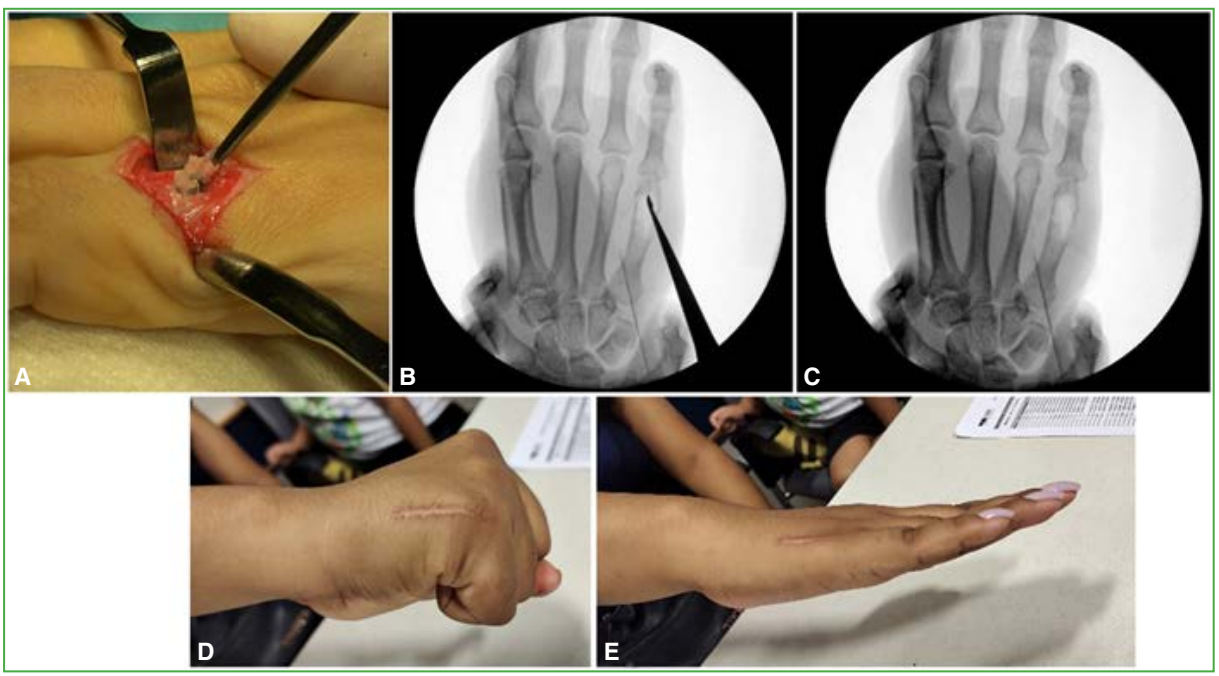

Figure 1. Case 5. **A.** Intraoperative clinical image showing curettage of the lesion. **B.** Intraoperative anteroposterior radiograph of the hand showing intralesional curettage. **C.** Intraoperative anteroposterior radiograph of the hand after lesion resection. **D and E.** Final clinical outcome.

Figure 2. Case 3. **A.** Intraoperative clinical image showing the lesion bed. **B.** Intraoperative anteroposterior radiograph of the fifth digit showing intralesional curettage. **C.** Postoperative anteroposterior radiograph of the fifth digit showing bone healing. **D and E.** Final clinical outcome.

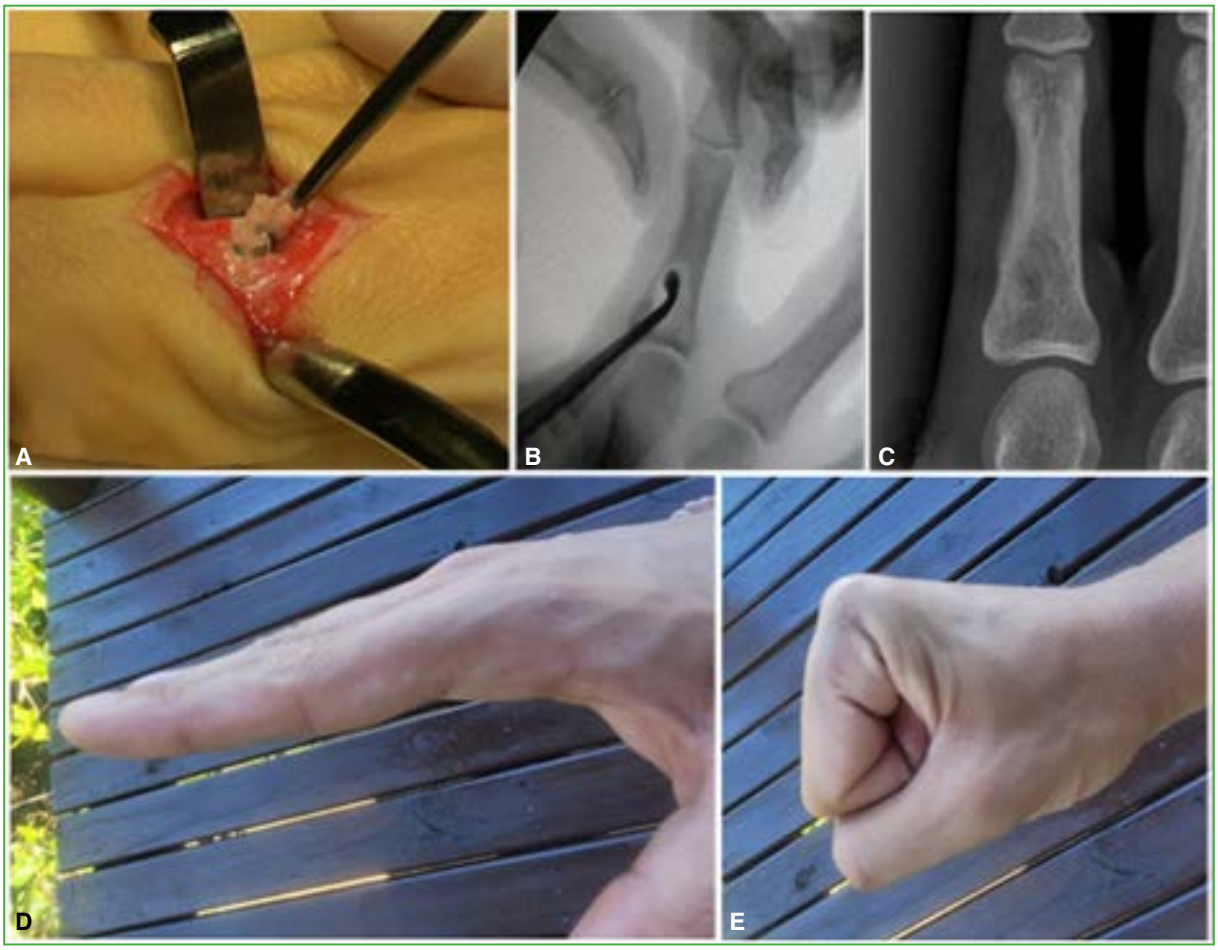

Figure 3. Case 4. **A.** Intraoperative clinical image showing the tumor. **B.** Intraoperative anteroposterior radiograph of the index finger showing intralesional curettage. **C.** Postoperative anteroposterior radiograph of the index finger showing bone healing. **D and E.** Final clinical outcome.

DISCUSSION

The results of this multicenter study of 10 cases strongly support the hypothesis that intralesional curettage alone is sufficient for the treatment of solitary enchondromas of the hand.

The controversy surrounding management of the cavity after curettage centers on concerns regarding the risk of postoperative fracture and healing time. However, our experience and recent scientific literature suggest that these concerns are unfounded in most cases.

The mean healing time of 4.4 months in our series is comparable to, or even shorter than, that reported in studies using bone grafts.[4] This may be explained by the intrinsic osteogenic potential of the bones of the hand. The spontaneous bone healing observed in our series may be attributed to the osteogenic potential of the remaining endosteum and intact periosteum, a biological mechanism widely accepted in the literature for short tubular bones.[5] In this context, the bone defect following curettage may behave similarly to a stable fracture, with the capacity for spontaneous healing. Goto et al. demonstrated spontaneous bone healing after curettage without grafting in enchondromas of the foot, suggesting that similar biological mechanisms may be expected in the short tubular bones of the hand.[6] Spontaneous bone healing is therefore a predictable phenomenon in short tubular bones.

Morbidity and Cost-Effectiveness

The main benefit of avoiding bone grafting is reduced morbidity and increased cost-effectiveness.

The use of autologous bone graft requires a donor site (such as the iliac crest or distal radius), introducing the risk of additional complications. Studies such as that by Migliorini et al. have documented morbidity associated with graft harvesting, including chronic donor-site pain, risk of iatrogenic fracture, hematoma, and increased operative time.[7] By avoiding this step, donor-site morbidity is eliminated and the procedure is simplified.

A 2015 systematic review by Bachoura et al. reported that simple curettage had the lowest complication rate (0.7%) compared with autografting (3.5%).[8] Our series of 10 cases without complications further supports this trend.

From the perspective of rational and cost-effective management, Akoh et al. analyzed the clinical and economic impact of overtreatment in patients with enchondromas and highlighted the importance of avoiding unnecessary interventions when they do not alter the final clinical outcome.[9] In this context, omitting bone grafting after intralesional curettage is consistent with a simpler and more efficient therapeutic approach without compromising safety or functional outcomes.

Functional Outcome

The excellent functional outcomes in all our patients, with a mean DASH score of 4.9, underscore that the absence of bone grafting not only does not compromise the final outcome but also, by avoiding the morbidity associated with a second surgical site, allows for early rehabilitation and a rapid return to activities of daily living.

The main limitations of this study are its retrospective design and small sample size. However, the consistency of the results across two different centers and their agreement with recent high-level evidence in the medical literature[8,10] lend support to our findings.

CONCLUSIONS

Intralesional curettage alone is a safe, effective, and cost-effective treatment option for solitary enchondromas of the hand. Spontaneous bone healing is a predictable phenomenon, occurring at a mean of 4.4 months and allowing for rapid functional recovery. Based on our results and the available evidence, intralesional curettage alone represents a valid, safe, and effective treatment option for solitary enchondromas of the hand, particularly for stable lesions, while avoiding the morbidity associated with bone grafting.

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Access to Musculoskeletal Imaging Studies in Argentina: Are Orthopaedic Surgeons Mere Bystanders?

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ABSTRACT

Introduction: Access to imaging study results has undergone substantial changes in recent years, affecting the practice of orthopaedic surgeons. **Objective:** To evaluate the perceptions of orthopaedic surgeons in Argentina regarding access to imaging studies, image quality, and the impact of these factors on clinical practice. **Materials and Methods:** A total of 323 members of the Argentine Association of Orthopaedics and Traumatology participated in the survey. Data were analyzed according to years in practice, geographic region, workplace, and subspecialty. **Results:** A significant change in access to imaging studies was observed, with 62% of respondents reporting a substantial impact. Nearly 50% reported being dissatisfied with current access methods, and 47% indicated that access difficulties frequently or very frequently had a negative impact on their clinical practice. According to 29% of respondents, attempts to access imaging studies took up as much as 40–50% of the consultation time. Ninety-two percent had received no formal training in the use of the new digital platforms. Perceptions of image quality varied, with 24% considering it worse than in their previous experience. **Conclusions:** Orthopaedic surgeons in Argentina report high levels of dissatisfaction and frequent difficulties accessing imaging studies. A lack of training and insufficient consideration of physicians as primary users contribute to this perception. This study highlights the need to involve healthcare professionals as key stakeholders in the design and implementation of imaging access systems.

Keywords: Digital imaging; orthopaedics and traumatology; outpatient imaging; diagnostic imaging; surveys; questionnaires.
Level of Evidence: IV

Acceso a estudios por imágenes musculoesqueléticas en la Argentina: ¿somos los ortopedistas convidados de piedra?

RESUMEN

Introducción: El acceso a los resultados de estudios por imágenes ha experimentado cambios sustanciales en los últimos años que influyen en la práctica del especialista en ortopedia y traumatología. **Objetivo:** Evaluar la percepción de los especialistas en ortopedia y traumatología de la Argentina sobre el acceso a estudios por imágenes, su calidad y el efecto en la práctica clínica. **Materiales y Métodos:** Participaron de la encuesta 323 miembros de la Asociación Argentina de Ortopedia y Traumatología. Los datos se analizaron según los años de ejercicio, la región geográfica, el lugar de trabajo y la subespecialidad. **Resultados:** Se observó un cambio significativo en el acceso a estudios por imágenes, el 62% reportó un impacto importante. Casi el 50% informó estar insatisfecho con los métodos actuales de acceso y el 47%, un impacto negativo frecuente o muy frecuente en su práctica clínica. Según el 29%, los intentos de acceso consumieron hasta el 40-50% del tiempo de consulta. El 92% no recibió capacitación formal en las nuevas plataformas digitales. La percepción de la calidad de las imágenes fue variable: el 24% las consideró peores que en experiencias previas. **Conclusiones:** Los especialistas argentinos en ortopedia y traumatología reportan altos niveles de insatisfacción y dificultades frecuentes en el acceso a estudios por imágenes. La falta de capacitación y la escasa consideración de los médicos como usuarios primarios contribuyen a esta percepción. Este estudio resalta la necesidad de involucrar a los profesionales como actores clave en el diseño e implementación de sistemas de acceso a imágenes.

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Nivel de Evidencia: IV

INTRODUCTION

Imaging studies play a fundamental role in the diagnosis, staging, therapeutic decision-making, preoperative planning, and monitoring of musculoskeletal conditions.[1,2]

Difficulties and limitations in accessing the information provided by diagnostic imaging studies can have a significant negative impact on orthopedic and trauma practice.[3]

In recent years, in our practice as orthopedic and trauma specialists, we have observed substantial and rapid changes in the ways imaging results are accessed.[4,5] Traditional radiographic films have progressively given way to formats including laser-printed images, compact discs, institutional Picture Archiving and Communication Systems (PACS), and digital platforms accessible from computers and mobile devices. Although these tools were designed to facilitate and streamline access to imaging studies, their implementation has not always met initial expectations.[5,6] In practice, the traditional, straightforward availability of printed studies has been replaced by difficulties associated with digital access, such as connectivity issues, technological incompatibilities, and the proliferation of online platforms. Furthermore, even when the images can be accessed, they are often accompanied by warnings stating that they are not suitable for diagnostic purposes (Figure 1), despite obviously having been requested for that purpose.

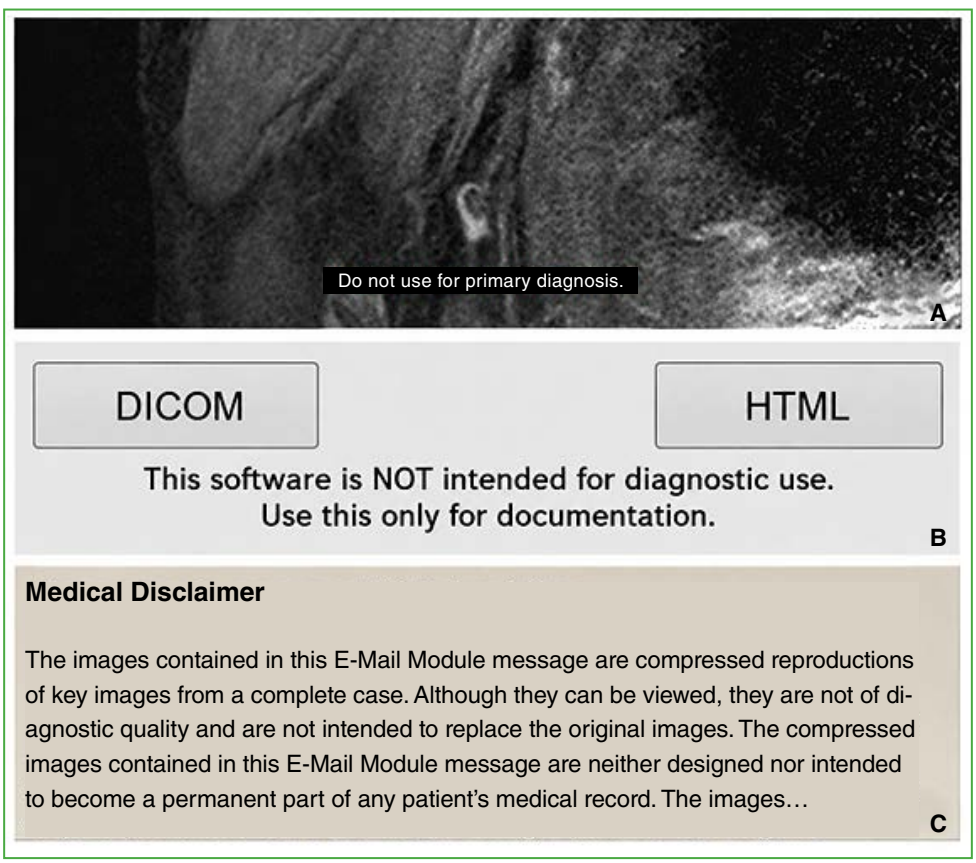

Figure 1. Examples of warning messages accompanying imaging studies requested for diagnostic purposes. **A.** Magnetic resonance imaging (MRI) study with a warning stating that it "should not be used for primary diagnosis." **B.** Another common disclaimer displayed when opening a compact disc containing diagnostic imaging studies states that it should not be used for diagnosis, but only for "documentation." **C.** Imaging studies accompanied by a warning stating that the images are not of "diagnostic quality."

It should be noted that orthopedic and trauma specialists have had limited, if any, involvement in the implementation of these changes and have been forced to adapt to them in their daily practice, regardless of whether they agreed with them. In most cases, these changes have been implemented without prior consultation and presented as a fait accompli.

The objective of this study was to evaluate the perceptions of orthopedic and trauma specialists in Argentina regarding the current process of accessing requested diagnostic images and the quality of those images.

MATERIALS AND METHODS

A semistructured survey was designed based on previous studies[7-9] and adapted to the local practice setting. Two of the authors developed the questions independently. Subsequently, two other authors conducted a pilot test to optimize the instrument. Consensus-based modifications were then made, resulting in the final version of the survey.

The final questionnaire included 15 questions divided into three sections (Table 1).

Table 1. Questions included in the survey

Demographic Data	1. How many years of experience do you have in orthopedics and traumatology?
	2. What is your main area of practice within the specialty?
	3. What type of institution do you work at?
	4. In which region of the country do you primarily work?
Assessment of Access to Imaging Study Results	5. Have you noticed a change in the process for accessing imaging study results since the pandemic (over the past 5 years)?
	6. Are you satisfied with the current system?
	7. Has your professional practice been affected by the lack of printed diagnostic images over the past two years?
	8. Have you had difficulty accessing your patients' imaging studies?
	9. What has been the main difficulty?
	10. Is access to the diagnostic imaging platforms you regularly use user-friendly?
	11. Do you feel that the new system negatively affects your workflow?
	12. Do you feel that the new system may affect your diagnostic ability?
	13. What percentage of your consultation time might be spent trying to access imaging studies?
	14. Do you consider the image quality in the studies you request to be, compared to usual, (much better/better/the same/worse/much worse)?
Training	15. Did you receive any notification of the changes or training on the new system from the imaging service providers?

The first section, consisting of four questions, was designed to collect participants' demographic data. Participants were asked to indicate their primary practice setting (public institution, private institution, or private practice). If they worked in more than one setting, they were instructed to select only the setting on which they would base their responses.

The second section included 10 questions designed to assess participants' perceptions of the new methods of accessing images and their impact on clinical practice.

Finally, participants were asked whether they had received any type of training from imaging service providers or from the institutions where they reported working.

The questions were uploaded to the SurveyMonkey® platform. The survey received prior approval from the Executive Committee of the Argentine Association of Orthopedics and Traumatology and was announced to its members via email and social media (Figure 2).

Figure 2. Promotion of the survey on social media. (*"Survey: Access to ancillary test results in our professional practice. YOUR OPINION IS VERY IMPORTANT!"*).

The researchers adhered to best practices for the responsible use of data (European General Data Protection Regulation). Responses were anonymous, and no personal data were collected from any participant. Only the principal investigator had access to the platform. Data from the responses were to be used solely for publication purposes. Once submitted, responses could not be edited. Each respondent could complete the survey only once, and all questions had to be answered for the response to be considered valid and included in the final analysis.

Where appropriate, ordinal data were analyzed using values ranging from 1 to 5. Open-ended responses were coded independently by two researchers, and consensus was reached for the qualitative analysis.

Statistical Analysis

The results for all questions were evaluated using Cronbach's alpha coefficient, which measures the internal consistency reliability of a scale or test by assessing the degree to which its items are correlated with one another. The internal consistency of the instrument was considered excellent (>0.9), with a Cronbach's alpha coefficient of 0.9689, indicating that the items were strongly correlated and measured the same construct; therefore, the questionnaire was considered reliable (Table 2).

Table 2. Internal consistency of the questionnaire

Item	Comments	Sign	Item correlation	Correlation with remaining items	Average inter-item covariance	Alpha
Question 5	323	+	0.7434	0.7038	0.8918	0.9699
Question 6	323	+	0.9477	0.9370	0.8341	0.9637
Question 7	323	-	0.9551	0.9425	0.7845	0.9628
Question 8	323	-	0.9445	0.9324	0.8253	0.9635
Question 9	323	+	0.8929	0.8585	0.7726	0.9673
Question 10	323	-	0.8785	0.8537	0.8422	0.9658
Question 11	323	-	0.9534	0.9410	0.7936	0.9628
Question 12	323	-	0.9477	0.9342	0.7986	0.9631
Question 13	323	+	0.9470	0.9310	0.7738	0.9635
Question 14	323	+	0.9364	0.9224	0.8241	0.9637
Question 15	322	+	0.4541	0.4327	0.9880	0.9763
Scale test					0.8299	0.9689

RESULTS

Demographic Data

A total of 323 physicians who were members of the Argentine Association of Orthopedics and Traumatology participated in the survey. The largest proportion reported practicing general orthopedics and traumatology (25%), while the remainder were distributed across 10 subspecialties (Table 3). Overall, 78.3% of respondents had more than 10 years of professional experience in the specialty.

Table 3. Distribution of participants by their area of practice in the field of orthopedics and traumatology.

Area of practice	
General orthopedics and traumatology	81 (25.08%)
Shoulder and elbow	64 (19.81%)
Hip and Knee	53 (16.41%)
Ankle and foot surgery	26 (8.05%)
Hand surgery	26 (8.05%)
Sports Traumatology	25 (7.74%)
Spine	22 (6.81%)
Pediatric Orthopedics	17 (5.26%)
Trauma	8 (2.48%)
Pediatric Oncology	1 (0.31%)
Neuroorthopedics	0
Total	323 (100%)

General orthopedics and traumatology showed a bimodal distribution according to years of practice, with the highest proportions among physicians with less than 5 years of practice (51.6%) and those with more than 30 years (30.43%). More recently developed subspecialties, such as shoulder and elbow surgery, peaked among physicians with 6-10 years of practice (35.9%), whereas more traditional subspecialties, such as hip and knee surgery, were more heavily represented among those with more than 30 years of practice (26.5%).

Regarding the primary practice setting, 67.8% reported working at a private institution, 16.4% at a public institution, and 15.8% in private practice. In addition, the proportion of physicians working in private practice increased with years of professional experience.

Regarding geographic distribution (Figure 3), physicians from all regions of the country participated, with a predominance of respondents from the Buenos Aires Metropolitan Area (AMBA) (52.6%), defined as the area comprising the Autonomous City of Buenos Aires and 40 surrounding municipalities in Buenos Aires Province.

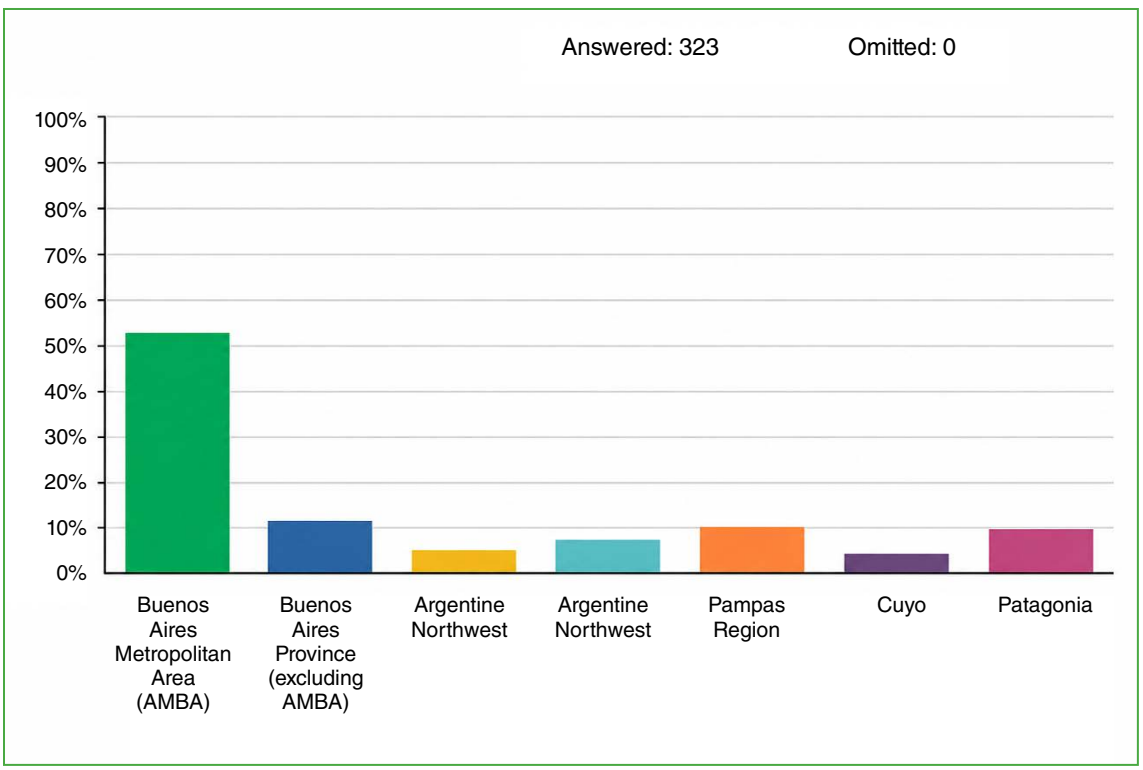

Figure 3. Geographic distribution of respondents' practice locations.

Perception of Change

Sixty-two percent of respondents reported having perceived a very significant change in the methods used to access imaging study results since the beginning of the pandemic (over the past 5 years), whereas only 0.62% reported no change. The perception of change was directly related to years of professional practice. It was considered very significant by 42% of physicians with up to 5 years of practice, compared with 72% of those with more than 30 years of experience.

Geographically, the greatest impact of these changes was observed in regions with larger urban centers, such as the AMBA, the Pampas Region, and northwestern Argentina.

The impact was most pronounced among physicians in private practice, 78% of whom rated the change as very significant, compared with 58.5% and 58.9% of those working in public and private institutions, respectively.

Finally, the subspecialties in which physicians reported the greatest impact were orthopedic oncology, spine surgery, and hip and knee surgery.

Level of Satisfaction

Fifty percent of respondents who perceived changes reported being slightly or not at all satisfied. Within this group, the highest proportion of respondents who were "not at all satisfied" was observed among physicians with more than 30 years of practice (28.26% of that subgroup).

Regarding geographic distribution, the highest level of dissatisfaction was recorded in the AMBA, where 69.42% reported being slightly or not at all satisfied. In contrast, the Cuyo region had the lowest level of dissatisfaction, with 20% of respondents falling into the same category.

Regarding practice setting, 53% of respondents who based their answers on their private practice reported dissatisfaction, compared with 49.3% of those working in private institutions and 49% of those working in public institutions.

Finally, the subspecialties reporting the highest levels of dissatisfaction were orthopedic oncology, spine surgery, and hip and knee surgery.

Impact of the Lack of Printed Imaging Studies

Forty percent of respondents reported being frequently or very frequently affected by the lack of printed imaging studies. Once again, years of professional practice influenced this perception: the proportion reporting a negative impact was highest among physicians with more than 30 years of practice, 57.6% of whom reported being frequently or very frequently affected.

Physicians in the AMBA were the most affected (54%), whereas those in the Cuyo region reported the lowest impact (7%).

Physicians working in public institutions reported the greatest impact (53%), followed by those in private practice (47%). In contrast, the impact was lower among physicians working in private institutions (35%).

Difficulty Accessing Imaging Studies

A total of 49.9% of respondents reported experiencing difficulties accessing imaging studies frequently or very frequently, whereas only 0.93% reported never having encountered any difficulties. Among physicians in the AMBA, 68% reported frequent difficulties, whereas orthopedic surgeons in the Cuyo region reported the lowest level of difficulty (13%).

Physicians working in public institutions reported frequent or very frequent difficulties in 55% of cases, followed by those in private practice (53%); this percentage was slightly lower among those working in private institutions (48%).

Regarding subspecialties, spine surgeons reported the greatest impact (68%), whereas sports orthopedics specialists were the least affected (20%).

Main Difficulties

For this question, participants were offered five response options:

- The patient forgets to bring the printed imaging studies.
- The imaging provider's platform cannot be accessed.
- The imaging studies are difficult to view on the patient's mobile phone.
- The studies were not uploaded correctly.
- All of the above.

The most frequent response was "all of the above" (49.9%), followed by inability to access the imaging platform (35%). Physicians with more than 30 years of practice (28.5%) and spine subspecialists (64%) were the groups that most frequently reported encountering all of the aforementioned problems.

Accessibility of Digital Platforms

A total of 56% of respondents considered the platforms difficult to use. Once again, spine specialists reported the most negative assessment, whereas sports orthopedics specialists reported the most favorable perception.

Impact of the Changes on Clinical Practice

Only 28.5% of respondents reported that the changes in access to imaging studies had little or no negative impact on their clinical practice. A total of 24.5% indicated that the negative impact occurred occasionally, whereas 47% reported that it occurred frequently or very frequently.

The lowest negative impact was observed among physicians with less than 5 years of practice (35.5%), whereas the highest was reported by those with more than 30 years of practice (63%). Geographically, the worst results were recorded in the AMBA, where 65% of responses were "frequent" or "very frequent." In the Cuyo region, the impact was lower, with only 13% reporting "frequent" and none reporting "very frequent."

Regarding practice setting, physicians working in public institutions (53%) and private practice (51%) were the most affected, compared with those working in private institutions (45%). Regarding subspecialties, spine surgeons reported the greatest negative impact (63%), whereas sports orthopedics specialists were the least affected (16%).

Diagnostic Ability

Twenty-seven percent of respondents considered that the new system could frequently (18%) or very frequently (9%) affect their diagnostic ability. Consistent with previous findings, this perception was more common among physicians with more than 30 years of practice (37%) and less common among those with less than 5 years of experience (16%). Geographically, the greatest impact was observed in the AMBA (35% reporting "frequent" or "very frequent"), whereas no responses in these categories were recorded in the Cuyo region.

Regarding practice setting, private practice was the most affected (35% reporting "frequent" or "very frequent"), whereas the impact was lower in private institutions (24%).

Regarding subspecialties, spine surgeons reported the greatest impact (36% reporting "frequent" or "very frequent"), whereas sports orthopedics specialists reported a lower impact (12% "frequent" and 0% "very frequent").

Time Consumption

A total of 29.5% of respondents estimated that attempts to access images could take up as much as 40–50% of the consultation time. No significant differences were observed according to years of practice, although geographic differences were evident. Once again, physicians in the AMBA were the most affected: 45% of respondents spent more than 40% of the consultation time attempting to access images, whereas physicians in the Cuyo region were the least affected (7%).

No significant differences were found according to practice setting. Regarding subspecialties, spine specialists reported the greatest impact (54%), whereas sports orthopedics specialists were the least affected (8%).

Image Quality

Twenty-four percent of respondents considered image quality to be inferior to what they had previously experienced; 27.5% rated it as equivalent, 38.5% as better, and 10% as much better. Physicians with more than 30 years of practice had the most negative perception, with 40% considering image quality to be worse or much worse, compared with only 13% among those with less than 5 years of practice.

The perceived decline in quality was most pronounced in the AMBA (32%) and least pronounced in the Patagonia region (3%).

Regarding practice setting, the worst results were reported by physicians in private practice (35%), followed by those working in public institutions (26.5%) and, to a lesser extent, private institutions (20.5%).

Regarding subspecialties, physicians specializing in spine surgery (23%) and hip and knee surgery (40%) reported the worst results, whereas the negative perception was much less frequent among sports orthopedics (8%) and orthopedic oncology specialists (0%).

Training

A total of 92.24% of respondents reported that they had not received any training on accessing and navigating digital platforms. All participants from the Cuyo region (n = 15) reported having received no training, whereas physicians from northwestern Argentina had the highest rate of training (26%). No significant differences were observed according to practice setting, although the lowest training rate was reported in private practice (5.8%) and the highest in public institutions (9.6%).

DISCUSSION

The survey findings reveal a marked change in access to imaging study results in the field of orthopedics and traumatology over the past five years, particularly since the COVID-19 pandemic. A significant level of dissatisfaction with current methods of accessing imaging studies was observed. The most affected were physicians with more years of professional experience, those working in private practice, and those located in the AMBA. Conversely, the least affected were specialists with less than 5 years of practice, those working in private institutions, and those in the Cuyo region.

Regarding subspecialties, spine surgeons reported the highest levels of dissatisfaction, whereas sports orthopedics specialists reported the lowest. It should be noted that the sample size and practice settings of both groups were comparable; therefore, these differences were not influenced by these variables.

Most respondents had not received any training from imaging service providers or the institutions where they worked; the changes were implemented without formal training. Nearly 50% expressed dissatisfaction with the new methods, a similar proportion reported frequent difficulties accessing information, and 47% reported a frequent or very frequent negative impact on their clinical practice. Furthermore, 27% considered that the changes could affect their diagnostic ability. It also became evident that accessing imaging studies can consume a considerable proportion of consultation time: nearly 30% of respondents indicated that attempts to access images could take up as much as 40-50% of the consultation time. As reported in other studies,[10] the worst conditions were observed in the AMBA.

In contrast, experiences in other settings have shown more favorable results following changes in methods of accessing images. Kruger et al.[1] reported that 94.5% of surgeons considered that the transition from physical to digital images improved access to imaging studies. Wojciech et al.[11] evaluated the introduction of the DICOM system and found that, in 90% of cases, digital images were successfully accessed on the first attempt. Lindsay et al.[12] reported that the implementation of PACS improved report turnaround time (70%) and medical staff workflow (57%). Jorwekar et al.[13] reported a 94% satisfaction rate among respondents following implementation of the same system. Chan et al.[14] found that referring physicians almost unanimously preferred PACS to printed films, and 91% reported improved productivity.

Why, then, is the perception in our setting so different? The medical literature suggests that users will adopt new technologies only if they perceive that they make their work easier;[15] however, the results of our survey show that this is not the case for many surgeons in our setting.

It has been proposed that the performance of a radiology center should be assessed according to six variables: productivity, report turnaround time, ease of access, finances, and physician and patient satisfaction.[12] In practice, healthcare intermediaries prioritize patient/client satisfaction, considering indicators such as complaints, satisfaction, and waiting times.[15,16] However, referring physicians, particularly those in private practice, are the true primary clients,[16] as they generate the demand for imaging studies and must use their results. Despite this, their opinions are rarely taken into account when changes are implemented or platforms are selected. This reflects a failure to recognize specialists as "clients" in the provision of imaging services.

Physicians frequently receive poor-quality studies, images deemed unsuitable for diagnosis by the imaging provider itself (Figure 1), inaccurate reports (Figure 4), inadequate images (Figure 5), inaccessible platforms (Figure 6), and data upload errors (Figures 7 and 8). Faced with these situations, the orthopedic surgeon must choose between making decisions based on inadequate studies or referring the patient back to have the examinations repeated, resulting in further difficulties and delays.

Clearly, the failure of imaging providers to identify the primary user hinders the implementation of improvements aimed at increasing physician satisfaction.

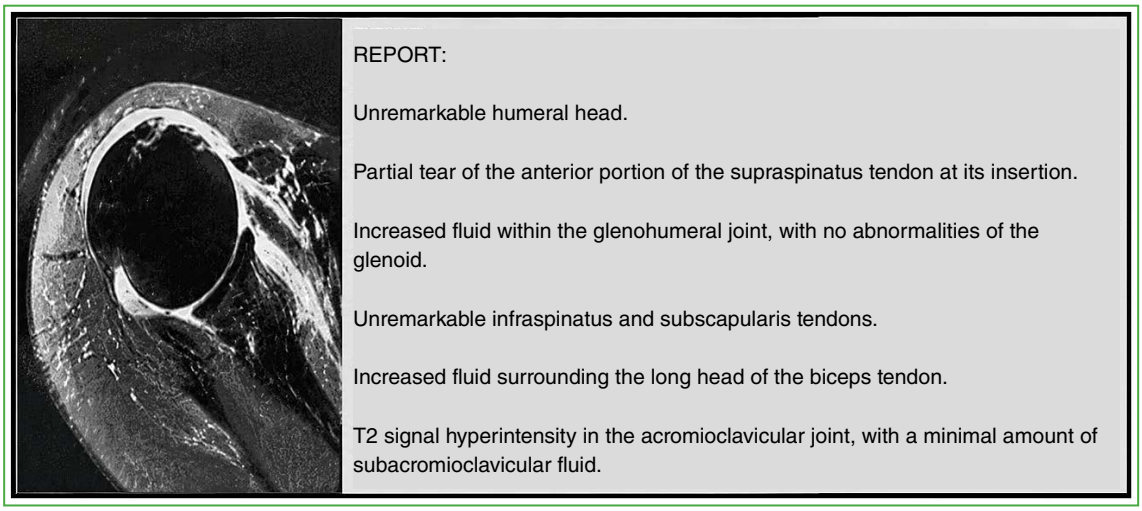

Figure 4. MRI study in which the report states that the subscapularis muscle shows no abnormalities, despite the presence of a full-thickness tear of its distal insertional tendon.

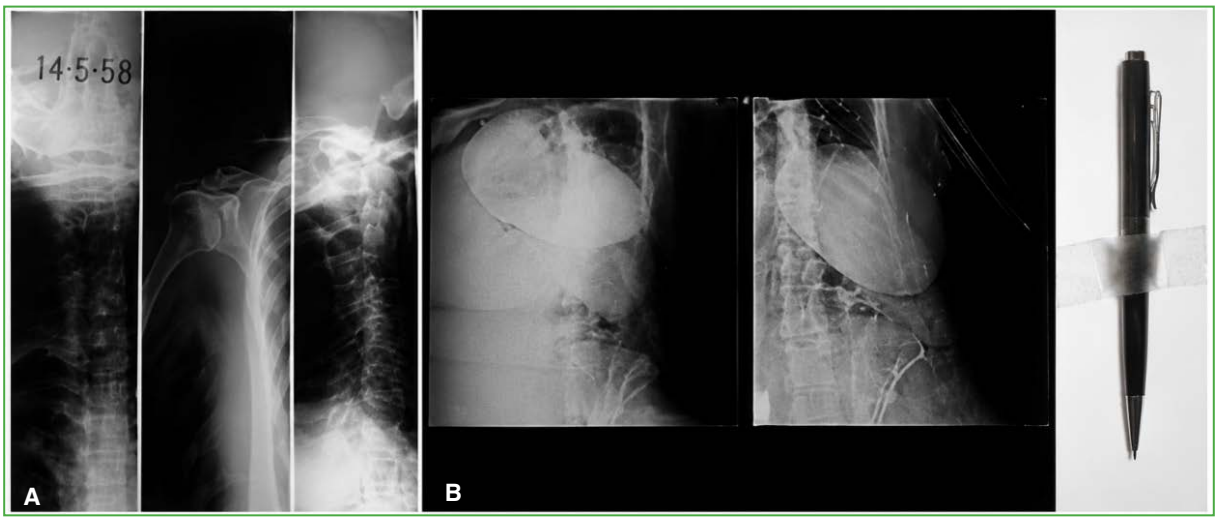

Figure 5. Examples of poor-quality diagnostic images. **A.** An anteroposterior shoulder image is inserted between two views of the cervical spine. The shoulder image is cropped, and large areas cannot be visualized because of technical errors. **B.** Anteroposterior and oblique images of the rib cage printed on a radiographic film the size of a pen.

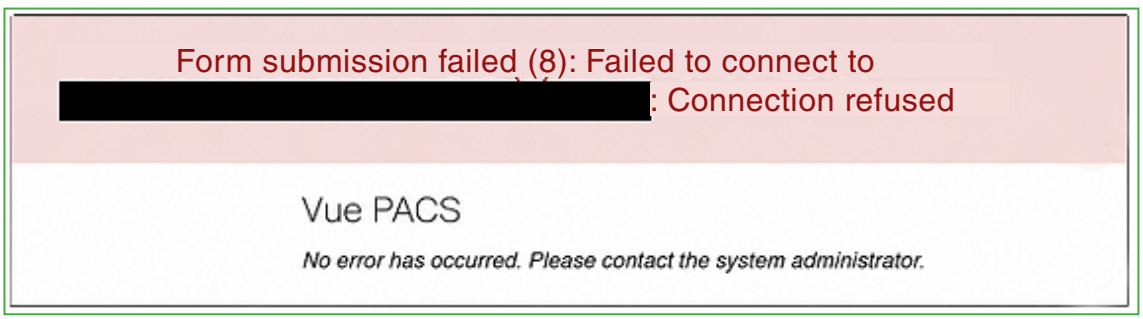

Figure 6. Examples of situations in which images stored in PACS cannot be accessed.

Figure 7. Example of an incorrect image upload. The patient had been referred for an MRI of the shoulder. The study is correctly labeled, but brain images from another patient were uploaded instead.

Figure 8. Another example of an incorrect image upload. The lumbar spine images were uploaded upside down. (The image was edited to include both views in a single figure.)

Limitations

This study has some limitations. First, the sample size is relatively small compared with the total population of orthopedic and trauma specialists in Argentina. The survey format, with predefined response options, may have limited the diversity of responses. In addition, the data were self-reported, which may have introduced response bias or resulted in incomplete information.

Strengths

This is the first study to assess the perceptions of orthopedic and trauma specialists regarding access to imaging study results in Argentina. Strategies were implemented to mitigate bias, including anonymous participation, and the study received institutional support.

CONCLUSIONS

To our knowledge, this survey is the first study to assess the perceptions of Argentine orthopedic and trauma specialists regarding access to imaging study results. Compared with international experiences, the level of dissatisfaction was high. The vast majority of physicians had received no training in the new methods of access.

The main contribution of this study is to provide an assessment of the current situation that may help ensure that orthopedic surgeons are recognized as relevant stakeholders and that their perspectives are considered when implementing technological changes in access to imaging studies.

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

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Functional Outcomes of Arthroscopic Treatment of Refractory Lateral Epicondylitis

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ABSTRACT

Introduction: Lateral epicondylitis is a common cause of elbow pain and disability. Although most patients respond to conservative treatment, refractory cases may require surgery. In recent years, arthroscopy has gained popularity because it provides a minimally invasive approach and allows associated intra-articular lesions to be treated. **Objective:** To evaluate functional outcomes, pain improvement, and the presence of associated intra-articular lesions in patients with refractory lateral epicondylitis treated with arthroscopic elbow debridement and release. **Materials and Methods:** Statistically significant improvements were observed in the MEPS score (from 45.83 to 85.00; $p < 0.0001$) and VAS score (from 7.50 to 1.25; $p < 0.0001$). Baker grade 2 was the most common. Associated lesions were found in 66.7% of patients; synovial plica was the most common, and all lesions were treated during the same procedure. Transient radial nerve neuropraxia was the only complication. **Results:** Statistically significant improvements were observed in MEPS (45.83 → 85.00; $p < 0.0001$) and VAS (7.50 → 1.25; $p < 0.0001$). Baker grade 2 was the most frequent. 66.7% of patients presented with associated injuries, which were treated during the same procedure, with synovial plica being the most common. A single complication was recorded: transient radial neuropraxia. **Conclusions:** Arthroscopic treatment of lateral epicondylitis through intra-articular debridement resulted in a significant reduction in pain and substantial functional improvement, supporting its use as an effective alternative in patients refractory to conservative management.

Keywords: Lateral epicondylitis; elbow arthroscopy; extensor carpi radialis brevis debridement; Baker classification.
Level of Evidence: IV

Resultados funcionales del tratamiento artroscópico de la epicondilitis lateral refractaria

RESUMEN

Introducción: La epicondilitis lateral es una causa frecuente de dolor del codo y discapacidad. Aunque la mayoría responde al tratamiento conservador, los casos refractarios pueden requerir cirugía. En los últimos años, la artroscopia ha ganado popularidad por permitir un abordaje mínimamente invasivo y el tratamiento de lesiones intrarticulares asociadas. **Objetivo:** Evaluar los resultados funcionales, la mejoría del dolor y la presencia de lesiones intrarticulares asociadas en pacientes con epicondilitis lateral refractaria tratados con desbridamiento y liberación artroscópica del codo. **Materiales y Métodos:** Estudio retrospectivo de 12 pacientes sometidos a una artroscopia de codo entre marzo de 2022 y abril de 2025, con un seguimiento promedio de 14 meses. La función y el dolor se evaluaron con la escala MEPS y la escala analógica visual antes y después de la cirugía. Las lesiones se clasificaron según la escala artroscópica de Baker y se registraron las lesiones asociadas. **Resultados:** Se observaron mejoras estadísticamente significativas en el puntaje MEPS (de 45,83 a 85,00; $p <0,0001$) y en la escala analógica visual (de 7,50 a 1,25; $p <0,0001$). El grado 2 de Baker fue el más frecuente. El 66,7% presentó lesiones asociadas, la más común fue la plica sinovial, y todas fueron tratadas en el mismo procedimiento. Se registró una neuropraxia radial transitoria como única complicación. **Conclusiones:** El tratamiento artroscópico de la epicondilitis lateral mediante desbridamiento intrarticular produjo una reducción significativa del dolor y una mejoría funcional sustancial, por lo que se consolida como una alternativa eficaz en pacientes refractarios al manejo conservador.

Palabras clave: Epicondilitis lateral; artroscopia de codo; desbridamiento del extensor radial corto del carpo; clasificación de Baker.
Nivel de Evidencia: IV

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INTRODUCTION

Lateral epicondylitis, commonly known as tennis elbow,[1] is an overuse injury resulting from eccentric overload of the common extensor tendon, primarily involving the origin of the extensor carpi radialis brevis (ECRB). This condition is mainly caused by repetitive strain from activities involving gripping under load or repeated wrist extension. It is common among individuals who participate in sports such as tennis or squash, or whose occupational activities require repetitive wrist extension, radial deviation, or forearm supination. In the general population, and particularly among manual workers, the reported incidence ranges from 1% to 3%. It affects men and women equally, with the highest prevalence in the fifth decade of life, and predominantly involves the dominant arm.[2]

It is characterized by microtears and degeneration of the ECRB, leading to a failed healing response.[3]

Initial treatment is conservative and includes relative or complete cessation of the triggering activity, depending on pain severity, together with oral analgesics, cryotherapy, and, in some cases, counterforce braces to reduce stress on the lateral epicondyle. Physical or occupational therapy focusing on stretching, progressive strengthening, and eccentric exercises is a fundamental component of treatment. Surgery should be considered only as a last resort after at least 6-12 months of conservative treatment.[2]

According to the literature, surgical techniques vary. Most surgeons perform varying degrees of ECRB debridement or release of its tendinous origin at the lateral epicondyle. Debridement of pathological tissue, together with the creation of a bleeding bone bed at the lateral epicondyle, is intended to promote healing.[1]

Although this condition is very common, the optimal treatment approach remains a matter of debate, particularly regarding the choice between open and arthroscopic surgery.[4] The latter allows intra-articular visualization of concomitant lesions, with the advantages of lower morbidity, faster recovery, and earlier return to work and sports.[5]

The objective of this study was to evaluate functional outcomes, pain improvement, and associated lesions in a consecutive series of patients with lateral epicondylitis who underwent arthroscopic debridement and release of the elbow after failure of conservative treatment.

MATERIALS AND METHODS

The study protocol was approved by our institution's Ethics Committee, and all patients provided informed consent before inclusion.

A retrospective study was conducted including 12 patients diagnosed with lateral epicondylitis who underwent arthroscopic elbow surgery between March 2022 and April 2025 (Table 1). The mean follow-up was 14 months (range, 6-24), with no patients lost to follow-up during this period.

The inclusion criteria were age >18 years, a clinical diagnosis of lateral epicondylitis, and failure of conservative treatment for at least 6 months.

The exclusion criteria were refusal to participate in the study, elbow osteoarthritis, a history of systemic or rheumatoid arthritis, and previous surgery on the affected elbow.

The clinical diagnosis of lateral epicondylitis was established using the Cozen and Maudsley tests and confirmed by complementary imaging studies, including anteroposterior and lateral radiographs of the elbow and magnetic resonance imaging (MRI).

All patients underwent functional and pain assessment using the *Mayo Elbow Performance Score* (MEPS) and the visual analog scale (VAS) before surgery and postoperatively.

During surgery, lesions were classified according to the Baker arthroscopic classification, and associated lesions were documented and treated (Table 2).

Table 1. Demographic characteristics, intra-articular findings, and clinical outcomes.

N	Age (years)	Manual laborer	Dominant hand	Baker's classification Baker	Associated injuries	Chondral injuries	Synovial plica	Postero-lateral Instability	SMILE-type finding	Annular ligament injury	Complications	Preoperative MEPS	Postoperative MEPS	Preoperative VAS	Postoperative VAS
1	53	Yes	Yes	2	Yes		x					50	90	8	2
2	46	Yes	Yes	2	Yes		x					60	80	7	1
3	40	Yes	No	3	Yes		x				x	40	85	8	2
4	38	No	Yes	2	No							35	75	6	0
5	45	Yes	Yes	2	Yes				x			40	80	7	1
6	46	Yes	Yes	2	Yes	x	x					45	95	8	2
7	25	No	Yes	1	Yes		x					55	80	9	3
8	41	No	No	2	No							40	100	8	1
9	50	Yes	Yes	2	Yes							65	95	7	0
10	38	No	Yes	3	Yes			x		x		35	75	8	1
11	61	Yes	Yes	1	Yes	x						40	80	7	1
12	61	No	No	1	No	x						45	85	7	1

MEPS = *Mayo Elbow Performance Score*; VAS = visual analog scale.

Table 2. Baker arthroscopic classification.

Type	Description	Arthroscopic Findings
1	Mild injury	Intact articular capsule; origin of the ECRB not visualized; minimal or no degenerative changes
2	Partial injury	Partial tear of the ECRB; thinned or partially torn capsule; partial visualization of the tendon with degenerative changes
3	Complete injury	Complete rupture of the ECRB; evident capsular defect with exposure of the tendon and the lateral condyle

ECRB = extensor carpi radialis brevis.

Surgical Technique

All procedures were performed by the same surgeon. The patient was placed in the lateral decubitus position under general anesthesia, and a pneumatic tourniquet was applied to the affected upper extremity. Elbow arthroscopy was performed using a 2.7-mm, 30° arthroscope. After joint insufflation, a soft-spot portal was established, followed by proximal anterolateral and proximal anteromedial portals.

A systematic inspection of the joint was performed, followed by routine synovectomy. Lesions were classified according to the Baker arthroscopic classification (Figure 1). A capsulotomy was then performed below the equator of the condyle, followed by tenotomy of the ECRB until the muscle belly of the extensor carpi radialis longus was exposed (Figure 2, Video).

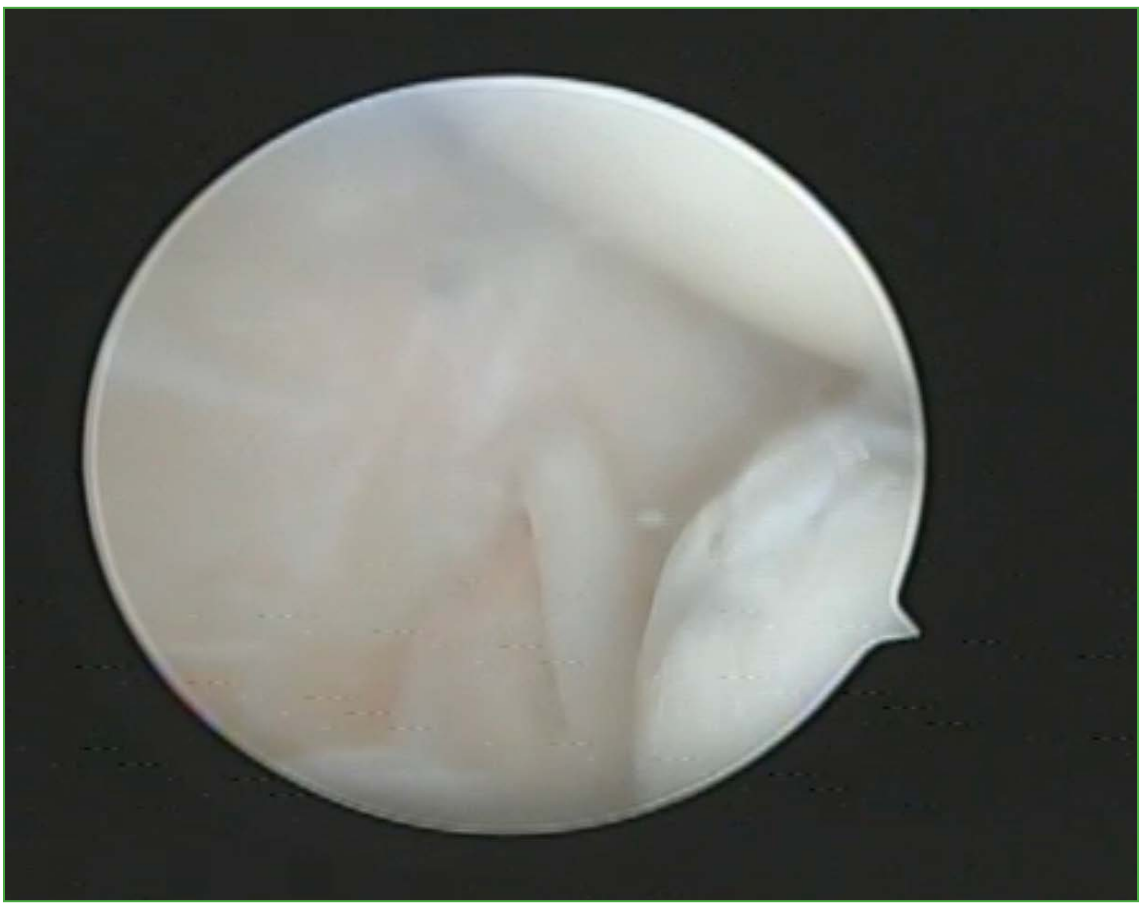

Figure 1. Intraoperative image showing a Baker type 2 lesion.

Figure 2. Intraoperative image showing tenotomy of the extensor carpi radialis brevis to the level of the muscle belly of the extensor carpi radialis longus.

Postoperative management consisted of compressive dressing, clinical follow-up at 48 hours, and an early physical therapy protocol. During the initial phase, active elbow motion within a pain-free range was encouraged while prolonged immobilization was avoided, with the aim of preventing stiffness and promoting functional recovery. During the second and third weeks, active motion was continued. In the fourth week, stretching exercises for the forearm extensor muscles were introduced, together with progressive strengthening, with an emphasis on eccentric exercises for the ECRB. From the fourth to the sixth week, functional strengthening exercises and progressive retraining tailored to the patient's specific activities were added. Gradual return to work and sports was allowed according to clinical progress.

Statistical Analysis

A descriptive analysis of the demographic and clinical variables was performed. Absolute frequencies, percentages, and corresponding mean values were calculated for each category. The distribution of cases according to the Baker classification was also determined, and the percentage of associated lesions was calculated, with the most frequent lesions identified.

Differences between preoperative and postoperative MEPS and VAS scores were assessed using Student's *t*-test for paired samples.

Statistical analysis was performed using RStudio (version 2023.06.0).

RESULTS

Twelve patients were included between March 2022 and April 2025. The study objectives were to analyze the demographic characteristics of the sample, including age, hand dominance, and the percentage of patients engaged in physically demanding work; determine the distribution according to the Baker classification; identify associated intra-articular lesions and their frequency; and compare preoperative and postoperative functional outcomes and pain using the MEPS and VAS.

Most patients were right-handed, reflecting the predominant hand dominance in this cohort.

An intermediate group combining strength and dexterity was identified, which may be relevant when designing specific interventions and making clinical and ergonomic decisions.

Regarding age, patients combining both characteristics tended to be older, suggesting that these functional characteristics may accumulate over time. In contrast, the distribution of manual dexterity was homogeneous, as the mean age of patients with a dominant hand was similar to the overall mean age of the cohort, suggesting that this characteristic was not significantly influenced by age (Table 3).

Table 3. Demographic characteristics of the sample.

Characteristics	n	Mean age
Total number of patients	12	45
Manual laborers	7	49
Skilled labor	9	45
Both conditions	6	50

In the study group, Baker grade 2 was the most common (7 patients). Grades 1 and 3 were less frequent (3 and 2 patients, respectively).

Associated lesions were present in 66.7% of patients. Synovial plica was the most frequent (41.7%), followed by chondral lesions (25%). Less frequent lesions included posterolateral instability, annular ligament injury, and SMILE-type lesions, each occurring in 8.3% of patients. In addition, 16.7% had multiple lesions that were treated during the same procedure. In patients with synovial plica, resection was performed until pronation-supination maneuvers confirmed the absence of impingement against the radial head. SMILE-type lesions (defined as injury to the lateral ligament complex with microinstability) and posterolateral instability (secondary to insufficiency of the lateral ligament complex) were treated with capsular plication, whereas chondral lesions were treated with debridement (Table 4).

Table 4. Associated injuries.

Types of injuries	n	%
Cartilage	3	25.0
Plica	5	41.7
Posterolateral instability	1	8.3
SMILE-type finding	1	8.3
Annular Ligament	1	8.3
Multiple	2	16.7

The MEPS showed an improvement in elbow function postoperatively, increasing from 45.83 ± 9.73 to 85.00 ± 8.26 (mean difference, 39.17 ± 10.62; p <0.0001). The VAS score decreased from 7.50 ± 0.80 to 1.25 ± 0.87 (mean difference, -6.25 ± 0.45; p <0.0001).

Overall, these results indicate that surgical treatment resulted in significant functional improvement and a marked reduction in pain (Figures 3 and 4).

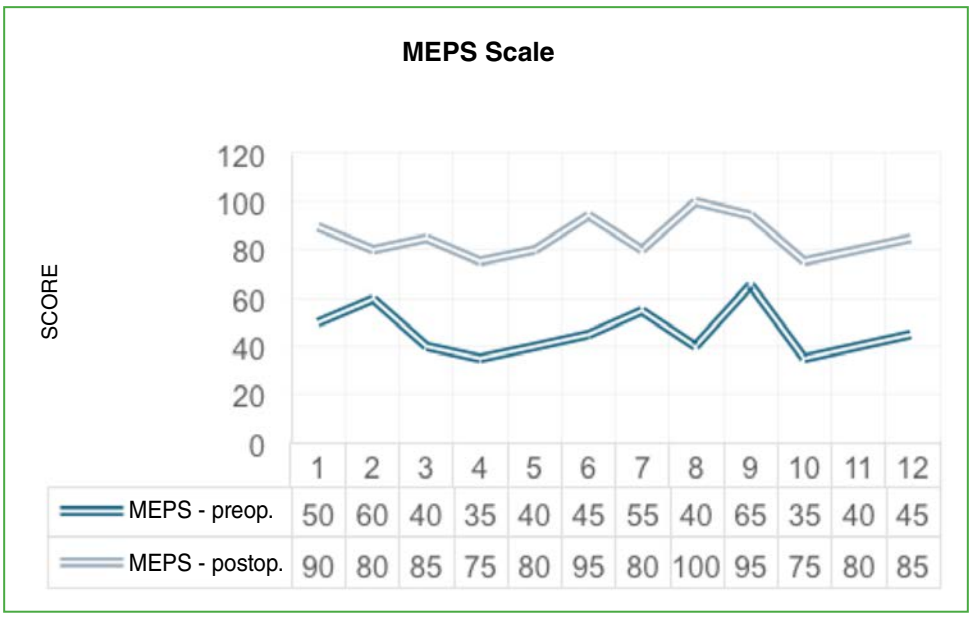

Figure 3. Comparison of preoperative and postoperative function assessed using the *Mayo Elbow Performance Score* (MEPS).

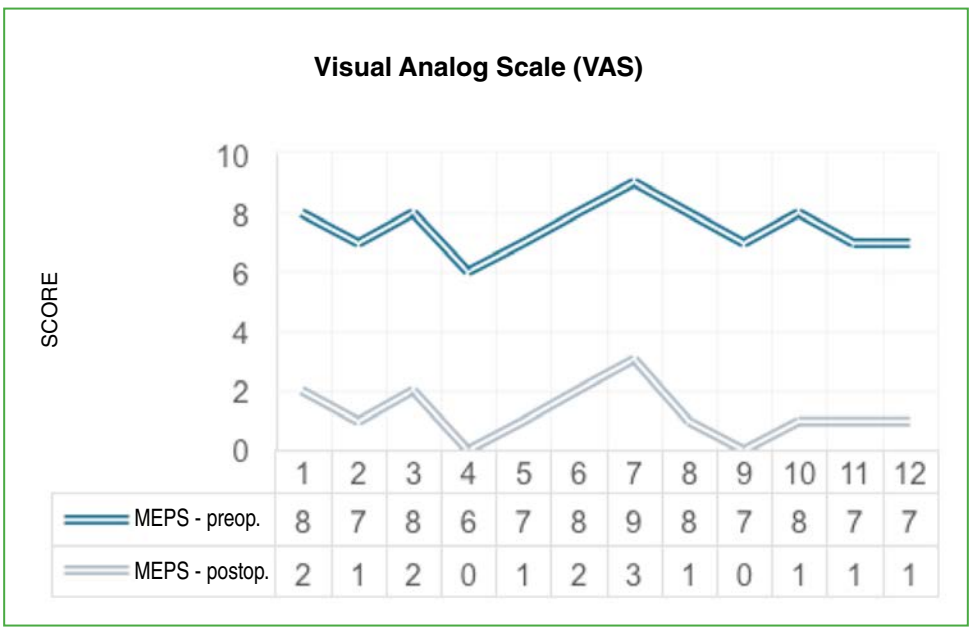

Figure 4. Comparison of preoperative and postoperative pain assessed using the visual analog scale (VAS).

The mean time to return to work was 21 days, while return to sports occurred at approximately 6 weeks. Patients who underwent tenotomy regained strength at approximately 2 months. Patients with associated lesions treated with capsular plication had a slower recovery, possibly because of the 2-week immobilization period; nevertheless, they showed progressive improvement with physical therapy.

Complications

One complication occurred in the series (Patient 3): transient radial nerve neuropraxia, which resolved completely within 24 hours.

DISCUSSION

This study included 12 patients who underwent elbow arthroscopy between March 2022 and April 2025, with a mean follow-up of 14 months. Function and pain were assessed using the MEPS and VAS both before surgery and postoperatively. Lesions were classified according to the Baker arthroscopic classification, and associated lesions were documented and treated. This technique yielded favorable outcomes, with significant functional improvement and pain reduction, supporting its use as an effective option for patients with lateral epicondylitis refractory to conservative treatment. In a long-term follow-up study, Baker and Baker demonstrated the sustained efficacy of arthroscopic ECRB debridement,[6] while Baker et al. initially proposed an arthroscopic classification and reported good clinical outcomes at 2 years.[7]

These findings have been reinforced by systematic reviews and meta-analyses. Pierce et al. reported that patients undergoing arthroscopic and percutaneous release experienced less pain than those treated with open procedures.[8] Similarly, Muir et al. reported encouraging outcomes with arthroscopic surgery and suggested that it should be considered a valid alternative in refractory cases.[9]

The literature has reported comparable functional outcomes between open and arthroscopic approaches, although arthroscopy offers practical advantages. Szabo et al. evaluated three surgical techniques and found no significant differences in complications, recurrence rates, or pain scores.[10] However, in a recent comparative meta-analysis, Ghandour et al. concluded that arthroscopy had a safety profile similar to that of open surgery, with additional benefits related to its minimally invasive nature.[11]

Regarding complications in our series, only one case of transient radial nerve neuropraxia occurred. Moran et al. reported no significant differences in complication or reoperation rates between arthroscopic and open surgery.[12] Pomerantz reported complication rates of 4.3% for open surgery and 1.1% for arthroscopy.[13] Similarly, Danaher emphasized that patients have favorable outcomes after resection of pathological ECRB tissue, regardless of the technique used. These findings suggest that procedural safety depends on surgical technique and surgeon experience.[14]

The presence of concomitant lesions in two-thirds of our patients reinforces the value of arthroscopy as a comprehensive diagnostic and therapeutic technique. In our series, synovial plica was the most common associated lesion, consistent with previous reports. Baker et al. reported that arthroscopy allows identification of intra-articular abnormalities, including synovitis and synovial folds, which may contribute to persistent pain.[7] Similarly, Pierce et al. and Muir et al. highlighted the diagnostic role of arthroscopy in identifying associated lesions, such as plicae and chondral lesions, which may go undetected during open surgery.[8,9]

Early return to work is one of the most notable benefits of arthroscopy. Baker et al. reported a mean time to return to work of 35 days compared with 66 days after open surgery.[7] Choudhury et al. also reported that arthroscopic release and decortication allowed an earlier return to work, with satisfaction levels similar to those achieved with intensive conservative management.[15] These findings are consistent with the early recovery observed in our series and with published evidence supporting arthroscopy as a first-line surgical option.

Wang et al. reported that, despite the benefits of arthroscopy, the open approach remains the technique most commonly used by recently trained orthopedic surgeons, accounting for more than 90% of cases, although the use of arthroscopy is increasing.[16] This suggests that the learning curve remains a barrier to its wider adoption.

Among emerging techniques, percutaneous ultrasonic tenotomy has yielded favorable long-term clinical and ultrasonographic outcomes, with a low complication rate.[17] Satake et al. explored selective neurectomy as an alternative treatment and reported significant pain reduction, although residual sensory disturbances represented a limitation.[18]

More recently, studies of arthroscopic repair using suture anchors have demonstrated significant clinical improvement and high patient satisfaction,[19] reflecting the ongoing evolution of minimally invasive techniques for this condition.

Overall, the evidence supports satisfactory outcomes with both open and arthroscopic surgery in patients with refractory lateral epicondylitis. However, arthroscopy offers additional advantages, including lower morbidity, simultaneous identification and treatment of associated lesions, earlier return to work, and low complication rates, supporting its role as an effective and safe surgical alternative.[11,19]

This study has several limitations that should be considered when interpreting the results. First, the small sample size limits the generalizability of the findings. In addition, the absence of a control group precludes direct comparison with other surgical techniques. For these reasons, future studies with larger samples, prospective controlled designs, and standardized structural assessments are needed to validate and expand upon our findings.

CONCLUSION

Arthroscopic treatment of lateral epicondylitis with intra-articular debridement resulted in a significant reduction in pain and substantial functional improvement, supporting its use as an effective alternative in patients refractory to conservative treatment.

AI Use Statement

During the preparation of this manuscript, the authors used ChatGPT as a language support tool for the initial draft of the abstract as well as for stylistic adjustments to the manuscript.

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

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Use of Radiofrequency for Chronic Low Back Pain with Sciatica: A Systematic Review

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ABSTRACT

Introduction: Chronic low back pain is a global health problem with a substantial occupational burden. Treatment is multidisciplinary and multimodal, combining pharmacological measures, rehabilitation, and minimally invasive therapies such as radiofrequency treatment. **Objective:** To determine the efficacy of radiofrequency treatment in patients with chronic low back pain and sciatica through a review of the scientific literature. **Materials and Methods:** A systematic review was conducted in accordance with the PRISMA methodology and registered in the PROSPERO database. The selected studies were evaluated by the investigators and screened using Rayyan software to verify the inclusion criteria and conduct the subsequent analysis. **Results:** Nineteen studies involving 3,591 participants were included. Short-term success rates for facet joint pain ranged from 47.68% to 70%, but robust evidence of long-term efficacy is lacking. For discogenic pain, radiofrequency treatment targeting the dorsal root ganglion had a 1-year success rate of 86.9%. However, the lack of high-quality evidence and its use in combination with other therapies limit the recommendation of radiofrequency treatment as monotherapy. **Conclusions:** Radiofrequency treatment is a therapeutic option for the short-term management of facet joint and discogenic pain. There is no high-quality evidence indicating that it provides sustained pain relief in patients with chronic low back pain and sciatica. Its high cost and the short duration of its benefits require rigorous selection of patients for this treatment.
Keywords: Radiofrequency therapy; denervation; low back pain; sciatica.
Level of Evidence: II

Uso de radiofrecuencia para la lumbociatalgia crónica: revisión sistemática

RESUMEN

Introducción: La lumbalgia crónica es un problema de salud mundial con una carga laboral importante. El tratamiento es multidisciplinario y multimodal, combina medidas farmacológicas, rehabilitación y terapias mínimamente invasivas, como la radiofrecuencia. **Objetivo:** Determinar la eficacia de la radiofrecuencia en pacientes con lumbociatalgia crónica mediante una revisión de la literatura científica. **Materiales y Métodos:** Revisión sistemática basada en la metodología PRISMA. Se registró en la base de datos PROSPERO. Los estudios seleccionados fueron evaluados por los investigadores y se filtraron en el programa Rayyan para la validación de los criterios de inclusión y el posterior análisis. **Resultados:** Se incluyeron 19 estudios con 3591 participantes. El éxito a corto plazo para el dolor facetario oscila entre el 47,68% y 70%, pero carece de evidencia sólida a largo plazo. En el dolor discogénico, el abordaje del ganglio de la raíz dorsal tiene una tasa de éxito del 86,9% al año. No obstante, la falta de pruebas de alta calidad y el uso con terapias combinadas limitan la recomendación de radiofrecuencia como monoterapia. **Conclusiones:** La radiofrecuencia es una opción terapéutica para el control del dolor facetario y discogénico a corto plazo. No hay pruebas de alta calidad que indiquen que la radiofrecuencia proporciona un alivio del dolor prolongado en pacientes con lumbociatalgia crónica. Su alto costo y el corto tiempo de su beneficio exigen una selección rigurosa de los pacientes a quienes aplicar este tratamiento.
Palabras clave: Terapia de radiofrecuencia; desnervación; dolor lumbar; ciática.
Nivel de Evidencia: II

INTRODUCTION

Lumbago with sciatica is defined as pain localized between the lower margin of the ribs and the lower border of the gluteal region, radiating to the posterior aspect of the thigh, leg, and foot, and may be associated with motor and sensory disturbances.[1] It is considered chronic when it persists for more than three months and does not respond to

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treatment.[2] It is a global public health problem, particularly among adults, with a peak incidence between 45 and 59 years of age. Approximately 70-85% of the population has experienced low back pain at some point in their lives.[3,4]

Lumbago with sciatica encompasses different types of pain, including somatic pain, neuropathic (radicular) pain radiating to the lower extremities, and, in some cases, nociplastic pain.[5] The most common cause of radiculopathy is irritation of a specific nerve as a result of compression within the thecal sac, which may be associated with disc herniation, facet joint or ligamentous hypertrophy, neoplastic processes, spondylolisthesis, or infectious processes. Forty percent of low back pain cases are of discogenic origin.[3,6]

Treatment of lumbago with sciatica depends on the underlying cause. Conservative treatment is aimed at controlling pain and promoting early return to work and includes analgesics, neuromodulators, muscle relaxants, physical therapy, and exercise. Epidural injection of a local anesthetic and corticosteroids in the region of the affected lumbar nerve root is recommended for patients with severe acute sciatica that does not respond to these strategies. Discectomy may be considered when conservative treatment fails, neurological deficits progress, and pain persists for more than 12 weeks.[7]

Radiofrequency therapy is based on the use of electromagnetic waves generated by the passage of alternating current through an electrode. This current causes ionic friction, which increases temperature and, when temperatures exceed 50-60 °C, results in coagulative tissue necrosis.[8]

Radiofrequency is applied to specific anatomical structures according to the source of pain. For facet-mediated pain, the current is generally applied to the lumbar medial branch that innervates the facet joints; this branch gives rise to fibers that extend to the joint capsule, posterior portion of the annulus fibrosus, and posterior portion of the disc via the sinuvertebral nerve. For discogenic pain, radiofrequency may be applied intradiscally, to the dorsal root ganglion, or to the sinuvertebral nerve.[9,10]

The effectiveness of radiofrequency in the treatment of chronic lumbago with sciatica remains controversial.[11] An overall 130.6% increase in the overuse of radiofrequency procedures has been reported, with a corresponding increase in costs.[12]

The objective of this study was to determine the efficacy of radiofrequency in patients with chronic lumbago with sciatica through a review of the scientific literature.

MATERIALS AND METHODS

A systematic review was conducted according to the PRISMA guidelines.[13] The PubMed database was searched. Search terms were based on Medical Subject Headings (MeSH) and included: "Radiofrequency Therapy" OR "Therapies, Radiofrequency" AND "Denervation" OR "Denervations" AND "Low Back Pain" OR "Pains, Low Back" AND "Sciatica" OR "Neuralgia, Sciatic" NOT "pediatrics."

The inclusion criteria were: 1) randomized controlled trials and analytical studies; 2) patients with chronic lumbago with sciatica (>3 months) with facet-mediated or discogenic pain who had previously been treated with analgesics, weak or strong opioids, and blocks, with or without a positive response; 3) clinical trials comparing the effects of radiofrequency denervation with placebo or other treatments, with no restriction on the temperature used and including both pulsed and continuous radiofrequency; 4) studies published between 2015 and 2025; and 5) studies published in any language.

The exclusion criteria were: 1) studies involving patients with acute trauma, patients <18 years of age, pregnant women, or patients with fractures, inflammatory or rheumatic diseases, neoplasms, or psychiatric disorders; 2) literature reviews, systematic reviews, and meta-analyses; and 3) editorials or narrative reviews without verifiable evidence.

The research question was: What is the efficacy of radiofrequency in patients with chronic lumbago with sciatica according to the available scientific evidence?

Data Collection and Processing

The following data were collected: year of publication, author, and country of the study; methodology, including a description of the methods used and the procedure performed or compared; and results, including the effect on pain reduction, treatment safety, and adverse events.

The review was conducted according to the PRISMA methodology (Figure). Data were obtained from the articles identified through the search using Boolean operators and the eligibility criteria. The protocol was registered in the *Prospective Register of Ongoing Systematic Reviews* (PROSPERO) under ID CRD420251062928.

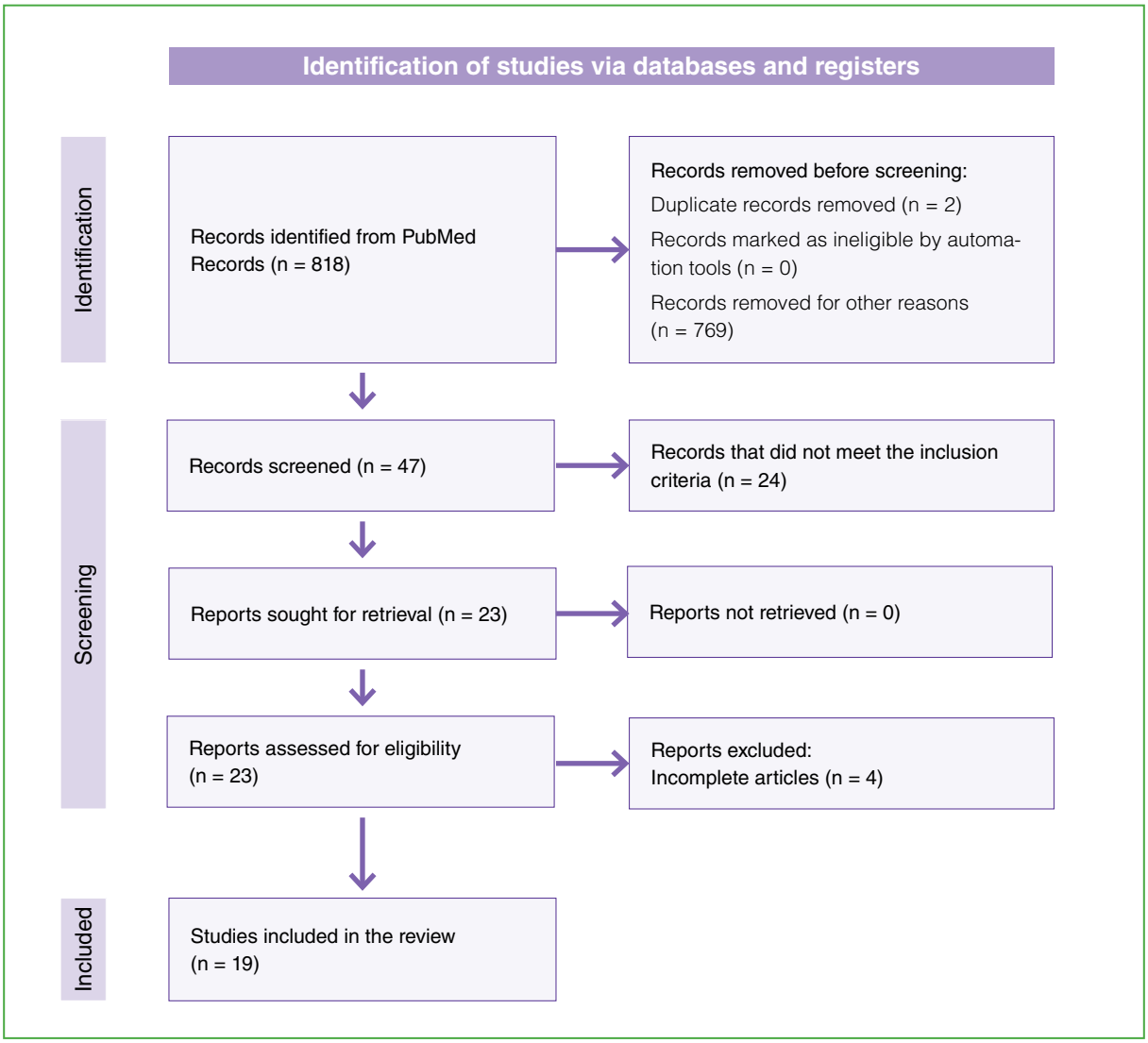

Figure. PRISMA flowchart.

The selected studies were independently evaluated and reviewed by the investigators. They were subsequently screened using Rayyan based on titles and abstracts, and the studies selected for inclusion underwent full-text review to confirm that they met the inclusion and exclusion criteria.

The PubMed search using the terms "Radiofrequency Therapy" AND "Low Back Pain" yielded 781 results; after filters based on the inclusion criteria were applied, 45 articles remained. Similarly, the search using "Radiofrequency Therapy" AND "Sciatica" yielded 37 publications; after the filters were applied, two results remained.

The results were uploaded to Rayyan, and two duplicate articles were removed.

Assessment of Risk of Bias

Risk of bias was assessed individually using the RoB 2 tool (Table 1), which consists of five domains rated as low, moderate, or high risk of bias.[14]

The quality of the selected studies was assessed using the *Grading of Recommendations Assessment, Development and Evaluation* (GRADE) system, which rates the quality of evidence as very low, low, moderate, or high.[15]

Table 1. Risk of bias assessment (Rob2).

Author	D1 Randomization	D2 Intervention	D3 Missing Data	D4 Measurement	D5 Reporting	Overall Risk
Holz and Sehgal (2016)[16]	High	Moderate	Low	Moderate	Low	High
Khalil et al. (2019)[17]	Low	High	Low	Medium	High	High
Chang et al. (2018)[18]	Medium	Low	Low	Low	Low	Medium
De et al. (2020)[19]	Low	Low	Low	Low	Low	Low
Juch et al. (2017)[20]	Low	High	Medium	Medium	Low	High
Lee et al. (2018)[21]	Medium	Medium	Low	Low	Low	Medium
Maas et al. (2019)[22]	Low	Low	Low	Low	Low	Low
Do et al. (2017)[23]	Medium	Low	Low	Low	Low	Medium
Moussa et al. (2016)[24]	Low	Low	Low	Low	Low	Low
Moussa et al. (2020)[25]	Low	Low	Low	Low	Low	Low
Truong et al. (2024)[26]	Low	Medium	High	Low	Low	High
Fischgrund et al. (2019)[27]	Low	Low	Low	Low	Low	Low
van Tilburg et al. (2016)[28]	Low	Low	Low	Low	Low	Low
Chang et al. (2017)[29]	High	Moderate	Low	Moderate	Low	High
Napoli et al. (2023)[30]	Low	Low	Low	Low	Low	Low
Papadopoulus et al. (2020)[31]	Low	Medium	Low	Low	Low	Low
Fathy et al. (2023)[32]	Low	Medium	Low	Low	Low	Low
Zhang et al. (2016)[33]	High	High	Low	Moderate	Low	High
Li et al. (2024)[34]	High	Low	Low	Low	Low	High

The internal validity of the findings was affected by varying degrees of methodological bias. Seven studies had a high overall risk of bias, three had a moderate risk, and nine had a low risk. The studies by Holz and Sehgal,[16] and Chang et al.[18] were retrospective, which increases the risk of selection bias and makes it difficult to establish causality because of the lack of adequate control groups. Juch et al.[20] conducted an unblinded trial, which entails a risk of bias in outcome measurement.

The study by Napoli et al.[30] had a lower risk of bias because of its multicenter, randomized design and adequate patient blinding. In contrast, the study by Papadopoulus et al.[31] had attrition bias due to a 22% loss to follow-up. Similarly, Mass et al.[22] reported a high attrition rate at the 12-month follow-up, which may introduce bias if the outcomes of participants who completed the study differed from those of participants who dropped out.

Chang et al.[29] and Fathy et al.[32] mitigated the risk of performance and measurement bias by using independent investigators and assessors who were blinded to group allocation when assessing functional scales.

The study by Napoli et al.[30] had adequate statistical power, with 351 participants, whereas other studies, such as those by Chang et al.[29] and Zhang et al.,[33] may be subject to imprecision because of their small sample sizes, which limits the generalizability of their conclusions.

RESULTS

A total of 19 studies met the previously established inclusion criteria and were selected, comprising a total of 3,591 participants (Table 2). The studies included both men and women with similar characteristics in terms of pain duration.

Table 2. Study characteristics and demographic details.

Author	Country	Year	Study type	Sample	Patient type	Radiofrequency application site	Outcomes	Quality of evidence (GRADE)
Holz and Sehgal[16]	U.S.	2016	Retrospective review	50 patients	With chronic facet joint pain	Facet joints	At 3 months, there was a mean improvement in disability scores of 12.63% and pain relief of 47.68%	Very low ⊕⊖⊖⊖
Khalil et al.[17]	U.S.	2019	Prospective, multicenter, randomized, controlled clinical trial	140 patients randomized 1:1	With chronic low back pain and Modic type 1 or 2 vertebral changes	Basicervical nerve	Radiofrequency ablation was statistically superior: the change in the ODI at 3 months was - 25.3 vs. -4.4 in the standard treatment group ($p < 0.001$). The change in the VAS was -3.46 vs. -1.02 ($p < 0.001$)	Low ⊕⊕⊖⊖
Chang et al.[18]	South Korea	2018	Retrospective cohort study	20 patients: (5 men, 15 women)	With chronic facet joint pain	Intra-articular	Pain scores (NRS) decreased significantly at 1, 3, and 6 months of treatment ($p < 0.05$). At 6 months, 10 of 20 (50%) reported pain relief of 50% or more	Very low ⊕⊖⊖⊖
De et al.[19]	India	2020	Prospective, triple-blind, randomized, active-controlled	50 patients randomized into two groups of 25 each: local anesthesia group and local anesthesia plus radiofrequency group	With chronic lumbago with sciatica	Dorsal root ganglion	The local anesthetic plus pulsed radiofrequency group showed a statistically significant reduction in VAS and ODI compared to the control group from 2 weeks through 6 months. At 6 months, 28% of patients in the local anesthetic plus radiofrequency group experienced ≥50% pain relief	Moderate ⊕⊕⊕⊖
Juch et al.[20]	The Netherlands	2017	3 multicenter, pragmatic, open-label, randomized clinical trials	A total of 681 participants randomized across the 3 trials	With chronic facet joint pain	Dorsal root ganglion	At 3 months, radiofrequency denervation did not result in a clinically significant improvement in pain intensity compared with the exercise program alone	High ⊕⊕⊕⊕
Lee et al.[21]	Taiwan, U.S.	2018	Prospective, randomized, and cost-effectiveness trial	60 patients randomized into two groups of 30: Group 1 (diagnostic block prior to pulsed radiofrequency) and Group 2 (direct pulsed radiofrequency)	With chronic low back pain	Dorsal root ganglion	The dorsal root ganglion block had a positive response rate of 80%. At 6 months, 20 patients in group 1 and 25 in group 2 had a successful outcome	Moderate ⊕⊕⊕⊖

(Continued.)

Table 2. *(Cont.)*

Maas et al.[22]	The Netherlands, Australia, Denmark	2019	Comparison of data from an RCT and a related observational study	1,148 patients: 125 from the facet RCT, 257 from observational group 2; 233 from observational group; 116 from the SI RCT, 198 from observational group 1, and 219 from observational group 2	With chronic facet pain	Facet joints	No differences were found in the course of symptoms between patients in the RCTs and patients in observational group 1 (eligible for the RCT)	Low ⊕⊕⊖⊖
Do et al.[23]	South Korea	2017	Randomized controlled trial	60 patients randomized into two groups of 30: intra-articular pulsed radiofrequency group and corticosteroid injection group	With chronic facet joint pain	Intra-articular	The corticosteroid injection had a superior short-term effect (2 weeks and 1 month), but at 3 and 6 months, the reduction in pain was not significantly different between the two groups	Moderate ⊕⊕⊕⊖
Moussa et al.[24]	Egypt	2016	Prospective, randomized, controlled, and double-blind	120 patients in 3 groups of 40: joint capsule denervation, medial branch denervation, and control (*sham*) group	With chronic facet joint pain	Facet joint capsule	At 2 years, only the joint capsule denervation group maintained a significant improvement in pain	Moderate ⊕⊕⊕⊖
Moussay et al.[25]	Egypt	2020	Prospective, randomized, controlled, and double-blind	150 patients divided into 3 groups of 50: pulsed radiofrequency of the dorsal root ganglion, medial branch denervation, and a control group	With chronic facet joint pain	Dorsal root ganglion	At 2 and 3 years, only the pulsed radiofrequency ablation of the dorsal root ganglion group maintained a significant improvement in pain	Moderate ⊕⊕⊕⊖
Truong et al.[26]	Denmark	2024	Single-center, single-blind RCT	120 patients randomized 1:1:1 to cryoneurolysis, radiofrequency, or placebo	With chronic facet joint pain	Medial branch nerve	Denervation of the medial branch using cryoneurolysis or radiofrequency, compared with placebo, did not show a statistically significant improvement in pain intensity or quality of life at short- or long-term follow-up	Low ⊕⊕⊖⊖
Fischgrund et al.[27]	U.S., Germany	2019	Prospective, multicenter, randomized, double-blind, and sham-controlled	225 randomized patients: 147 in the treatment group and 78 in the sham group	With chronic low back pain and Modic type 1 and 2 changes	Basicervical nerve	At 3 months, the treatment group showed a significantly greater reduction in the ODI (20.5) compared with the sham group (15.2) ($p = 0.019$)	Moderate ⊕⊕⊕⊖
van Tilburgy et al.[28]	The Netherlands	2016	Multicenter, randomized, double-blind, sham-controlled trial	60 randomized patients: 30 in the treatment group and 30 in the sham group	With chronic facet pain	Medial branch of the dorsal branch	There was no statistically significant difference in pain reduction or in the Perceived Global Effect between the treatment group and the sham group	Moderate ⊕⊕⊕⊖

(Continued.)

Table 2. *(Cont.)*

Chang et al.[29]	South Korea	2017	RCT	50 patients randomized into 2 groups of 25: bipolar pulsed radiofrequency group and monopolar pulsed radiofrequency group	Chronic lumbosacral radicular pain	Dorsal root ganglion	At 3 months, 76% of patients in the group that received bipolar radiofrequency reported ≥50% pain relief, compared with 48% in the other group	Moderate ⊕⊕⊕⊖
Napoli et al.[30]	Italy	2023	Randomized clinical trial	351 patients in 2 groups: combined treatment with radiofrequency plus transforaminal epidural corticosteroid injection vs. transforaminal epidural corticosteroid injection as a single treatment	With sciatica secondary to lumbar disc herniation	Dorsal root ganglion	The combination treatment reduced pain and achieved greater functional improvement than transforaminal epidural corticosteroid injection alone at 52 weeks of follow-up	High ⊕⊕⊕⊕
Papadopoulus et al.[31]	Greece	2020	Randomized, double-blind clinical trial	36 patients: 18 receiving intradiscal injection of gelled ethanol, and 18 receiving a combination of gelled ethanol and radiofrequency	With discogenic pain.	Intradiscal (toward the nucleus pulposus)	The combination of gelified ethanol and radiofrequency was more effective for pain relief at 6 and 12 months (>80%)	Low ⊕⊕⊖⊖
Fathy et al.[32]	Egypt	2023	Prospective, randomized, and controlled	80 patients: 40 with radiofrequency and 40 with radiofrequency plus transforaminal epidural corticosteroid injection	With lumbar disc herniation	Dorsal root ganglion	The combination of transforaminal epidural injection and pulsed radiofrequency yielded results similar to those of transforaminal epidural injection alone	Moderate ⊕⊕⊕⊖
Zhang et al.[33]	China	2016	Prospective, uncontrolled experimental study	23 patients	With discogenic low back pain	Intervertebral disc	Significantly reduced pain and improved function at the one-year follow-up; success rate: 86.9%	Low ⊕⊕⊖⊖
Li et al.[34]	China	2024	Prospective, randomized	167 patients	With chronic discogenic low back pain	Intervertebral and sinuvertebral nerve	The combination of percutaneous intervertebral radiofrequency ablation and sinuvertebral nerve ablation provides greater pain control and improves functional status for up to 6 months	Moderate ⊕⊕⊕⊖

GRADE = Grading of Recommendations, Assessment, Development and Evaluation; ODI = Oswestry Disability Index; VAS = visual analog scale; NRS = numerical rating scale; RCT = randomized controlled trial.

A total of 13 articles on chronic low back pain of facet origin were included. In two studies, radiofrequency was applied to the facet joints; in two, to the basivertebral nerve; in two, intra-articularly; in four, to the dorsal root ganglion; in one, to the facet joint capsule; and in two, the medial branch nerve was targeted.

Six randomized clinical trials involving patients with chronic discogenic lumbago with sciatica were included. The anatomical targets of radiofrequency treatment for discogenic pain were the dorsal root ganglion in three studies and the intervertebral disc in three studies.

The results of the analyzed articles indicate that radiofrequency is a safe procedure, with a very low rate of complications or adverse effects (Table 3).

Table 3. Reported adverse events of radiofrequency ablation.

Randomized clinical trial	Adverse events or complications
De et al.[19]	Sensation of heaviness in the legs (n = 4)
Truong et al.[26]	Pain and paresthesia in the hip and groin
Fischgrund et al.[27]	Nerve root injury (n = 1) Lumbar radiculopathy (n = 1) Retroperitoneal hemorrhage (n = 1) Transient sensory or motor deficit (n = 4)
von Tilburg et al.[28]	Vertebral compression fracture (n = 1)
Zhang et al.[33]	Post-lumbar puncture headache (n = 3)

DISCUSSION

The efficacy of radiofrequency varies depending on the anatomical target and the technique used. Evidence regarding the long-term efficacy of pulsed radiofrequency targeting the medial branches that innervate the facet joints is limited.[16]

In patients with chronic facet joint pain, Holtz and Sehgal[16] reported a 12.63% improvement in *Oswestry Disability Index* (ODI) scores and 47.68% pain relief three months after radiofrequency treatment of the facet joints. However, Truong et al.[26] found no statistically significant differences in pain intensity between radiofrequency and placebo in either the short or long term. In the study by Juch et al.,[20] radiofrequency did not result in clinically meaningful pain improvement compared with an exercise program at 3 or 12 months.

Studies that did not use pulsed radiofrequency targeting the medial branches of the facet joints reported better results. Moussa et al.[24] compared medial branch denervation with facet joint capsule denervation in patients with chronic facet joint pain. Their results were favorable in terms of short-term pain relief: after three months, more than 70% of patients in both groups had improved. After up to two years, the capsule denervation group maintained significant pain relief, whereas the effect was no longer significant in the other group.

In the study by Chang et al.,[18] which used intra-articular pulsed radiofrequency, pain decreased significantly for up to 6 months.

In the short term, radiofrequency ablation of the basivertebral nerve resulted in improvement in the ODI, with a mean reduction of 20.5 points. At longer-term follow-up (6 and 12 months), patients showed improvement compared with placebo.[27] Similarly, Khalil et al.[17] reported a statistically significant improvement of 20.9 points in the ODI and 2.44 points on the visual analog scale for pain.

When comparing radiofrequency with corticosteroid injections, Do et al.[23] reported that, at one month, pain had improved in patients who received intra-articular corticosteroid injections (dexamethasone plus bupivacaine) into the lateral facet joint. At 3 and 6 months, pain reduction was similar between patients treated with corticosteroid injections and those treated with radiofrequency; pain relief exceeded 50%, and 46.7% achieved satisfactory outcomes.

Regarding the combination of anesthetic injections and radiofrequency, Holz and Sehgal[16] concluded that pain decreased in patients who received medial branch blocks with 2% lidocaine and 0.75% bupivacaine plus radiofrequency neurotomy.

Similarly, De et al.[19] reported that pulsed radiofrequency applied to the dorsal root ganglion combined with a transforaminal epidural injection of local anesthetic reduced pain by 28% to 80%, with the effect lasting up to six months.

Radiofrequency can provide rapid analgesic relief in patients with discogenic low back pain. According to Chang et al.[29] and Napoli et al.,[30] pain reduction in patients receiving this treatment was statistically significant as early as the first month, which has been attributed to the ability of pulsed radiofrequency to alter synaptic transmission and reduce the expression of proinflammatory mediators. Long-term pain control remains controversial; however, the synergistic effect observed when radiofrequency is combined with intradiscal substances such as gelled ethanol resulted in adequate pain control in 80% of patients at 12 months, suggesting that a multimodal approach may be superior to monotherapy.[31]

The reviewed articles reported significant reductions in ODI scores. For example, Zhang et al.[33] observed a decrease in the ODI from 43.8 to 22.5 at one-year follow-up, whereas Li et al.[34] reported greater functional improvement during the first 6 months when intradiscal radiofrequency was combined with sinuvertebral nerve ablation, as well as a reduction in pain of more than 50% in 86.9% of patients at one year.

The limitations of this systematic review include the limited availability of studies with a low risk of bias, as only nine of the included studies met this criterion. This suggests that the available evidence remains limited in terms of sample size, methodological rigor, and study design for evaluating the effectiveness of radiofrequency denervation. In addition, heterogeneity among the studies precludes meaningful direct comparisons.

CONCLUSIONS

The efficacy of radiofrequency in patients with chronic lumbago with sciatica varies and depends on identifying the anatomical source of pain and selecting the appropriate technique. In cases of facet joint pain, short-term therapeutic success rates range from 47.68% to 70%, with improvements in the ODI of up to 20.5 points. However, these results are highly variable, and some studies have found radiofrequency to be no more effective than placebo. In the long term, the evidence is insufficient to support sustained pain relief, as only two articles targeting specific anatomical sites, such as the dorsal root ganglion and the facet joint capsule, reported pain relief at two-year follow-up.

There is no high-quality evidence indicating that radiofrequency provides prolonged pain relief in patients with chronic lumbago with sciatica. Specifically, in patients with discogenic pain, one study reported improvements in pain and function at one-year follow-up, with a success rate of 86.9%; however, the remaining studies combined radiofrequency with corticosteroids, gelled ethanol, or nerve ablation to increase its efficacy. For discogenic pain, targeting the dorsal root ganglion yielded better clinical outcomes than targeting other anatomical structures.

Although radiofrequency has a favorable safety profile and a low incidence of reported adverse events, its use remains controversial because of the decline in therapeutic effectiveness after one year of follow-up and its high cost. Therefore, the indication for this procedure should be based on an appropriate cost-effectiveness assessment.

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Treatment of Chronic Shoulder Dislocation with Reverse Shoulder Arthroplasty and Glenoplasty: A Case Report

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ABSTRACT
Glenohumeral dislocation is one of the most common joint dislocations, accounting for 45% of all cases. More than 90% are anterior dislocations. Chronic anterior shoulder dislocation is common in older patients; however, many cases are not diagnosed early, making treatment challenging. The objective of this article is to describe a glenoplasty technique using an autologous humeral head graft combined with reverse shoulder arthroplasty. We present the case of a 79-year-old woman with pain and functional impairment of the right shoulder of more than 3 years' duration. Her range of motion was 20° of forward flexion, 20° of extension, and 10° of abduction, with no external or internal rotation. Radiographs and computed tomography scans revealed bone loss in both the glenoid and the humeral head. Reverse shoulder arthroplasty was performed. Satisfactory outcomes were achieved in terms of range of motion, pain relief, and return to activities of daily living. **Conclusion:** This technique is useful in older patients with chronic dislocation and glenoid bone loss and provides satisfactory outcomes.
Keywords: Dislocation; arthroplasty; bone graft; glenoid, humeral head.
Level of Evidence: IV

Resolución de la luxación inveterada de hombro con una técnica de artroplastia invertida y glenoplastia. Reporte de un caso

RESUMEN
La luxación glenohumeral es una de las luxaciones articulares más frecuentes, representa el 45%. Más del 90% son luxaciones anteriores. La luxación anterior de hombro crónica es frecuente en pacientes añosos; sin embargo, muchas no se diagnostican de manera temprana y su tratamiento se convierte en un desafío. El objetivo de este artículo es comunicar una técnica de glenoplastia con injerto autólogo de la cabeza humeral y artroplastia invertida de hombro. Se presenta el caso de una paciente de 79 años que tenía dolor e impotencia funcional de hombro derecho de más de 3 años de evolución, y rangos de movilidad de 20° de flexión anterior, 20º de extensión, 10º de abducción, rotaciones externa e interna nulas. Las imágenes radiográficas y tomográficas revelaban pérdida de tejido óseo tanto en la glena como en la cabeza humeral. Se decidió realizar una artroplastia invertida de hombro. Se obtuvieron resultados satisfactorios en los rangos de movilidad, el alivio del dolor y el retorno a las actividades cotidianas. Conclusiones: Esta técnica es útil en pacientes mayores con luxación crónica y pérdida de tejido óseo en el componente glenoideo, y sus resultados son satisfactorios.
Palabras clave: Luxación; artroplastia; injerto óseo; glenoides; cabeza humeral.
Nivel de Evidencia: IV

INTRODUCTION

Glenohumeral dislocation is one of the most common joint dislocations, accounting for 45% of all dislocations. More than 90% are anterior dislocations.[1] Chronic anterior shoulder dislocation is common in elderly patients; however, many cases are not diagnosed early.

In elderly patients, associated injuries such as rotator cuff tears, fractures, and even osteonecrosis of the humeral head are common. Failure to diagnose the condition may lead to loss of shoulder function, early osteoarthritis,

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humeral head necrosis, instability, and even nerve injury.[2] Surgical treatment is indicated in the presence of instability and aims to improve pain, neurological symptoms caused by nerve compression or injury, function, and quality of life.[3,4]

The objective of this article is to present a technique involving glenoplasty with an autologous humeral head graft and reverse shoulder arthroplasty in a case of chronic anterior shoulder dislocation with glenoid bone loss.

CLINICAL CASE

A 79-year-old woman presented with right shoulder pain and functional limitation associated with paresthesia in the right upper limb for more than 3 years. Her pain had worsened over the previous year, prompting her family to bring her for consultation.

Physical examination revealed deltoid atrophy. The muscle was clinically functional and active, with no evidence of axillary nerve injury, which could have occurred given the duration of the dislocation; therefore, the atrophy was considered secondary to disuse. Range of motion was 20° of forward flexion, 20° of extension, and 10° of abduction, with no external or internal rotation. Anteroposterior and lateral radiographs of the right shoulder showed loss of glenohumeral joint congruity with a humeral bone defect (Figure 1).

Figure 1. Anteroposterior and lateral radiographs of the right shoulder showing loss of glenohumeral joint congruity with a humeral bone defect.

Computed tomography confirmed anterior loss of glenohumeral joint congruity, with anatomic changes in the glenoid, a significant anterior glenoid bone defect of 30%, classified as type D according to the modified Walch classification, and 50% erosion of the humeral head (Figure 2).

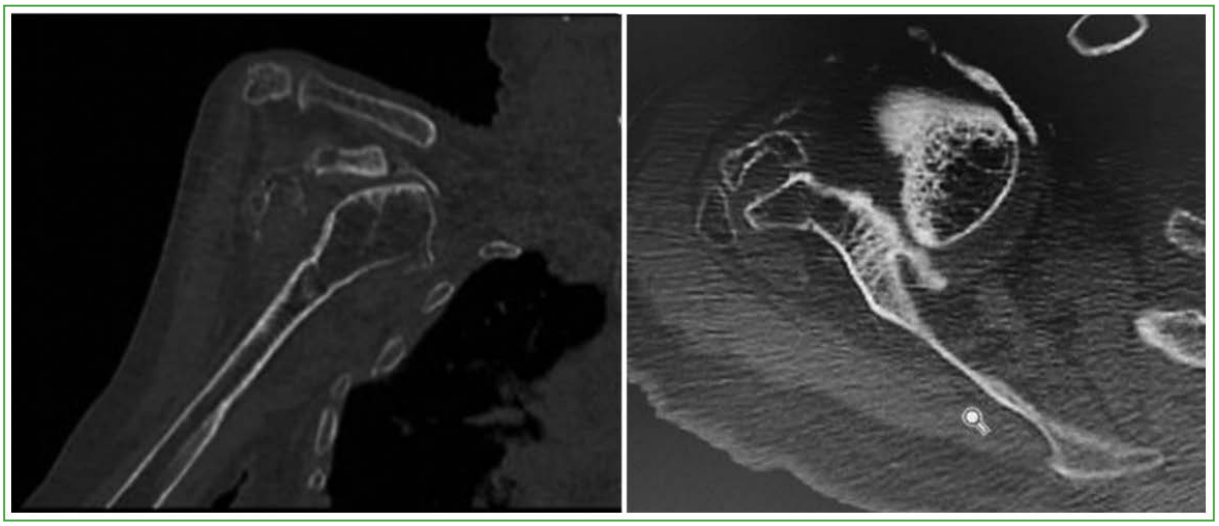

Figure 2. Representative CT images showing the dislocated humeral head impacted anteriorly and an axial view demonstrating anatomic changes in the glenoid with an anterior bone defect >30%.

The patient was placed in the beach-chair position under general anesthesia. Through a deltopectoral approach, an osteotomy of the humeral head was performed. The glenoid was then prepared for placement of an autologous graft obtained from a portion of the humeral head. The graft was shaped to fit the defect and fixed with cannulated screws. A glenoid component (size 36), a glenosphere (size 36), and a 10-mm-diameter uncemented humeral stem with a porous metaphyseal surface for osseointegration were implanted. In this case, bone cement was used to provide rotational stability at the distal end of the stem, which lacks a porous surface. The tuberosities were repaired with high-strength sutures (Figures 3-5).

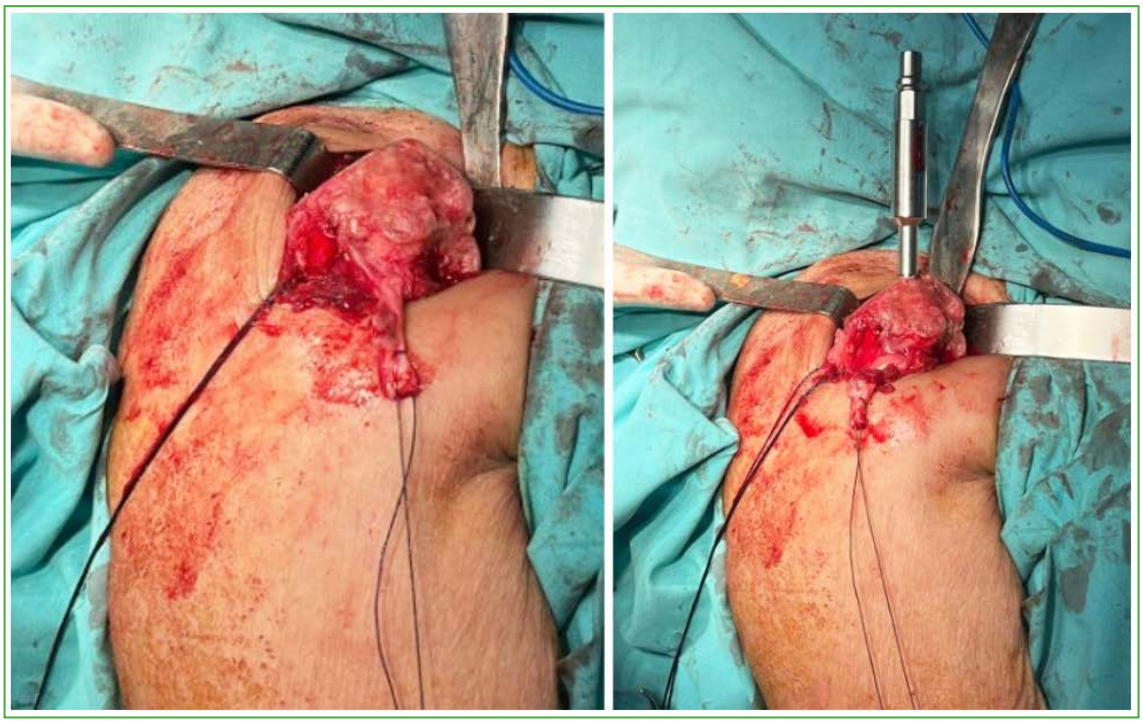

Figure 3. Exposure of the humeral head and insertion of the guide for humeral osteotomy. The humeral head defect is visible.

Figure 4. Exposure of the glenoid region. The initial glenoid defect is shown, followed by the reconstructed glenoid after placement of the autologous humeral head graft.

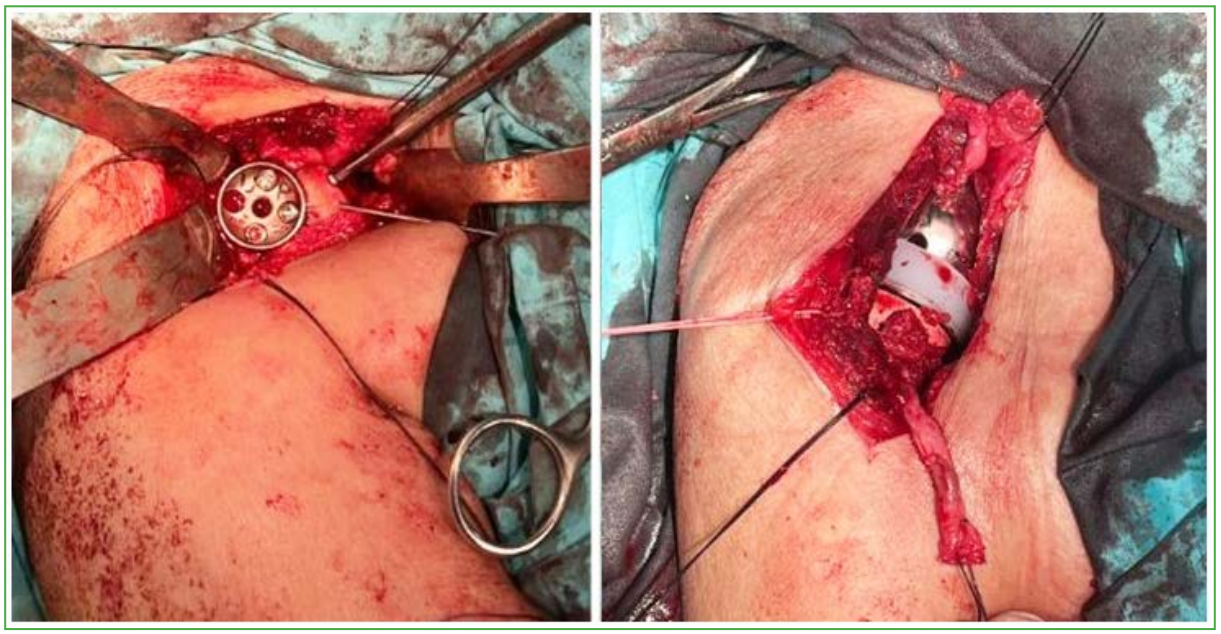

Figure 5. Placement of the glenoid component on the reconstructed glenoid. The prosthesis is shown in place and reduced.

Postoperatively, the patient wore a sling for one month and was followed weekly. During the first week, pendulum exercises without resistance were prescribed. Beginning in the third week, assisted active and passive range-of-motion exercises were initiated under the supervision of a physical therapist. Finally, progressive muscle-strengthening exercises were initiated at the sixth week, with assessment of range of motion.

At 18 months, range of motion was 80° of forward flexion, 40° of abduction, 20° of external rotation, and 20° of internal rotation.

Follow-up radiographs showed adequate osseointegration of the prosthesis and congruity of its components (Figure 6).

The ASES (*American Shoulder and Elbow Surgeons*) score was 70, which we considered indicative of an adequate return to functional activities.

Figure 6. Follow-up anteroposterior and lateral radiographs of the right shoulder. The components are congruent, and the screws securing the graft show no evidence of loosening.

DISCUSSION

The exact timeframe for defining a shoulder dislocation as chronic is not clearly established in the literature. Some authors define it as a dislocation persisting for >3 weeks.[5] Diagnosis is often delayed in elderly patients with low functional demands because of factors such as an incomplete physical examination and inadequate radiographic assessment.

The diagnosis is confirmed by radiographs. Computed tomography may be obtained for more accurate assessment and treatment planning. Based on CT findings, our case was classified as type D according to the modified Walch classification, defined as any degree of glenoid anteversion or anterior subluxation of the humeral head <40%.

This definition is based on the modified Walch classification, which describes glenoid morphology in primary glenohumeral osteoarthritis.[6] The modified Walch classification adds types B3 and D and redefines types A2 and C.

Type A: centered humeral head, concentric wear, and no humeral head subluxation. A1: minor central erosion. A2: substantial central erosion, with the humeral head protruding into the glenoid cavity.

Type B: posteriorly subluxated humeral head and a biconcave glenoid with asymmetric wear. B1: posterior joint-space narrowing, subchondral sclerosis, and osteophytes. B2: biconcave glenoid with posterior rim erosion and glenoid retroversion. B3: monoconcave glenoid with posterior wear and retroversion >15° or posterior humeral head subluxation >70%, or both.

Type C1: dysplastic glenoid with retroversion >25°, regardless of erosion.

Type C2: biconcave glenoid with posterior bone loss and posterior translation of the humeral head.

Type D: glenoid anteversion or anterior subluxation of the humeral head <40%.[1]

Bone defects of the humeral head and glenoid, together with soft-tissue contractures, make these injuries challenging to treat.

Reverse shoulder arthroplasty became widely used for the treatment of rotator cuff arthropathy, and its indications have expanded to include patients with extensive soft-tissue involvement and poor bone quality.[7]

Accordingly, reverse shoulder arthroplasty is indicated in patients with chronic glenohumeral dislocations, particularly elderly patients, those with humeral head defects involving >40% of the articular surface, significant glenoid bone loss, irreparable rotator cuff tears, nerve compression or injury, and dislocations of more than 6 months' duration.[8]

Statz et al. compared 3 hemiarthroplasties, 7 total shoulder arthroplasties, and 9 reverse shoulder arthroplasties performed in 21 patients (7 with glenoid defects reconstructed using a humeral head autograft), with a 2-year follow-up. The authors reported that reverse shoulder arthroplasty was superior in terms of stability and reoperation rates.[9]

Frías et al. reported the follow-up of six patients with chronic anterior shoulder dislocation treated with reverse shoulder arthroplasty. One patient had anterior glenoid bone loss that was also treated with an autologous humeral head graft. The authors concluded that reverse shoulder arthroplasty for this chronic condition, even in the presence of correctable bone defects, provides good functional outcomes.[10]

Our patient had no complications during follow-up. However, in one of the series with longer follow-up, Matsoukis et al. compared reverse shoulder arthroplasty in patients with primary osteoarthritis and those with chronic dislocation. They reported better outcomes and fewer complications in patients with primary osteoarthritis, although patients with chronic dislocation also achieved good outcomes in terms of function and quality of life. Complications associated with reverse shoulder arthroplasty included postoperative instability and glenoid component failure.[11]

CONCLUSIONS

Chronic glenohumeral dislocations are underdiagnosed injuries that generally occur in elderly patients. Because diagnosis is often delayed, treatment selection can be challenging. In the presence of soft-tissue injuries and associated bone defects, reverse shoulder arthroplasty is considered a good treatment option because glenoid bone defects can be reconstructed with autologous grafts, providing good stability and satisfactory functional outcomes.

We consider this technique a good treatment option for patients with the conditions described.

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

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Surgical Repair of Distal Pectoralis Major Tendon Avulsion Sustained during Sports: Our Experience. A Case Report

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ABSTRACT

Pectoralis major tendon rupture is an uncommon injury that occurs in weightlifters and rugby players. The objective of this article is to report a clinical case, including its diagnosis and treatment, compare it with similar cases in the published literature, and describe our experience in its management. We present the case of a 45-year-old man with acute pain of 1 week's duration following physical activity. Physical examination revealed pectoral asymmetry, extensive ecchymosis, and loss of the deltopectoral groove. A deltopectoral approach was used, and three anchors were placed in a double-row configuration. There were no complications, and the patient regained full range of motion and resumed his usual sports activity 6 months after surgery. **Conclusion:** The outcomes and complications were similar to those reported in the literature reviewed, although there is no consensus regarding the material to be used for surgical repair. An accurate diagnosis should be made and appropriate treatment indicated to prevent future complications.

Keywords: Muscle tear; pectoralis major; anchors; humerus; arm; sports.

Level of Evidence: IV

Reparación quirúrgica del pectoral mayor por desinserción distal durante la práctica deportiva. Nuestra experiencia. Reporte de caso

RESUMEN

La rotura del tendón del pectoral mayor es una lesión poco común que ocurre en levantadores de pesas y jugadores de *rugby*. El objetivo de este artículo es comunicar un caso clínico, su diagnóstico y el tratamiento, compararlo con casos similares publicados, y concluir con nuestra experiencia para su resolución. Presentamos a un paciente de 45 años que refiere dolor agudo de una semana de evolución luego de realizar actividad física. En el examen físico, se detecta asimetría pectoral, un hematoma extenso y borramiento del surco deltopectoral. Se realizó un abordaje deltopectoral y se colocaron 3 anclajes en doble hilera. No hubo complicaciones y el paciente recuperó la movilidad completa y reanudó su actividad deportiva habitual a los 6 meses de la cirugía. **Conclusiones:** Los resultados y las complicaciones según la bibliografía analizada fueron similares, si bien no hay un consenso sobre qué material utilizar para la reparación quirúrgica. Se debe realizar un diagnóstico correcto e indicar el tratamiento apropiado para evitar futuras complicaciones.

Palabras clave: Desgarro muscular; pectoral mayor; anclajes; húmero; brazo; deporte.

Nivel de Evidencia: IV

INTRODUCTION

Muscle injuries due to overload are very common, particularly in sports. The muscles most frequently affected are those that cross two joints, act predominantly eccentrically, and contain a high proportion of fast-twitch fibers.[1] Pectoralis major tendon rupture is a rare injury that occurs primarily in men who participate in sports such

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as rugby or weightlifting.[2] The pectoralis major muscle has a broad origin; its muscle fibers form two heads, the sternal and clavicular heads, which converge to form a common tendon that inserts on the lateral lip of the bicipital groove.[2]

These injuries occur when the muscle is subjected to sudden stretching as a result of abrupt elongation during eccentric contraction. The pathologic lesion invariably involves the muscle fibers closest to the myotendinous junction. Several grades are distinguished according to severity: grade 1, tearing of a few muscle fibers; grade 2, tearing of a greater number of fibers with intact fascia; grade 3, tearing of multiple fibers with fascial disruption; and grade 4, complete rupture of the muscle and fascia. In the latter case, surgical repair is the only indicated treatment.[3]

Typical symptoms include severe pain during physical activity, swelling, and functional impairment. Complete injuries may produce an "axe-blow" sign, while extensive injuries may result in hematoma formation.[3] Musculoskeletal ultrasound and magnetic resonance imaging (MRI) are complementary studies used to support the diagnosis.[1,3]

Ultrasound is the imaging modality of choice for diagnosing muscle injuries. Its main role is to confirm the clinical suspicion, determine the location of the injury, and assess its extent. [3]

The pectoralis major is generally divided into two portions, clavicular and costosternal, which converge to form a common tendon that inserts distally on the lateral lip of the bicipital groove of the humerus.[4]

Pectoralis major tendon tears are classified according to type, location, and extent; however, most authors agree that acute tears are those of less than 3-6 weeks' duration.[5] Ecchymosis, swelling, and severe pain associated with acute injuries can make the initial clinical diagnosis difficult and differentiation between complete and partial tears challenging.[5,6]

Ultrasound can be used to diagnose pectoralis major injuries and accurately characterize the tear. It may show avulsion of the tendon from its humeral insertion, with a wavy appearance; in other cases, the tendon cannot be visualized. Hyperechoic fluid may also be observed adjacent to the humeral cortex and along the tendon bed due to the associated hematoma.[7,8]

The objective of this article is to report a clinical case, including its presentation, diagnosis, and treatment; compare it with similar cases reported in the literature; analyze the differences; and present our experience with its management.

CLINICAL CASE

A 45-year-old man with no relevant medical history and a history of nonmedical anabolic-androgenic steroid use presented with acute pain that had begun one week earlier while performing a 120-kg flat bench press at the gym. He was admitted to the emergency department for observation and received intravenous hydration and corticosteroids. Compartment syndrome was ruled out in the setting of an extensive brachiothoracoabdominal hematoma. Physical examination revealed pectoral asymmetry, hematoma, loss of the deltopectoral groove, and limited left glenohumeral adduction due to pain. Musculoskeletal ultrasound showed a complete tear of the pectoralis major tendon at its humeral insertion.

MRI showed an extensive area of fiber disruption with heterogeneous signal intensity in the superolateral portion of the left pectoralis major, accompanied by fluid collections and measuring approximately 123 x 73 mm, consistent with a tear and avulsion involving the humeral insertion (Figure 1).

No involvement of the clavicular portion at the level of the pectoralis minor was detected. This finding was accompanied by an extensive deep fluid collection between the pectoralis major and minor muscles, corresponding to a hematoma measuring approximately 12 x 33 mm (Figure 2).

The patient provided informed consent for publication of the case and clinical images.

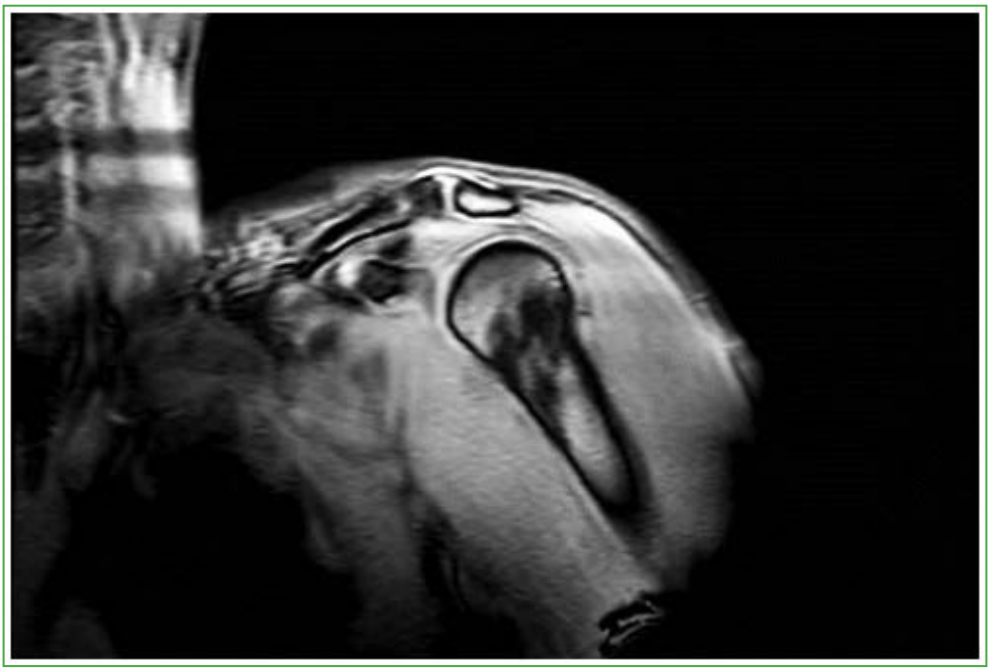

Figure 1. Coronal MRI of the shoulder showing an extensive area of fiber disruption with heterogeneous signal intensity in the superolateral portion of the pectoralis major.

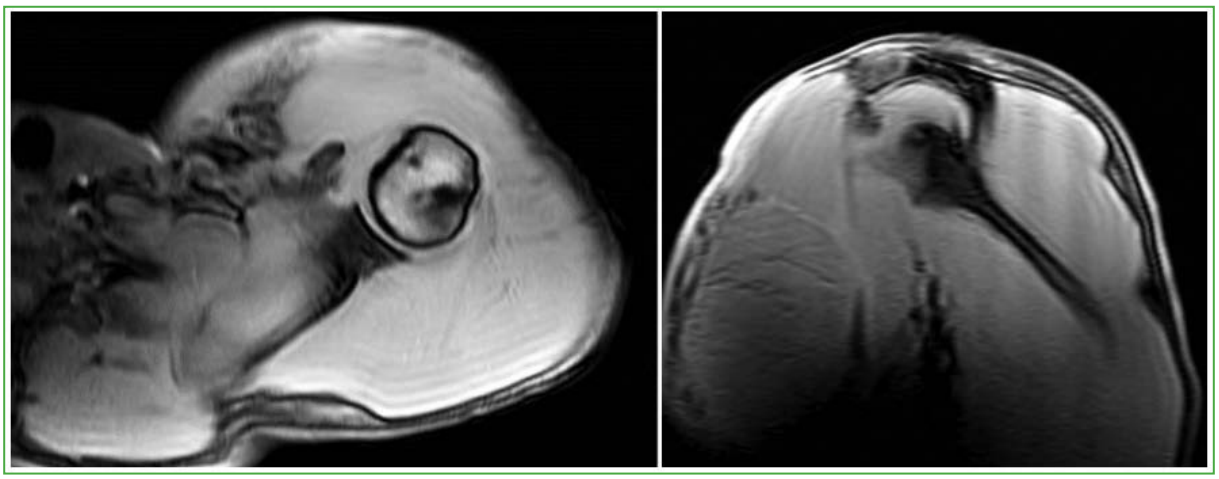

Figure 2. Axial MRI of the shoulder showing an extensive deep fluid collection between the pectoralis major and minor muscles, corresponding to a hematoma measuring approximately 12 x 33 mm.

Surgical Technique

The patient was placed under general anesthesia in the beach-chair position with the operating table inclined at 45°. A deltopectoral approach to the left shoulder was performed. During exploration, the pectoralis major tendon was identified and found to be retracted. It was repaired with a Vicryl® suture (Figure 3). Three 2.7-mm anchors were then placed in a double-row configuration along the lateral edge of the bicipital groove (Figures 4 and 5).

Figure 3. Deltopectoral approach, exploration of the muscle plane, and identification and traction of the pectoralis major with forceps.

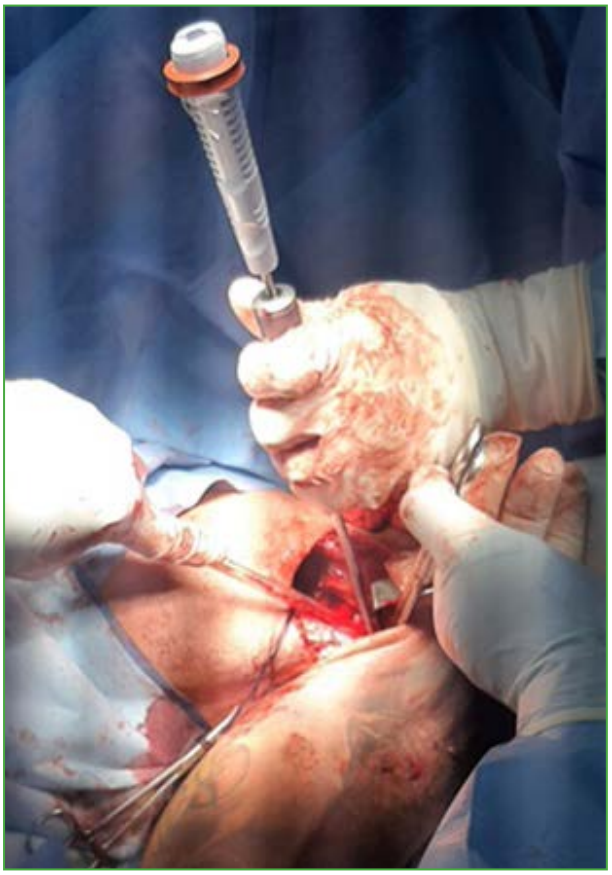

Figure 4. Placement of anchors in the proximal humerus.

Figure 5. Placement of three anchors in the proximal humerus.

To optimize visualization of the anatomical landmarks, the deltoid and the clavicular head of the pectoralis major were retracted (Figure 6).

The sutures were then passed through the myotendinous junction (Figure 7) and tied. Finally, the wound was closed in anatomical layers, with an intradermal skin closure (Figures 8 and 9).

Figure 6. Placement of three anchors in a double-row configuration from the pectoralis major to the bicipital groove and greater tuberosity of the humerus.

Figure 7. Anchors placed along the edge of the bicipital groove and in the greater tuberosity, with sutures passed through the pectoralis major.

Figure 8. Layered closure with myorrhaphy of the pectoralis major and deltoid muscles.

Figure 9. Intradermal skin closure.

Immediately after surgery, the patient was immobilized in a Vietnam shoulder sling for 4 weeks. During this period, he began pendulum exercises and flexion-extension exercises of the elbow 5 times a day, supplemented with physical therapy. Return to sports was allowed at 3 months, and return to the gym with moderate loads was planned for 6 months.

The patient had a favorable course without complications. Six months after surgery, he had regained full range of motion and returned to his usual physical and sports activities.

The modified Constant-Murley score indicated a poor functional score (<50) before surgery. Three months after surgery, the functional outcome was fair (70 points); at 6 months, it was good (85 points); and at 1 year, it was excellent (90 points).

DISCUSSION

Some authors, such as De Cicco et al., reported clinical and cosmetic improvement with treatment in both the acute and chronic stages and noted that direct repair can be performed using suture anchors, cortical button fixation, or transosseous sutures.[2] In a case report, Arismendi et al. noted that the use of conventional MRI for the diagnosis of pectoralis major tendon ruptures has been questioned. Nevertheless, most authors agree that MRI is the diagnostic method of choice for acute complete avulsion of the tendon from its humeral insertion.[6]

In a study of 36 surgically treated pectoralis major tears, Chang et al. reported that MRI is highly useful in acute pectoralis major injuries when the technologist and radiologist are aware of the suspected injury.[9]

Compared with conservative treatment, surgical treatment provides better functional outcomes, with recovery of strength and shoulder range of motion. Surgical techniques using anchors, screws, or staples have also been reported, all with satisfactory results. This technique provides good functional outcomes, is minimally invasive, and carries a low risk of neurovascular injury.[10]

Eid Caballero used botulinum toxin as an initial procedure to relax the pectoralis muscle bundles, prevent retraction, and allow tension-free closure. In a second stage, mesh placement was considered to reinforce the repair of the torn area.[11]

In controlled laboratory studies involving 24 cadaveric shoulders, Sherman et al. evaluated different fixation methods and found no statistically significant differences with respect to age, bone density, sex, or shoulder laterality. Failure patterns were similar in all groups and occurred at the tendon-suture interface.[12]

Butt et al., in a comprehensive literature review and expert opinion, noted that chronic injuries in which primary reconstruction is not possible may be repaired using autografts such as hamstring tendon, fascia lata, or patellar tendon grafts.[13] In a meta-analysis of 112 cases, Bak et al. reported that surgical treatment was superior to conservative treatment and recommended surgery for complete tears. They also reported better outcomes in patients who underwent surgical repair during the acute stage (0-8 weeks) than in those treated during the chronic stage (9-52 weeks).[2,6,14]

In recent years, tendon ruptures and injuries have been associated with anabolic steroid use. These substances have been shown to induce changes in tendons that result in decreased elongation and a lower force required to produce tendon failure under maximal stress.[10,15]

The modified Constant-Murley score was used to assess shoulder function before surgery and at 3, 6, and 12 months. This tool includes both subjective and objective components and is divided into four subscales: pain (maximum, 15 points), activities of daily living (maximum, 20 points), range of motion (maximum, 40 points), and strength (maximum, 25 points). Higher scores indicate better function (range, 0-100). Scores of 0-55 indicate a poor outcome; 56-70, a fair outcome; 71-85, a good outcome; and >86, an excellent outcome.[16]

In our experience, imaging studies such as ultrasound and MRI were highly useful for diagnosis and surgical planning. Surgical treatment consisted of exploration and identification of the pectoralis major, followed by repair using anchors in a double-row configuration.

The severity of this type of injury in weightlifters, as in our case, should be emphasized, given the substantial loads involved in this sport.

CONCLUSIONS

The outcomes and complications reported in the literature were similar, although there is no consensus regarding the optimal material for surgical repair. Accurate diagnosis and appropriate treatment are essential to prevent complications. In our experience, surgical treatment consisting of exploration of the injury, identification of the pectoralis major, and reattachment to its insertion site using three anchors in a double-row configuration, followed by early rehabilitation, allowed the patient to return to his usual activities without complications.

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Subungual Bizarre Parosteal Osteochondromatous Proliferation: A Unique Case Report

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ABSTRACT

Introduction: Bizarre parosteal osteochondromatous proliferation (BPOP), also known as Nora's lesion, is a rare benign condition that predominantly affects the short bones of the hands and feet. Its subungual presentation is exceedingly rare. Differentiating it from malignant tumors is essential. We present the case of a 32-year-old man with a painful, progressively enlarging mass in the nail bed of the right second toe. Radiographs and computed tomography revealed a well-defined juxtacortical lesion without continuity with the medullary canal. Complete excision of the tumor, including the periosteum and superficial cortex, was performed, followed by nail-bed reconstruction. Histopathological examination confirmed the diagnosis of Nora's lesion. No recurrence was detected during follow-up, and full functional recovery was achieved. **Conclusions:** Recognition of this entity is essential to avoid diagnostic errors and unnecessarily aggressive surgery. Wide resection encompassing the affected cortical bone and periosteum is the treatment of choice to reduce the risk of recurrence.

Keywords: Nora's lesion; bizarre parosteal osteochondromatous proliferation; subungual tumor; bone neoplasms; toe.
Level of Evidence: IV

Proliferación osteocondromatosa parostal atípica subungueal: presentación de un caso único

RESUMEN

Introducción: La proliferación osteocondromatosa parostal atípica, conocida también como lesión de Nora, es una alteración benigna y poco frecuente que afecta, de forma predominante, a los huesos cortos de manos y pies. Su presentación subungueal es excepcional. Es clave su diagnóstico diferencial con tumores malignos. Se presenta el caso de un hombre de 32 años con una tumoración dolorosa, de crecimiento progresivo, en el lecho ungueal del segundo dedo del pie derecho. La radiografía y la tomografía computarizada mostraron una lesión yuxtacortical bien delimitada, sin continuidad con el canal medular. Se realizó la exéresis completa del tumor, inclusive el periostio y la cortical superficial, y la reconstrucción posterior del lecho ungueal. El examen histopatológico confirmó el diagnóstico de lesión de Nora. En el seguimiento, no se detectó recidiva y la recuperación funcional fue completa. **Conclusiones:** El reconocimiento de esta entidad es esencial para evitar errores diagnósticos y cirugías innecesariamente agresivas. La resección amplia, que incluya el hueso cortical y el periostio afectado, es el tratamiento de elección para reducir el riesgo de recurrencia.

Palabras clave: Lesión de Nora; proliferación osteocondromatosa parostal atípica; tumor subungueal; tumores óseos; dedo del pie.
Nivel de Evidencia: IV

INTRODUCTION

Atypical parosteal osteochondromatous proliferation was first described by Nora et al. in 1983 as an exophytic osteocartilaginous mass arising from the cortical surface, generally without medullary continuity.[1] Since then, fewer than 200 cases have been reported.[2]

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Its etiopathogenesis remains unknown. Two main hypotheses have been proposed: a reactive process following repetitive microtrauma or a possible neoplastic origin.[3]

Its occurrence in the subungual region is exceptional and poses a diagnostic challenge because of its similarity to both benign and malignant lesions, including osteochondroma, periosteal chondroma, and parosteal osteosarcoma.[4,5] Therefore, definitive diagnosis requires correlation of clinical, radiographic, and histopathological findings.

CLINICAL CASE

A 32-year-old man with no history of trauma presented with pain and progressive swelling of the second toe of the right foot, accompanied by partial ulceration of the nail.

Physical examination revealed a firm, nonmobile mass adherent to the deep tissues, with mild local signs of inflammation.

Radiographs showed a well-defined juxtacortical lesion without medullary involvement, consistent with a slow-growing lesion. Computed tomography confirmed cortical integrity and the absence of soft-tissue invasion (Figure 1).

Figure 1. A. Intraoperative image. **B–D.** Anteroposterior and oblique radiographs of the right foot. **D.** Coronal computed tomography image of the second toe of the right foot showing a well-defined, exophytic, juxtacortical lesion without continuity with the medullary canal.

En bloc excision of the tumor, including the periosteum and underlying cortex, was performed, followed by reconstruction of the nail bed (Figures 2 and 3). Histopathological examination revealed immature bone trabeculae covered by hyaline cartilage without cellular atypia, findings consistent with atypical parosteal osteochondromatous proliferation.

Figure 2. Intraoperative sequence of the surgical procedure showing exposure of the subungual lesion, en bloc resection, and closure after reconstruction of the nail bed.

Figure 3. Surgical specimen obtained after complete excision of the lesion.

The postoperative course was favorable, with no complications during follow-up. Clinical and radiographic follow-up showed no recurrence, and the patient fully recovered function and sensation in the second toe (Figures 4 and 5).

The patient provided written informed consent for publication of this case.

Figure 4. Clinical outcome 2 weeks after surgery.

Figure 5. Clinical outcome at the end of follow-up, showing complete functional recovery and a satisfactory cosmetic outcome of the second toe.

DISCUSSION

Atypical parosteal osteochondromatous proliferation is a benign entity with the potential for local recurrence. It most commonly affects young adults and typically involves the short bones of the hands and feet.[6]

On imaging, it appears as a well-defined, exophytic, juxtacortical mass without periosteal reaction or continuity with the medullary canal, which helps differentiate it from malignant lesions such as parosteal osteosarcoma.[7,8] Computed tomography and magnetic resonance imaging allow precise assessment of its extent, cartilaginous component, and relationship to adjacent structures.[9]

Histologically, it is characterized by immature bone, cartilage, and disorganized fibrovascular stroma. Mild chondrocyte atypia and basophilic matrix may be present, features that can also be encountered in some malignant lesions.[4]

The recommended treatment is complete resection together with the adjacent periosteum and cortex to reduce the risk of recurrence. Recurrence rates of up to 50% after incomplete resection have been reported in some series.[10] In our patient, wide resection prevented recurrence during follow-up and allowed full functional recovery.

Despite its locally aggressive behavior, atypical parosteal osteochondromatous proliferation has an excellent prognosis after complete surgical resection. To date, no secondary malignant transformation has been reported.[11]

CONCLUSIONS

Nora lesion should be considered in the differential diagnosis of painful subungual masses. Clinical and radiographic recognition is essential to guide the diagnosis and avoid unnecessary treatment. Wide surgical excision provides excellent functional outcomes with a minimal risk of recurrence.

AI Use Statement

ChatGPT (OpenAI) was used to assist in translating the abstract's content. The authors verified the accuracy and originality of the AI-generated content.

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Dupuytren Disease: Planning Surgical Approaches

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ABSTRACT
Dupuytren disease is a fibroproliferative disorder of the palmar fascia that causes flexion contractures and functional impairment. Its course is variable, and recurrence rates are high; therefore, surgery remains the mainstay of treatment for patients with advanced disease. The anatomical complexity of the palmodigital region and the heterogeneous presentation of the disease make careful planning of the surgical approach essential to optimizing outcomes. Knowledge of the anatomy of the palmar aponeurosis and its digital extensions allows the cords and their relationship to the neurovascular structures to be identified, which is crucial for safe resection. The choice of skin incision should be based on the extent of the disease, the number of digits and joints involved, the anatomical pattern, and the condition of the skin, rather than on the degree of contracture. The main incision options (longitudinal, transverse, and combined) as well as dermofasciectomy in selected cases are discussed, together with the authors' preferences. Although minimally invasive alternatives are available, fasciectomy continues to provide more durable results. Appropriate planning can improve exposure, reduce complications, and optimize functional outcomes.
Keywords: Dupuytren contracture; fasciectomy; palmar fascia; flexion contracture.
Level of Evidence: V

Enfermedad de Dupuytren: planificación de los abordajes quirúrgicos

RESUMEN
La enfermedad de Dupuytren es un cuadro fibroproliferativo de la fascia palmar que genera contracturas en flexión y deterioro funcional. Su evolución es variable y la tasa de recurrencia es alta, por lo que la cirugía sigue siendo el tratamiento principal en pacientes con estadios avanzados. La complejidad anatómica de la región palmodigital y la presentación heterogénea hacen que la planificación del abordaje quirúrgico sea determinante para optimizar los resultados. El conocimiento de la anatomía de la aponeurosis palmar y sus prolongaciones digitales permite identificar las cuerdas y su relación con las estructuras neurovasculares, lo que resulta clave para una resección segura. La elección del abordaje cutáneo debe basarse en la extensión de la enfermedad, la cantidad de dedos y articulaciones comprometidos, el patrón anatómico y el estado de la piel, más que en el grado de contractura. Se analizan las principales opciones de incisión (longitudinales, transversales y combinadas), así como la dermofasciectomía en casos seleccionados, junto con las preferencias de los autores. Aunque existen alternativas mínimamente invasivas, la fasciectomía sigue ofreciendo resultados más duraderos. Una adecuada planificación permite mejorar la exposición, reducir complicaciones y optimizar los resultados funcionales.
Palabras clave: Enfermedad de Dupuytren; fasciectomía; fascia palmar; contractura en flexión.
Nivel de Evidencia: V

INTRODUCTION

Dupuytren's disease is a condition of the hand characterized by pathological proliferation of the palmar fascia, with the formation of nodules and cords that cause flexion contractures and functional impairment.[1] Its course is variable and unpredictable, with varying degrees of severity and a tendency to recur. Several treatment options are available; however, surgery remains the most commonly used treatment.

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The anatomical complexity of the palmodigital region and the variability in disease extent make surgical approach planning essential to achieve adequate release and optimize outcomes. Despite the numerous techniques described, there is no clear systematic approach to guide the selection of the surgical approach for each patient.

The objective of this article is to present a practical approach to planning surgical approaches in patients with Dupuytren's disease.

SURGICAL ANATOMY

A detailed understanding of the anatomy of the palmar aponeurosis and its digital extensions is essential for appropriate surgical planning in patients with Dupuytren's disease, in order to achieve complete resection of pathological tissue and reduce the risk of injury to neurovascular structures, which are frequently displaced by the disease.

The palmar aponeurosis is a complex three-dimensional system whose primary functions are to protect the deep structures and stabilize the skin during grasping.[2] Anatomically, it is divided into three regions: the central, thenar, and hypothenar palmar aponeuroses, with the central region being the most frequently affected (Figure 1).[2,3]

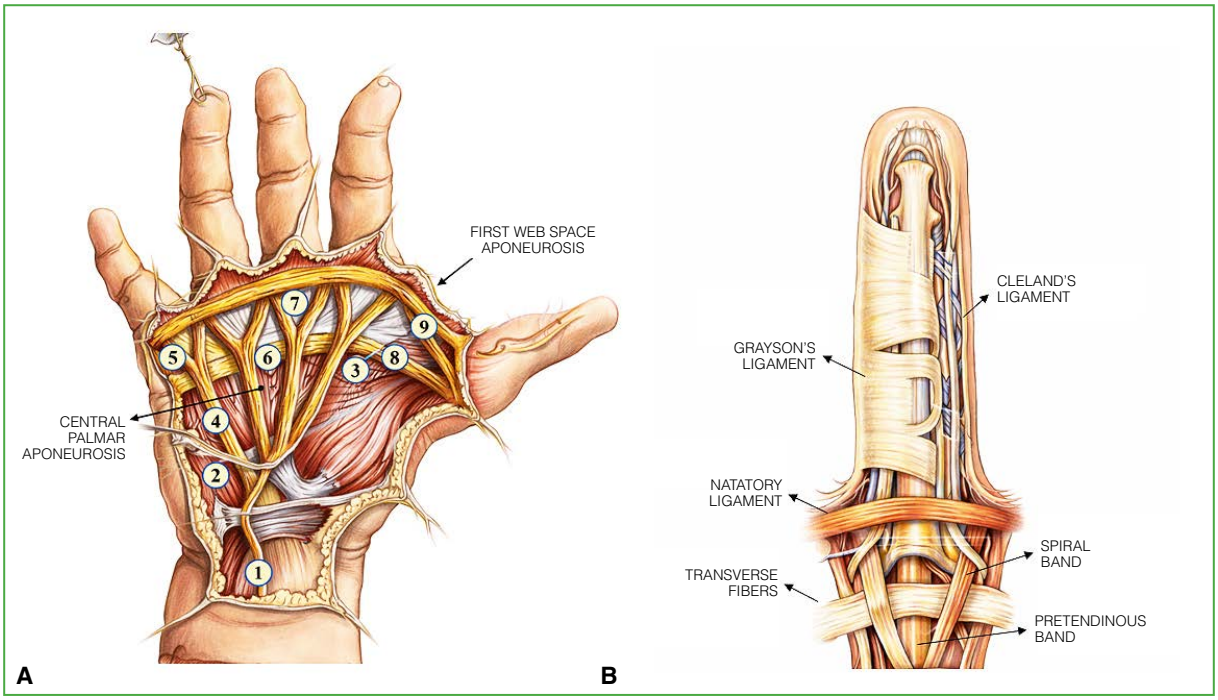

Figure 1. A. Middle palmar aponeurosis. 1. Palmaris brevis. 2. Hypothenar aponeurosis. 3. Thenar aponeurosis. 4. Pretendinous bands. 5. Spiral band. 6. Deep transverse fibers. 7. Natatory ligament. 8. Proximal commissural ligament. 9. Distal commissural ligament. **B.** Palmodigital aponeurosis.

Central Palmar Aponeurosis

It is shaped like an inverted triangle, with its proximal apex at the palmaris longus tendon, when present, and consists of three fiber systems:

• *Longitudinal fibers (pretendinous bands):* These run from proximal to distal toward the fingers and constitute the main anatomical substrate for cord formation in Dupuytren's disease. Some terminate in the skin of the distal palmar crease (Grapow fibers), whereas others attach to the flexor tendon sheath and extend toward the vicinity of the extensor tendon. Most divide into two bands that surround the metacarpal heads, forming the spiral band (Gosset fibers), which continues into the natatory ligament and the lateral digital sheet.[2,3]

• *Transverse fibers:* Located deep at the level of the distal palmar crease, these fibers have a stabilizing function and, unlike other structures, are rarely affected by the disease.[2,3]

• *Vertical or sagittal fibers (septa of Legueu and Juvara):* These connect the dermis to the deep planes, delimiting compartments through which the tendons and neurovascular bundles run alongside the lumbrical tendon.[2,3]

Palmodigital Aponeurosis

This is a critical transition zone from a surgical standpoint, where multiple structures intersect:

• *Natatory ligament:* A system of transverse fibers that forms the interdigital commissures. Its involvement may result in commissural cords that limit finger abduction.[2,3]

• *Spiral bands and lateral digital sheet:* Derived from the pretendinous bands, these structures pass deep to the neurovascular bundle and the natatory ligament before inserting into the lateral digital sheet. They contribute to the formation of spiral cords, which can encircle and displace the neurovascular bundle, thereby increasing the risk of injury during surgery.[2,3]

Digital Aponeurosis

In the fingers, the fascia is organized in relation to the neurovascular bundle and the extensor mechanism:

• *Grayson's ligament (volar) and Cleland's ligament (dorsal):* These stabilize the digital skin and delimit the neurovascular tunnel. Thomine also described a retrovascular fascia consisting of fibers located dorsal to the neurovascular bundle and volar to Cleland's ligament.[2,3]

• *Lateral digital sheet and retinacular structures:* These structures contribute to force transmission and the progression of contracture toward the interphalangeal joints. The lateral digital sheet originates at the commissure from fibers of the natatory ligament and spiral band. Some of these fibers insert into the periosteum of the adjacent phalanx, the joint capsule, and the tendon sheaths.[2]

Anatomical Implications of the Disease

From a surgical standpoint, it is essential to recognize the different types of cords (pretendinous, central, lateral, abductor digiti minimi, retrovascular, and spiral), as their anatomical arrangement determines:

- the pattern of contracture,
- the relationship with the neurovascular bundle, and
- the risk of injury during dissection.

In particular, spiral cords can displace the neurovascular bundle into a more superficial and central position, creating one of the highest-risk scenarios during surgical dissection.[2,3]

Planning the Surgical Approaches

The surgical goals in patients with Dupuytren's disease, as proposed by Tubiana, include correction of deformities, prevention of complications, reduction of recovery time, and, ideally, reduction of the risk of recurrence.[4]

Since there is no curative treatment, management is essentially symptomatic and aimed at correcting contractures. However, no treatment has completely eliminated the risk of recurrence or disease progression.[5]

Three fundamental aspects must be considered in surgical planning: 1) management of the skin, 2) management of the fascia, and 3) management of joint contracture, particularly at the proximal interphalangeal joint.[5] In this article, we focus specifically on the cutaneous component.

Planning the skin incision is one of the main challenges in the surgical treatment of this disease, as it determines exposure of the underlying structures, the possibility of complete resection of pathological tissue, and the final functional outcome. Incisions should be planned individually for each patient, taking into account the location of the disease (palmar or digital), the type of contracture (metacarpophalangeal or interphalangeal), the number of involved fingers, associated deformities, and skin quality.

Skin management options include incision or excision, the latter performed en bloc with the fascia as a dermo-fasciectomy.[5] When skin replacement is required, a full-thickness skin graft harvested from various donor sites is usually the first option considered.

Since Dupuytren's original description, numerous incision techniques have been proposed for the surgical treatment of this disease (Figure 2).[2] Transverse incisions, which were initially used, were gradually replaced because they were associated with scar contracture and greater vascular compromise. Currently, longitudinal incisions are preferred because they allow the exposure to be extended as needed. In cases of advanced disease involving multiple fingers, combined incisions incorporating both longitudinal and transverse components may be used.[5]

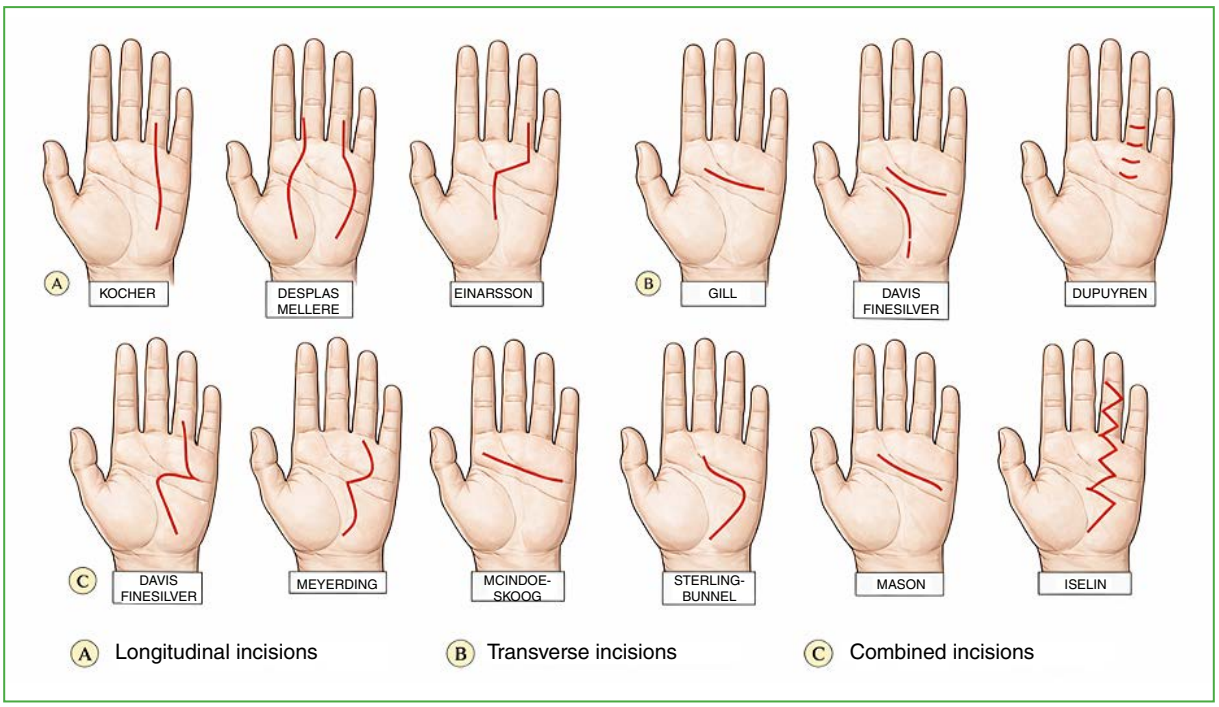

Figure 2. Incisions described by different authors for the treatment of Dupuytren's disease.

Longitudinal Incisions

All longitudinal incisions share several general principles: avoiding scars that cross concavities (e.g., the palmar midline), creating flaps that provide adequate exposure, and allowing skin lengthening through Z-plasty or V-Y plasty when necessary.[5]

Longitudinal incisions are the approach of choice when a single finger is involved. The most commonly used patterns include:

a) *Straight incision with multiple Z-plasties*: This allows progressive exposure of the neurovascular structures and lengthening of the scar through transposition of triangular flaps.[6] Its effectiveness depends on the angle and length of the limbs. Angles of 45° and 60° are most commonly used, providing approximate increases in length of 50% and 75%, respectively (Figure 3).[6,7]

In *first web-space contracture* secondary to commissural cords, more complex Z-plasty variants may be used, such as the four-flap or five-flap Z-plasty (jumping man flap), which provide adequate release and widening of the web space (Figure 4).[7,8]

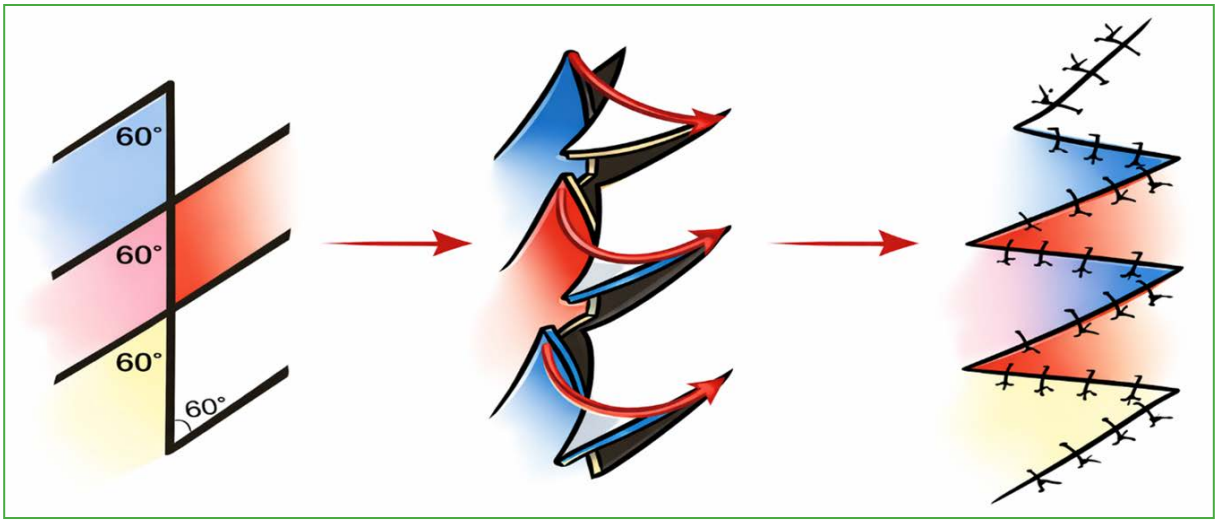

Figure 3. Design of multiple Z-plasties.

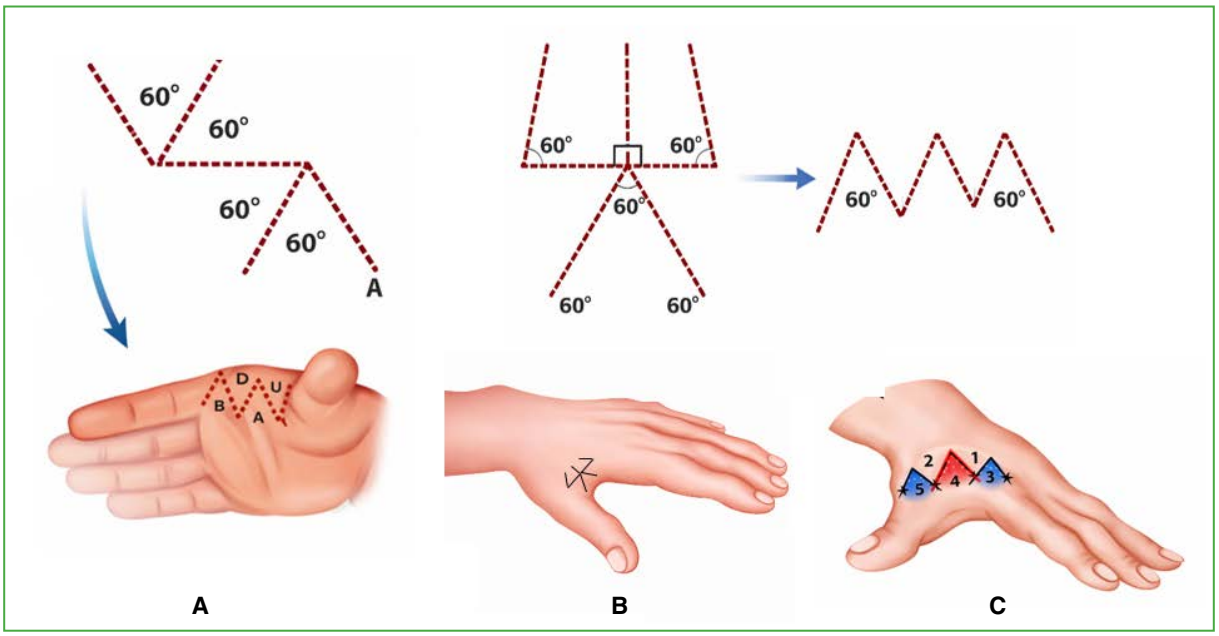

Figure 4. A. Four-flap Z-plasty. **B.** Five-flap Z-plasty (trident or *jumping man flap*).

b) *Bruner-type zigzag incision:* This incision is widely used in surgery for Dupuytren's disease. It provides adequate exposure while avoiding scar contracture across flexion creases. It does not provide skin lengthening and may be associated with ischemia at the tips of the flaps in cases of severe contracture. It is used primarily when involvement is moderate and tension-free closure can be achieved (Figure 5A).[5]

c) *V-Y advancement flaps:* These provide additional skin lengthening and may be combined with zigzag incisions as needed (Figure 5B).[5]

d) *Moermans' small curved incisions:* These consist of small, intermittent longitudinal incisions along the cord, allowing segmental resection in selected cases (Figure 5C).[9]

e) *Lateral approach:* This approach is indicated when there is predominant involvement of the proximal interphalangeal joint and may be supplemented with distal or proximal zigzag extensions, depending on the exposure required (Figure 5D).

Figure 5. A. Bruner-type incision. **B.** V-Y plasty (Shaw RB Jr, Chong AK, Zhang A, Hentz VR, Chang J. Dupuytren's disease: history, diagnosis, and treatment. *Plast Reconstr Surg* 2007;120(3):44e-54e). **C.** Moermans' curved incisions (Dias JJ, Aziz S. Fasciectomy for Dupuytren contracture. *Hand Clin* 2018;34(3):351-66.). **D.** Lateral incision.

Transverse Incisions

Transverse incisions are associated with a higher risk of scar contracture; therefore, their use as isolated incisions has gradually been abandoned, and they are now generally reserved for combination with longitudinal incisions. The open-palm technique described by McCash[10] consists of leaving the transverse wound open to heal by secondary intention; however, it is associated with prolonged healing times and a higher risk of contracture. It may be supplemented with a full-thickness skin graft.

Combined Incisions

Combined incisions are most appropriate when two or more fingers are involved, as they provide broad exposure of the palmar region and can be extended into the fingers. Typically, an incision is made along the distal palmar crease and extended into the fingers using longitudinal or zigzag incisions.

The transverse palmar incision extended into the digits with Z-plasties, as described by Skoog, provides excellent exposure and skin lengthening (Figure 6A).[11]

When skin involvement is moderate, the incision may be continued with Bruner-type zigzag incisions, without the need for additional plasties (Figures 6B and 7A).

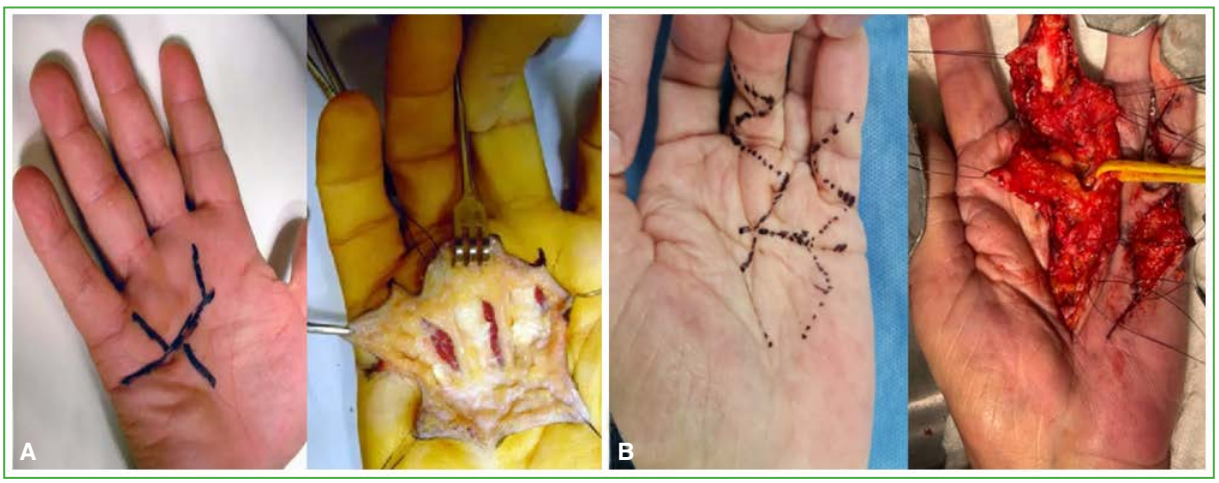

Figure 6. A. Combined Skoog incision for palmar Dupuytren's disease. **B.** Combined Skoog incision for Dupuytren's disease with palmodigital involvement.

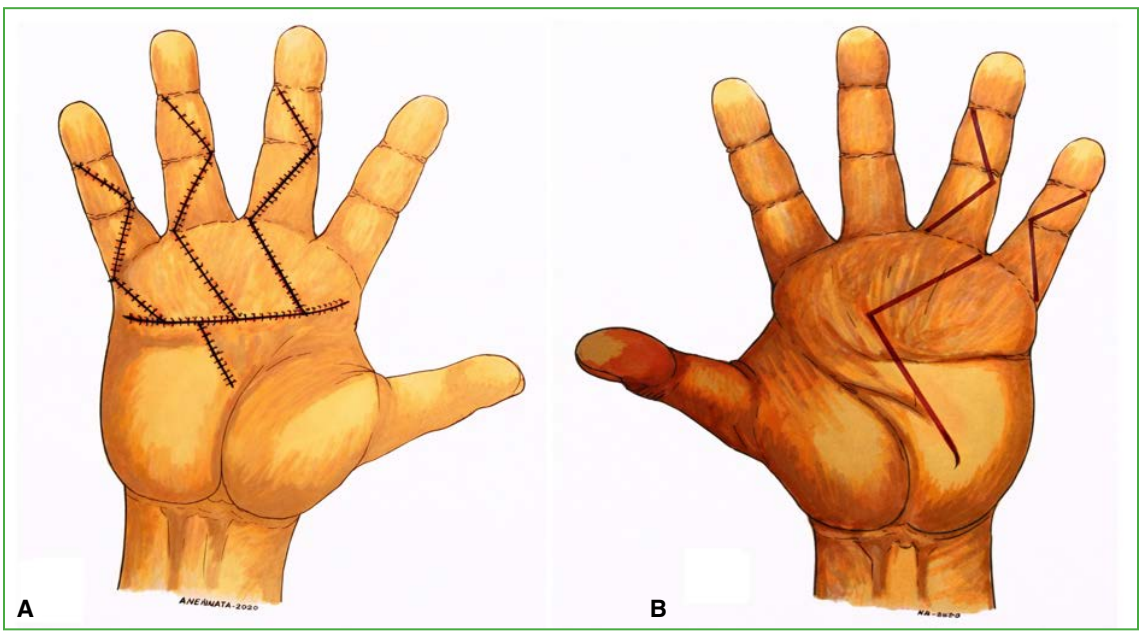

Figure 7. Combined incisions. **A.** Combined Skoog incision with zigzag extensions into the digits. **B.** V-V incision for palmodigital disease involving the fourth and fifth digits.

In patients with extensive palmodigital disease involving the ulnar digits, the "V-V" incision, described by one of the authors of this article, may be used. This technique combines a palmar "V" incision with digital "V" incisions, facilitating exposure and redistribution of the skin during closure (Figures 7B and 8).[2]

Figure 8. Patient with palmar Dupuytren's disease treated using a V-V approach in the palm.

Skin Excision: Dermofasciectomy

Dermofasciectomy is indicated in cases of significant skin involvement or recurrent disease and allows en bloc resection of the affected skin and fascia. This technique was popularized by Hueston[5] as an alternative for addressing skin shortening or replacing dermis infiltrated by myofibroblasts. Although it does not completely eliminate the risk of recurrence, some studies suggest lower recurrence rates compared with fasciectomy alone, although the evidence is inconsistent.[12,13] Coverage is achieved with a full-thickness skin graft, usually harvested from the hypothenar region or the arm. Split-thickness skin grafts are not recommended because of their greater tendency to contract during healing (Figure 9).[14]

Figure 9. A 58-year-old man treated with dermofasciectomy. **A.** Preoperative images. **B.** Intraoperative images. Graft harvested from the medial aspect of the arm. **C.** Four months after treatment.

Authors' Preference

In our practice, the choice of surgical approach for Dupuytren's disease is based on the extent of the disease, the number of involved fingers and joints, the anatomical pattern of the cords, and the condition of the skin, with the strategy tailored to each individual case. The degree of contracture according to the different classification systems is not a primary criterion in decision-making.

Single-finger involvement: We prefer Bruner-type zigzag incisions. When involvement of the proximal interphalangeal joint predominates and retrovascular cords are suspected, we use a lateral approach, which may be supplemented with zigzag extensions. In cases of significant skin contracture, we use longitudinal incisions combined with Z-plasties.

Involvement of two or more fingers: We typically use a Skoog-type transverse palmar incision with extensions into the fingers. Alternatively, particularly when the ulnar digits are involved, we use "V-V" incisions.

First web-space contracture: We release the first web space using a five-flap Z-plasty (*jumping man flap*) (Figures 4B and 10).

Recurrent disease: We consider dermofasciectomy with a full-thickness skin graft, typically harvested from the proximal forearm (Figures 9 and 10).

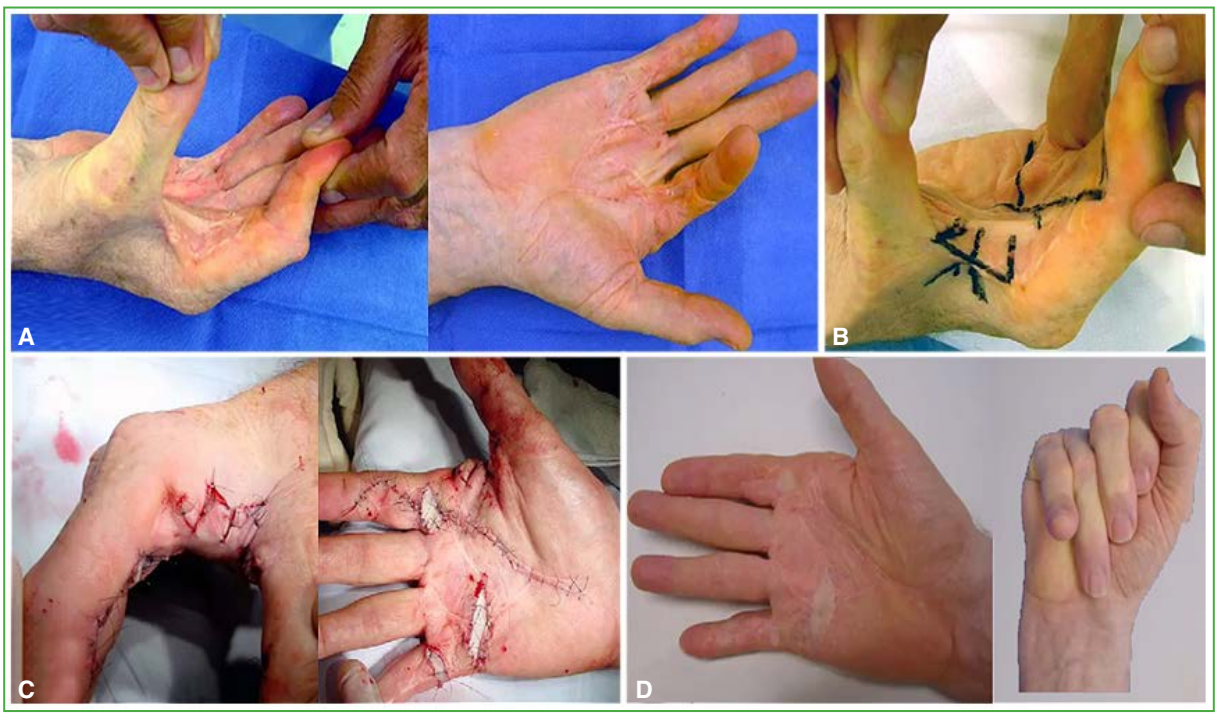

Figure 10. A 67-year-old man who underwent seven surgeries for recurrent Dupuytren's disease with flexor tendon involvement. **A.** Preoperative images. **B.** Design of the five-flap Z-plasty (*jumping man flap*) for the first web space. **C.** Intraoperative images. A five-flap Z-plasty of the first web space and dermofasciectomy with skin grafting were performed. **D.** Functional images 4 years after surgery.

Other Treatments

In addition to open surgery, there are less invasive alternatives, such as percutaneous aponeurotomy and injection of *Clostridium histolyticum* collagenase, which can release the contracture in selected patients.[15,16] Evidence shows that both achieve comparable outcomes, with no significant differences in correction, recurrence, or patient-reported outcomes. However, collagenase is associated with a higher rate of local complications.[15]

In our setting, the use of these treatments may be limited by their high cost and availability.

Compared with these minimally invasive techniques, limited fasciectomy results in a smaller residual extension deficit and a lower long-term recurrence rate, with better functional outcomes and no differences in serious complications.[16]

Overall, although minimally invasive techniques are valid options in selected cases, fasciectomy continues to provide more durable results. In this context, careful planning of the surgical approach is essential.

The Future

In recent years, advances in our understanding of the pathophysiology of Dupuytren's disease have led to the identification of multiple therapeutic targets aimed at modulating fibroblast proliferation, myofibroblast differentiation, and extracellular matrix production. In this context, several pharmacological strategies are currently under investigation, including transforming growth factor-β antagonists, Wnt pathway inhibitors, tyrosine kinase inhibitors, anti-tumor necrosis factor therapies, interferons, and antifibrotic agents (5-fluorouracil), as well as the development of new collagenases.[17]

Among the therapies that have advanced furthest in clinical development, tumor necrosis factor inhibition with intranodular adalimumab injections has significantly reduced nodule hardness and size in patients with early-stage disease in phase 2b clinical trials.[18]

Other emerging lines of research propose a paradigm shift in the treatment of fibrosis, focusing not only on its elimination but also on its reversal. In *in vitro* and *in vivo* models, therapies based on adipose-derived stem cells combined with platelet-rich plasma have shown the ability to reduce markers of fibrosis and promote the conversion of myofibroblasts into adipocytes, potentially leading to less invasive therapeutic strategies with lower recurrence rates.[19]

However, despite these advances, *Clostridium histolyticum* collagenase remains the only pharmacological therapy approved for clinical use in patients with Dupuytren's disease, and the available evidence supporting the other strategies remains limited. Consequently, surgery continues to be the mainstay of treatment for advanced disease, further emphasizing the key role of surgical planning in its management.

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

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Postoperative Hypofractionated Volumetric Modulated Arc Therapy with a Simultaneous Integrated Boost for Soft Tissue Sarcomas

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ABSTRACT

Soft tissue sarcomas (STS) are rare neoplasms whose standard treatment combines surgery and radiotherapy. Conventional postoperative radiotherapy regimens involve prolonged treatment courses, which has prompted the exploration of hypofractionated alternatives. The development of advanced techniques, such as intensity-modulated radiotherapy (IMRT) and volumetric modulated arc therapy (VMAT), together with the use of a simultaneous integrated boost (SIB), allows biologically equivalent doses to be delivered over a shorter period, optimizing dose distribution and reducing irradiation of healthy tissues. We present a retrospective series of 51 patients with STS treated with postoperative hypofractionated radiotherapy delivered in 15 fractions. Acute and late toxicity and oncologic outcomes were evaluated. The results showed satisfactory local control and survival, a low incidence of acute toxicity, and a moderate rate of late fibrosis. These findings suggest that hypofractionation using IMRT/VMAT is a viable therapeutic alternative in selected settings.

Keywords: Intensity-modulated radiotherapy; sarcoma; survival; toxicity.
Level of Evidence: IV

Radioterapia posoperatoria de intensidad volumétrica modulada hipofraccionada con refuerzo simultáneo integrado en sarcomas de partes blandas

RESUMEN

Los sarcomas de partes blandas son neoplasias poco frecuentes cuyo tratamiento estándar combina cirugía y radioterapia. Los esquemas convencionales de radioterapia posoperatoria implican tratamientos prolongados, lo que ha motivado la exploración de alternativas hipofraccionadas. El desarrollo de técnicas avanzadas, como la radioterapia de intensidad modulada y la radioterapia volumétrica, junto con el uso de refuerzo simultáneo integrado, permite administrar dosis biológicamente equivalentes en menor tiempo, optimizando la distribución de dosis y reduciendo la irradiación a tejidos sanos. Se presenta una serie retrospectiva de 51 pacientes con sarcoma de partes blandas tratados con radioterapia posoperatoria hipofraccionada en 15 fracciones. Se evaluaron la toxicidad aguda y tardía, y los resultados oncológicos. Los resultados muestran un control local y una supervivencia adecuados, una baja incidencia de toxicidad aguda y una tasa moderada de fibrosis tardía. Estos hallazgos sugieren que el hipofraccionamiento con radioterapia de intensidad modulada/radioterapia volumétrica constituye una alternativa terapéutica viable en contextos seleccionados.

Palabras clave: Radioterapia de intensidad modulada; sarcoma; supervivencia; toxicidad.
Nivel de Evidencia: IV

INTRODUCTION

Soft tissue sarcomas (STS) account for 1% of all neoplasms in adults.[1,2] The most common sites are the extremities (43%), visceral organs (19%), retroperitoneum (15%), and trunk (10%).[3]

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The histological classification of STS is based on the World Health Organization classification, which has incorporated new entities and updated diagnostic criteria.[4] Prognosis depends on multiple factors.[5] In the absence of radiotherapy, the local recurrence rate is approximately 30%, while the incidence of distant metastases ranges from 30% to 50%.[6]

Standard treatment consists of a combination of surgery and radiotherapy, which has reduced the local recurrence rate to less than 15%.[7]

Postoperative radiotherapy is associated with less acute toxicity but a higher incidence of late toxicity, such as fibrosis, edema, fractures, and joint stiffness.[8,9] Yang et al.[10] compared limb-sparing surgery alone with surgery plus adjuvant radiotherapy in 141 patients with STS (91 high-grade and 50 low-grade). With a mean follow-up of 9.6 years, 10-year local control was significantly higher in the surgery plus radiotherapy group (100% vs. 78%, p = 0.003); among patients with low-grade tumors, however, the difference did not reach statistical significance (95% vs. 68%, p = 0.067). Beane et al.[7] confirmed these findings in a study of 141 patients with STS (both low- and high-grade), with a mean follow-up of 17.9 years, reporting a local recurrence rate of 25% after surgery alone and 1.4% with adjuvant radiotherapy (p = 0.0001).

The standard postoperative dose is 64-66 Gy, administered in 1.8-2.0 Gy fractions over 32 or 33 sessions.[9] Bone fractures occur more frequently in patients receiving high doses (60-66 Gy) than in those receiving 50 Gy (10% vs. 2%).[11]

Regarding overall survival (OS), the data are conflicting. Yang et al.[10] reported no OS benefit with radiotherapy, whereas Kachare et al.,[8] in an analysis of 2606 patients with high-grade extremity STS treated with surgery and radiotherapy, found an OS benefit in both univariate and multivariate analyses.

According to a randomized trial, postoperative radiotherapy is associated with less acute toxicity than preoperative radiotherapy, but with a higher incidence of late toxicity, such as fibrosis, edema, fractures, and joint stiffness.[9] Bone fractures are more frequent in patients receiving high doses (60-66 Gy) than in those receiving 50 Gy (10% vs. 2%).[11] The standard postoperative dose ranges from 64 to 66, administered in 1.8-2.0 Gy fractions over 32 or 33 sessions.[9]

Radiotherapy techniques have evolved from two-dimensional radiotherapy to computed tomography (CT)-based three-dimensional conformal radiotherapy and, more recently, to intensity-modulated radiotherapy (IMRT).[12] IMRT allows modulation of the radiation beam and sparing of adjacent tissues, particularly bone, because of the conformal shape that can be achieved with the dose distribution. In patients with extremity STS, IMRT has been shown to be feasible and to have a favorable toxicity profile,[12] allowing the dose delivered to bone to be reduced and thereby decreasing the incidence of fractures associated with high radiation doses.[13] These newer techniques make it possible to consider shorter treatment regimens.

The objective of this article is to describe a clinical experience with hypofractionated postoperative radiotherapy using a simultaneous integrated boost (SIB) and to analyze its utility in clinical practice.

Patient Selection

We retrospectively reviewed the medical records of 51 patients diagnosed with STS who were treated at a single institution between January 2017 and October 2024. Data on age, sex, functional status according to the Eastern Cooperative Oncology Group Performance Status (ECOG-PS), histological subtype, tumor location, and disease stage according to the 8th edition of the American Joint Committee on Cancer (AJCC) staging system[14] were obtained from the medical records, as were data on surgical treatment and chemotherapy administered.

Patients with STS of the extremities or trunk who had undergone surgery followed by postoperative hypofractionated radiotherapy using IMRT/volumetric modulated arc therapy (VMAT) with an SIB to the tumor site identified on preoperative magnetic resonance imaging (MRI) or CT, as well as adjuvant chemotherapy when indicated, were included.

Patients with retroperitoneal, visceral, or head and neck STS were excluded from the analysis, as were those with stage IV disease or those who had undergone amputation as part of their surgical treatment.

Follow-up was calculated from the first day of radiotherapy to the last in-person or telephone clinical follow-up or the date of death. During treatment, patients were evaluated weekly by the radiation oncologist. Follow-up imaging studies were obtained three months after completion of radiotherapy.

Toxicity was graded according to the Common Terminology Criteria for Adverse Events, version 5.0.[15] Acute toxicity was defined as toxicity occurring during treatment and up to three months thereafter, and late toxicity as toxicity occurring more than three months after treatment.

Local recurrence was defined as recurrence occurring within the previously described irradiated volumes.

Vacuum bags were used for patient immobilization. During virtual simulation, a radiopaque marker was placed over the surgical scar, which was covered with a 0.5-cm-thick synthetic gel (Superflab) or wax bolus of sufficient extent to cover the entire scar. The patient's position was marked on the vacuum bag to ensure accurate reproducibility at each treatment session (Figure 1).

Figure 1. Simulation using a vacuum bag and bolus over the surgical scar. Patient immobilization using a vacuum bag. During virtual simulation, a radiopaque marker was placed over the surgical scar, which was covered with a synthetic gel bolus (Superflab); the marker allows the scar to be delineated.

CT imaging (Somatom GoUp, Siemens) was performed using 3-mm-thick slices and a field of view sufficiently wide to include the patient's entire external contour. CT acquisition included the target volume with margins of at least 5 cm at its superior and inferior ends.

CT images were imported via a DICOM network into the Eclipse treatment planning system, version 15.6 (Varian Medical Systems). Treatment volumes were delineated according to the recommendations published by Hass et al.16 using the simulation CT images and the preoperative MRI images as a guide.

Postoperative radiotherapy was delivered in 15 consecutive fractions at the following doses: tumor bed (SIB), total dose (TD) 48.75 Gy, with a daily dose of 3.25 Gy. The equivalent dose in 2-Gy fractions (EQD2), using

an α/β ratio of 1, was estimated at 64 Gy in patients with negative surgical margins; in patients with positive margins, the TD was increased to achieve an EQD2 of 68 Gy. Clinical target volume 1 (CTV1) received a TD of 43.9 Gy at 2.93 Gy per fraction (EQD2 54 Gy), and CTV2 received a TD of 41.8 Gy at 2.79 Gy per fraction (EQD2 50 Gy).

Planning with IMRT/VMAT

Treatment was delivered using VMAT with 6-MV photon beams, employing two complementary arcs and daily image-guided radiotherapy (Figure 2).

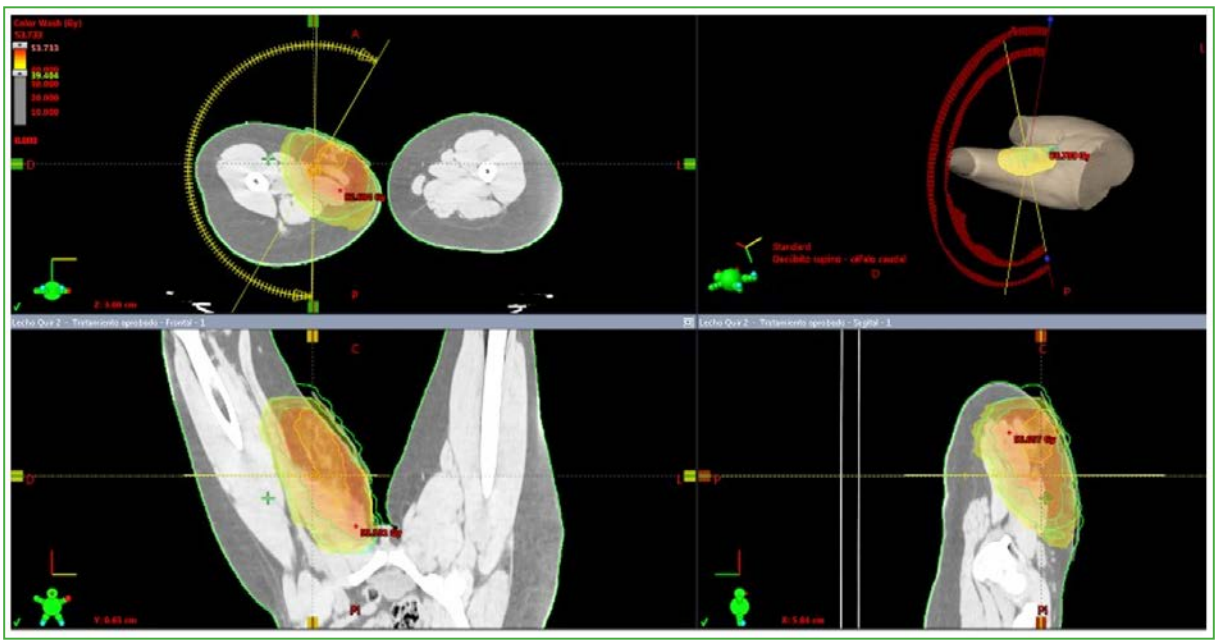

Figure 2. Treatment plan showing dose distribution in the tumor bed of the soft tissue sarcoma of the left thigh. The different isodose lines show coverage of the clinical target volume and its relationship to adjacent healthy tissues on axial, coronal, and sagittal images.

The defined volumes were the tumor bed (SIB), CTV1 (microscopic extension), CTV2 (surgical scar), and the planning target volume (PTV; 5-mm expansion).

Patient-specific quality assurance was performed, including an independent three-dimensional dose calculation using RadCalc v7.3 and portal dosimetry for each arc.

Treatments were delivered using TrueBeam STx or Novalis Tx linear accelerators (Varian Brainlab), both equipped with high-resolution multileaf collimator systems.

All participants provided written informed consent, and the study was conducted in accordance with the ethical principles of the 1975 Declaration of Helsinki.

Statistical Analysis

For descriptive analysis, quantitative variables, such as age, are expressed as mean ± standard deviation and range (minimum–maximum). Categorical variables, such as sex, are reported as absolute frequencies (number of cases) and relative frequencies (percentages).

Survival was estimated using the Kaplan-Meier method,[17,18] with the last day of radiotherapy considered the starting point. The outcomes analyzed were local recurrence-free survival, overall survival (OS), and metastasis-free survival.

Statistical analysis was performed using Statistica software, version 14.1.0.8.

Description of the Cohort

A total of 51 patients (mean age, 55 ± 17 years; range, 18–82) were analyzed, with a mean follow-up of 43 ± 17 months (range, 1.4–100). Twenty-four patients (47.1%) were women and 27 (52.9%) were men. Forty-two (82.4%) had negative surgical margins and nine (17.6%) had positive margins. Seven patients (13.7%) received adjuvant chemotherapy, while 44 (86.3%) did not. The mean interval between surgery and the start of intensity-modulated radiotherapy was 82 ± 44 days (range, 17–226). Tumor locations, listed in order of frequency, are detailed in Table 1.

Table 1. Location of sarcomas (n = 51).

Location of sarcomas	n	%
Lower extremity	28	54.9
Trunk	13	25.5
Upper extremity	10	19.6

The distribution by stage (AJCC 8th edition), as well as tumor grade and size, is shown in Table 2. Mean tumor size was 8.2 ± 5.1 cm (range, 1.3–30.0).

Table 2. Tumor stage, grade, and size (n = 51).

Variable		n	%
Stage			
	IA	2	3.9
	IB	6	11.8
	II	15	29.4
	IIIA	15	29.4
	IIIB	12	23.5
	IV	1	2
Tumor grade			
	I	10	19.6
	II	11	21.6
	III	30	58.8
Tumor size			
	≤5 cm	18	35.3
	>5 cm	33	64.7

Tumor histology is presented in Table 3. Liposarcoma was the most frequent subtype (15 patients, 29.4%), followed by spindle cell tumors (9 patients, 17.6%). Within the liposarcoma group (n = 15), the following histological subtypes were identified: dedifferentiated (5 patients, 33.3%), myxoid (4 patients, 26.7%), pleomorphic (2 patients, 13.3%), and well-differentiated (1 patient, 6.7%).

Table 3. Tumor histology (n = 51).

Histology	n	%
Liposarcoma	15	29.4
Spindle cell sarcoma	9	17.6
Leiomyosarcoma	8	15.7
Undifferentiated pleomorphic sarcoma	8	15.7
Fibromyxoid sarcoma	5	9.8
Epithelioid sarcoma	2	3.9
Synovial sarcoma	2	3.9
Fibrosarcoma	1	2.0
Malignant peripheral nerve sheath tumor	1	2.0

Early Toxicity

Grade 1 radiation dermatitis occurred in 37 patients (72.5%), grade 2 in 12 (23.5%), and grade 3 in two (4.0%). Grade 1 edema occurred in 15 patients (29.4%) and grade 2 in one (1.9%), while 35 (68.7%) did not develop this complication. Surgical scar complications (infection) occurred in two patients (4%).

Late Toxicity

Late toxicity was assessed in 49 of the 51 patients. Grade 1 scar fibrosis was observed in 30 patients (61.2%), grade 2 in 10 (20.4%), and grade 3 in one (2.0%), while eight (16.3%) had no fibrosis. Grade 1 edema was detected in 20 patients (40.8%) and grade 2 in two (4.1%). Twenty-two patients (44.9%) had skin changes consistent with post-radiation hyperpigmentation. One patient sustained a bone fracture one year after completing radiotherapy.

Survival

Local recurrence-free survival was 97.9 ± 2.1% at 12 months, 94.6 ± 3.8% at 24 months, and 89.6 ± 6.0% at 48 months (Figure 3A). The OS rate was 97.7 ± 2.2% at 12 months, 95.4 ± 3.2% at 24 months, and 87.3 ± 6.2% at 48 months (Figure 3B). Metastasis-free survival was 87.5 ± 4.8% at both 12 and 24 months and 77.3 ± 6.9% at 48 months (Figure 3C).

DISCUSSION

The results suggest that hypofractionated postoperative radiotherapy using IMRT/VMAT provides adequate local control and survival rates, with an acceptable toxicity profile. In the study by Wang et al.,[19] 80 patients with STS of the extremities and trunk were treated with IMRT in 25 fractions, with equivalent doses of 66 to 70 Gy to the tumor bed, depending on margin status. Similarly, Bourdais et al.[20] evaluated 59 patients treated with postoperative IMRT in 25 fractions, with doses ranging from 60 to 66 Gy adjusted according to the type of resection.

Unlike these conventional regimens, patients in our series received radiotherapy in 15 fractions, maintaining a similar equivalent dose but with a shorter treatment course.

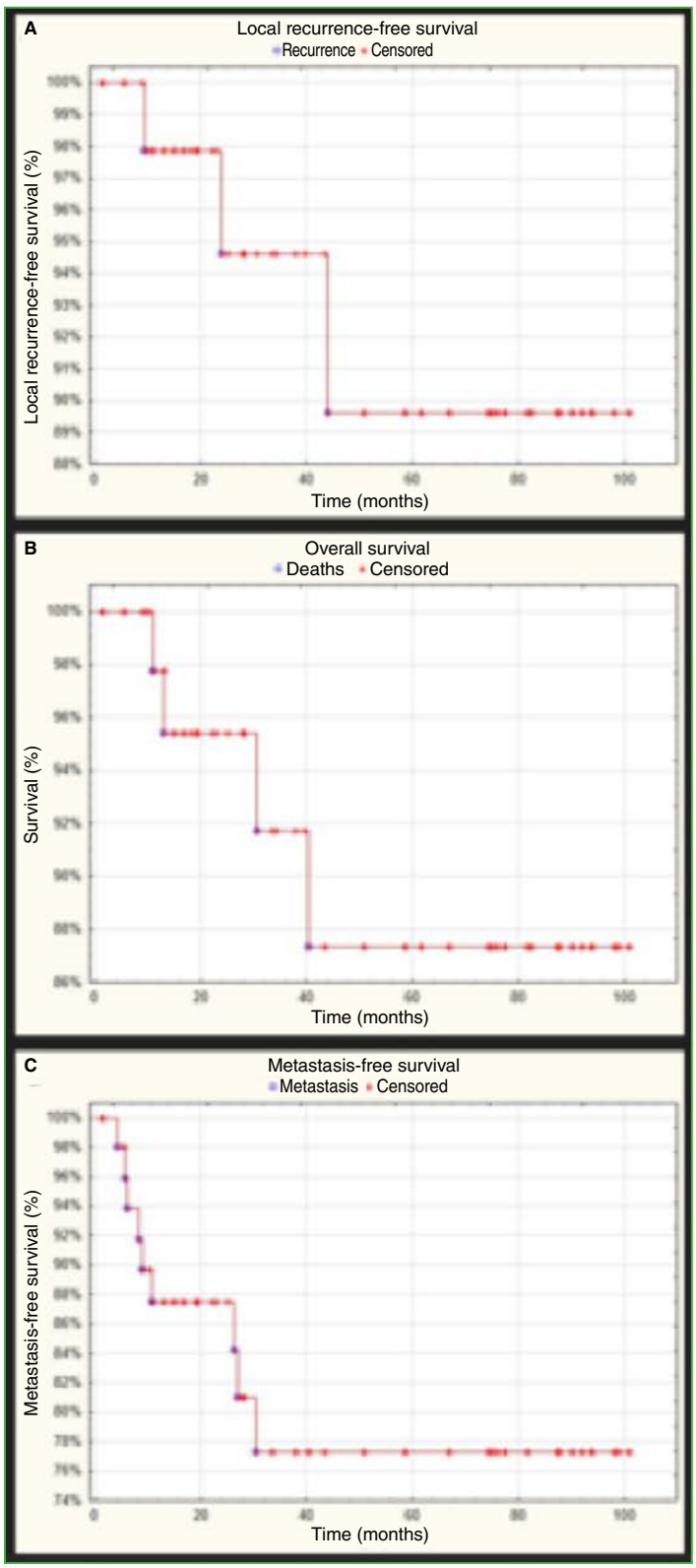

Figure 3. A. Local recurrence-free survival. Local control of 89.6% up to 100 months. **B.** Overall survival. Declines occurred before 40 months, followed by stabilization at 87.3% after 40 months. **C.** Metastasis-free survival. Most events occurred before 30 months, followed by stabilization at 77.3% thereafter.

Regarding acute toxicity, grade 2 and grade 3 radiation dermatitis occurred in 23.5% and 4.0% of patients, respectively; grade 2 or higher edema occurred in 1.9%, and wound-healing complications in 4%. Regarding late toxicity (n = 49), grade 2 or higher fibrosis occurred in 22.4% and grade 2 or higher edema in 4.1%. Wang et al.[19] reported a single case of grade 3 radiation dermatitis with a wound complication and an incidence of limb edema of 17.6%, with no fractures attributable to radiation. Similarly, Bourdais et al.[20] reported edema (29%) and chronic pain (32%) as the most frequent acute toxicities, with no bone fractures. Di Brina et al.[21] evaluated 109 patients treated with three-dimensional conformal radiotherapy (n = 38) or VMAT (n = 71) over 33 days and reported grade 2 fibrosis in 11.3%, with no fractures. Seddon et al.,[22] in a study of 53 patients treated with postoperative IMRT over 30–33 days, reported grade 2 or higher fibrosis in 10.8% and a single fracture.

Taken together, these three studies describe postoperative radiotherapy regimens administered primarily in 25–33 fractions using IMRT or VMAT, with relatively high rates of acute edema and a lower incidence of grade 2 or higher late fibrosis, with no radiation-induced fractures.[19-21]

Regarding oncologic outcomes in our study, local recurrence-free survival, OS, and metastasis-free survival rates at 48 months were 89.6%, 87.3%, and 77.3%, respectively. Consistent with these findings, the corresponding 48-month rates reported by Wang et al.[19] were 92.9%, 87.4%, and 81.2%, while Mills et al.[23] reported rates of 100%, 86%, and 68%, respectively, in patients treated with postoperative IMRT in 28 fractions.

CONCLUSIONS

Despite the limitations inherent to a retrospective study, the findings suggest that hypofractionated postoperative radiotherapy with IMRT/VMAT and SIB is a safe, effective, and efficient alternative for the adjuvant treatment of STS, with a low toxicity profile, the ability to avoid or reduce radiation dose to bone, and favorable oncologic outcomes.

Statement on the Use of AI

The use of artificial intelligence applications was limited to 3% of the work; ChatGPT® was used for grammatical correction of some texts.

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

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