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Importance of a Research Ethics Committee

Bibiana Dello Russo

Chairperson of the AAOT Research Committee



When is research ethical? Ethical evaluation must integrate a system whose objective contemplates the level that establishes the protection of individuals from risk and harm, in order to reach more distant goals, such as integral health, well-being and human development.

A Research Ethics Committee or Institutional Review Board (IRB) is an independent, multidisciplinary and multispectral group of health professionals, as well as professionals from other fields of knowledge, and members of the community, balanced in age and gender, whose objective is to contribute to safeguarding the dignity, rights, safety and well-being of current and potential research participants, ensuring that the benefits and drawbacks of research are equitably distributed among groups and classes of society, as well as safeguarding the scientific relevance and correctness of the research protocol under consideration (modified from the World Health Organization Operational Guidelines, 2000).

Its antecedents are recent, starting in the second half of the 20th century when the idea was introduced that ethical evaluation should be independent and external to the field of physicians and researchers. The need for evaluations of the ethical aspects involved in research to be carried out by people other than the researchers themselves was the consequence of various historical circumstances. Numerous events occurred during the late nineteenth and mid-twentieth centuries (particularly in research related to the search for vaccines for infections that killed thousands of people) that culminated in the atrocities committed by doctors in Nazi concentration camps and, as a result, the adoption of the Nuremberg Code. The contemporary history of health research ethics and IRBs dates back to the 20th century. It is marked by the crimes committed by the Nazis during World War II, whose leaders were tried in Nuremberg by the United Nations. These trials included crimes related to medical research that left countless victims and, from there, the Nuremberg Code was born. This code contemplates the basic ethical standards for medical research on human subjects and establishes that the participation of individuals in research must be voluntary and autonomous. All subjects should freely decide to participate, with prior knowledge of the risks of the study; the responsible investigators should explain to the subjects what their participation consists of and how the risks will be prevented or managed when they materialize. From the atrocities committed by the Nazis also emerges the Universal Declaration of Human Rights, adopted at the United Nations General Assembly in 1948 (Ghooi 2011; Shuster 1997; Unesco 2005a, 7-8).

The Nuremberg Code was followed in 1964 by the Declaration of Helsinki of the World Medical Association, which promulgates ethical principles for research on human subjects. The Declaration of Helsinki, in its 1975 version, includes an amendment from the 29th Assembly of Tokyo (Japan) that requires, in addition to the subjects' voluntary participation, that the research protocol be approved by an independent committee comprised of peers of the researchers and other community members who evaluate and verify that ethical aspects are included in the research to ensure the safety and protection of the volunteers, with due regard for the rights of the subjects; this refers precisely to the IRBs (World Medical Association 1964; 1975; Unesco 2006, 41).

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IRBs evaluate proposed human-participant studies to ensure that they comply with internationally and locally accepted ethical criteria, monitor the studies after they begin, and, if applicable, participate in follow-up and surveillance procedures after the research is concluded. IRBs have the authority to approve, reject or stop studies, or to require modifications to research protocols. They may also perform other functions, such as setting standards or offering opinions on current research ethics issues.

Evaluation is also essential if investigators intend to publish the findings of their research, as most medical journals will not publish the findings of research that has not been approved by an IRB.

The primary responsibility of an IRB is to protect potential research participants, but it must also take into account the potential risks and benefits to the community in which the research will be conducted. Its ultimate purpose is to promote high ethical standards in health research.

In international research, the IRB represents the interests of the local population. Therefore, it should ensure that participants and their communities receive fair benefits from the design. IRBs should evaluate what acceptable treatment and care will be offered to participants in studies with medical interventions.

The ethical and legal integrity of IRBs must be strongly protected, because corruption not only undermines citizens' trust in medicine and science, but it also fundamentally breaks the fine thread that allows vulnerable countries with low levels of development and precarious health conditions to participate in local or international health research that promotes the health and well-being of their communities while exposing them to the least amount of risk and enjoying the benefits of the results, within a universal framework of justice and equity. IRBs must ensure that these objectives are met in a way that ensures every individual is treated with equal dignity.

As final conclusions, we wondered what the role of an Ethics Committee in the Argentine Association of Orthopedics and Traumatology would be. We summarize it in the following lines: To help to understand and appreciate the bioethical policies and concepts that inspire them. To emphasize the issues that researchers should be aware of. To consider the scientific, bioethical and regulatory dimensions of research proposals. To review the scientific and ethical approaches of the protocols presented. To address the difference with Hospital Bioethics Committees. To monitor the search, methodology and participant screening. To promote bioethics training. To ensure that conflicts of interest do not arise within the group.

At this point, it is important to note that IRBs have an educational responsibility not only towards Committee members, but also towards the organizations' collaborators and the general public, in order to help them comprehend core bioethics policies and concepts.

40th anniversary of the AAOT Library

María de los Ángeles Gutiérrez
Chair of the Library Committee



The 40th anniversary of the AAOT Library finds me as Chair of the Committee (period 2021-2025) and, in general terms, it comes at a historical turning point. In this sense, the spectacular technological and scientific innovations, as well as the profound geopolitical, economic, and socio-cultural transformations that began steadily in the early 1980s and are becoming more acute this far into the 21st century, become the natural framework for the real revolution that is currently taking place in the field of scientific communication and dissemination in 2020, spurred by the pandemic and confinement.

In this context, and as a reminder of the Library's origins, it is worth noting that it was established in November 1983 at the initiative of the Continuing Medical Education Committee, then led by Dr. Carlos L. Aiello, and opened its doors to the local orthopedic community on September 1, 1986. Already at that time, the library had bibliographic material published at the dawn of the Association, which today is treasured in an archive containing publications from 1936 onwards. Throughout these 40 years, it has followed each of the transcendental communicational advances that have taken place: from the materialization of scientific information by means of photocopies of textbooks and journals, through technological advances such as video cassettes and CD-ROMs, to the emergence of the Internet. In 2023, between January and August of this year, 3000 of bibliographic searches were carried out virtually. In the same vein, it is worth mentioning the availability of scientific platforms that offer users full-text access, as well as the possibility of subscriptions to publications in general orthopedics and traumatology, and in different subspecialties.

The aforementioned transformations, which have been unconditionally supported by the AAOT authorities for the past 40 years, enable the Library to provide a service with unfailingly updated material and the unavoidable premise of raising its hierarchy, always at the pinnacle of the expectations generated by the fact that it is Argentina's only one of its kind.


Today, after 40 years of existence, the AAOT Library has an active social media presence and an outstanding website (<https://aaot.org.ar/biblioteca-aaot/>), and is represented by a Committee composed of six orthopedists and two prominent and renowned librarians, Verónica Mauceri (in office since 1988) and Silvina Dicranian (since 1997). In the implicit words of one of the outstanding professionals who collaborate in the tribute that is currently being carried out on the occasion of the 40th anniversary (<https://aaot.org.ar/40-anos-1983-2023/>), they are the guardians of the soul of our institution, enthusiastic promoters of this work of revision and reflection on the proactive spirit of our specialty, which is reflected in the reviews that make up this space:

1 Adolescent kyphoscoliosis in 80 years and more. Prof. Dr. Gutiérrez M. Ángeles

2 Functional Treatment of Clubfoot. Dr. Fernández Claudio A.

3 AAOT Library. From the pioneers of shoulder surgery to the present day. Dr. Daniel Moya

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Well into the middle of the third decade of this century, our idiosyncrasy in general presents the excessive and feverish pulse of Zygmunt Bauman's elusive liquid world (Liquid Times, 2007). Regarding our specialty, Orthopedics and Traumatology, we have progressed from the time of the Library's creation when the "AO" experience was a challenge for many orthopedists who were still focused on the advances made after WWII, to the 40th anniversary, when the professional perspective has become more versatile, vast, and audacious, to the point of dreaming of biological therapies and regenerative medicine.

Given this turning point and, why not, venturing into the Bauman universe... what better than our Library to shape the liquid world —of scientific research, academic knowledge, collegiate experience, shared knowledge— and lay it at our feet?

REFERENCES

- Cosentino R. Inauguración de la Biblioteca de la Asociación Argentina de Ortopedia y Traumatología. *Bol Trab Asoc Argent Ortop Traumatol* 1983;48(5):638-9.
- Patiño JM. Comité de Biblioteca 2013. Editorial 30 Años. *Rev Asoc Argent Ortop Traumatol* 2013;78(4):164-5. Available at: <https://raaot.org.ar/index.php/AAOTMAG/article/view/336/127>
- Bauman Z. *Liquid times. Living in an Age of Uncertainty*. Barcelona: Tusquets Editores; 2007.

Case Presentation

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Resolution on page 692.

The patient is a 9-month-old girl, victim of a car accident. Her mother, sitting in the passenger seat and wearing a seat belt, carried the child in her arms on her lap. She was referred from another health care center, with 48 hours of evolution. Examination on admission revealed a score 13 on the Glasgow scale, paralysis of both upper limbs with metameric level C5, but with response to nociceptive stimuli, intact neurological status of the trunk and lower limbs, respiratory distress with net decrease of air entry in the right hemithorax. Initial studies included cervical spine and chest radiographs and magnetic resonance imaging (MRI) of both regions.

FINDINGS AND INTERPRETATION OF IMAGING STUDIES

Anteroposterior and lateral radiographs of the cervical spine showed no abnormalities. The tracing of the four sagittal lines recommended in trauma was normal. However, the C2I-C3 facet relationship was questionable (Figure 1). Decreased air entry in the right hemithorax was associated with diaphragmatic paralysis and massive pulmonary atelectasis. (Figure 2). MRI of the cervical spine and skull base revealed epiphysiolysis of the axis, posterior ligament injury and significant perivertebral edema (Figure 3).

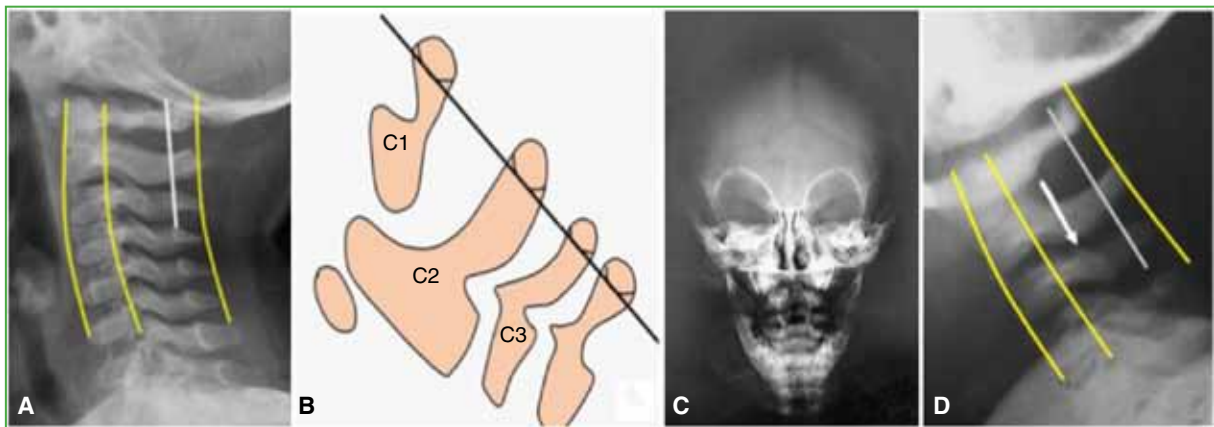


Figure 1. A and B. Normal lateral radiograph of the cervical spine and drawing showing the parallelism and harmony of the lines bordering the vertebral bodies, the spinous processes (yellow) and Swischuk's line (white) extending from the spinolaminar cortex of the atlas to that of C3. The one corresponding to the axis should lay on it with a tolerable dispersion of 1.5 mm to 2 mm. An excessive value in the anterior direction implies pathological subluxation and, in the posterior direction, spondylolisthesis of the axis. Its tracing is not possible in the presence of hypoplasia or absence of ossification of the atlas. **C and D.** Radiographic pair on admission. **C.** Odontoid AP view: preserved spinal axis, no segmental rotation, no evidence of trauma. **D.** Lateral: no anomalies of the above-mentioned parameters. However, the C2-C3 facet relationship raises the suspicion of subluxation (white arrow). The initial diagnosis was SCIWORA (*Spinal Cord Injury Without Radiographic Abnormality*).

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Figure 2. Chest radiograph and MRI of the neck and trunk . Paralysis of the right hemidiaphragm due to involvement of the phrenic nerve related to the C4 somite. Note the elevated liver (yellow asterisks), collapsed lung and atelectasis (yellow arrow).

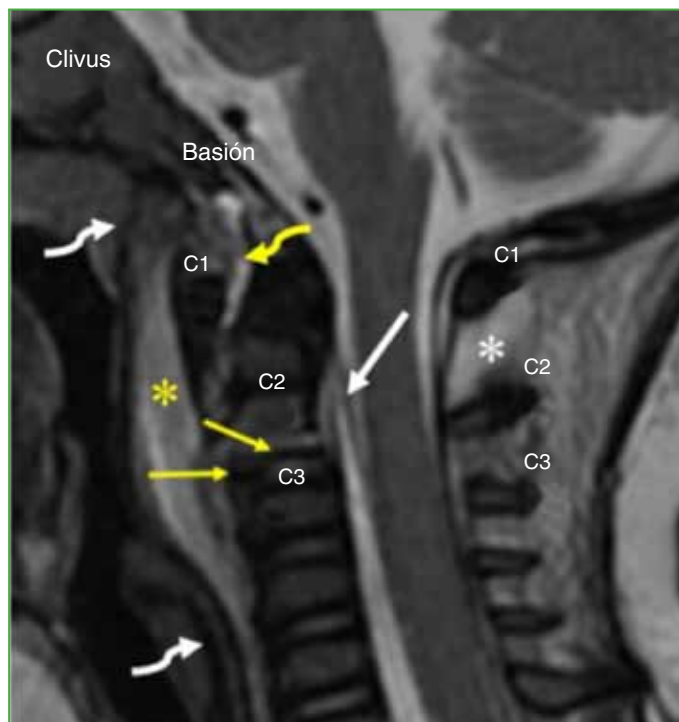


Figure 3. MRI of the skull base and upper cervical spine in T2 relaxation. Prevertebral or retropharyngeal fluid collection of 12 mm in its apical sector (average normal value in children and adolescents 5 ± 2 mm, yellow asterisk) extending from the clivus to C4 (curvilinear white arrows). Similar image in the preodontoid space propagating to the basion (curvilinear yellow arrow). Interspinial fluid signal in C1-C2 (white asterisk) and behind the tectorial membrane (white arrow). Salter-Harris type II epiphysiolysis of the base of the axis (upper yellow arrow), note the small Thurstan-Holland fragment (lower yellow arrow).

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Extensor Carpi Radialis Longus Tendon Transfer to Extensor Carpi Ulnaris: Does It Significantly Improve the Correction of Radial Deviation in the Rheumatoid Wrist?

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ABSTRACT

Introduction: Inflammatory arthritis can lead to caput ulnae syndrome with radial deviation of the wrist and metacarpals. Treatment includes salvage arthroplasty of the distal radioulnar joint and relocation of the extensor carpi ulnaris (ECU) tendon. However, the ECU may be too weak to correct the deviation. To strengthen the ECU, Clayton described the transfer of the extensor carpi radialis longus (ECRL) tendon to the ECU. The aim of this work is to compare the correction of the radial deviation of the metacarpals in patients with and without transfer of the ECRL to the ECU. **Materials and Methods:** Retrospective cohort study. Patients with rheumatoid arthritis and caput ulnae syndrome, treated with ECU tenoplasty with or without ECRL, were included. The patients were divided into two groups: ECRL to ECU transfer (group A) and no transfer (Group B). The correction of the metacarpal-radial angle (Clayton's angle) was calculated by comparing the measurements before surgery and at end of follow-up, and the results obtained were compared. **Results:** The average follow-up was 28 months. The preoperative Clayton angle was on average 44.54° (SD ± 7.52) in group A and 60.24° (SD ± 12.28) in group B ($p = 0.001$). The correction average was 6.57° (SD ± 4.11) and 0.95° (SD ± 9.17) for group A and B respectively ($p=0.026$). **Conclusions:** The level of correction obtained was higher in group A. However, although both techniques managed to improve the angle, the degree of correction could be subject to the magnitude of the preoperative angle.

Keywords: Rheumatoid arthritis; caput ulnae; tendon transfer; Clayton's angle.

Level of Evidence: IV

Transferencia tendinosa del primer radial externo al cubital posterior: ¿mejora significativamente la corrección de la desviación radial en la muñeca reumática?

RESUMEN

Introducción: La artritis inflamatoria puede conducir al síndrome de caput ulnae con desviación radial de la muñeca y los metacarpianos. El tratamiento es la artroplastia de rescate de la articulación radiocubital distal y la reubicación del tendón del extensor cubital del carpo (ECC). Sin embargo, puede ser débil para corregir la desviación. Clayton describió la transferencia del tendón del extensor radial largo del carpo (ERLC) al ECC. El objetivo de este estudio fue comparar la corrección de la desviación radial de los metacarpianos en pacientes operados con transferencia del ERLC al ECC o sin ella. **Materiales y Métodos:** Estudio de cohorte retrospectiva en pacientes con artritis reumatoide y síndrome de caput ulnae, sometidos a tenoplastia del ECC con ERLC o sin este procedimiento. Se formaron dos grupos: pacientes con transferencia (grupo A) y sin transferencia (grupo B). Se calculó la corrección del ángulo de Clayton comparando las medidas preoperatoria y del último control, y se compararon los resultados.

Resultados: El seguimiento promedio fue de 28 meses. El ángulo de Clayton preoperatorio promedio era de 44,54° (DE ± 7,52) en el grupo A y 60,24° (DE ± 12,28) en el grupo B ($p = 0,001$). El promedio de corrección fue de 6,57° (DE ± 4,11) y 0,95° (DE ± 9,17), respectivamente ($p = 0,026$). **Conclusiones:** El nivel de corrección fue mayor en el grupo A. No obstante, si bien ambas técnicas lograron mejorar el ángulo, el grado de corrección podría estar supeditado a la magnitud del ángulo preoperatorio.

Palabras clave: Artritis reumatoide; caput ulnae; transferencia tendinosa; ángulo de Clayton.

Nivel de Evidencia: IV

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INTRODUCTION

Rheumatoid arthritis (RA) is a chronic inflammatory autoimmune disease that causes joint and extra-articular manifestations.¹ Most patients with RA develop structural deformities during the course of the disease. When it affects the hands, it is usually disabling and more than 90% of RA patients will end up with wrist involvement within 10 years of diagnosis.^{2,3} The distal radioulnar joint is usually the first site of involvement. One of the characteristic deformities is caput ulnae syndrome. Described by Backdahl⁴ in 1963, caput ulnae syndrome is the consequence of a progressive impairment of the ulnocarpal ligaments due to the synovitis characteristic of the inflammatory disease. Synovitis of the extensor carpi ulnaris tendon (ECU) causes incontinence of its sheath, allowing its volar dislocation from extensor to flexor and supinator of the wrist. This, associated with distal radioulnar synovitis and the consequent distension of its ligaments, causes volar dislocation of the radius, with dorsal protrusion of the ulnar head. The end of this pathophysiological pathway is the imbalance of the lateral forces of the wrist, with weakness of the ulnar side forces, and the progressive rotation and radial deviation of the wrist and metacarpals, often also with ulnar deviation of the fingers.⁵

This condition, which combines caput ulnae syndrome with radial deviation of the wrist and metacarpals, requires rebalancing forces at the wrist, which includes arthroplasty or salvage arthrodesis of the distal radioulnar joint and repositioning of the ECU tendon to its normal dorsal position. However, the ECU tendon, in some cases, may be too weak to correct radial deviation and restore the essential balance that would restore the tendinous skeletal axis to the wrist, metacarpals and fingers.^{5,6}

In these cases, in order to strengthen the ECU, which is often very deteriorated and weakened by the disease, Clayton and Ferlic⁷ described the transfer of the extensor carpi radialis longus tendon (ECRL) to the ECU with the double objective of improving the balance of forces by strengthening the ulnar side of the wrist, and decreasing, in turn, the radial deflection force produced by both extensor carpi radialis tendons (ECRL and the extensor carpi radialis brevis) by taking one of them as a donor tendon.

The purpose of this study was to compare the correction of radial deviation of the metacarpals in patients who underwent surgery with or without a transfer from ECRL to ECU.

MATERIALS AND METHODS

After approval by the Ethics Committee of our institution, a retrospective cohort analytical observational study was carried out. Prospectively completed electronic medical records of all patients with rheumatic disease and wrist involvement who had been treated at our institution between 2010 and 2018 were reviewed.

Patients were included with: RA and caput ulnae syndrome, treated with a palliative distal radioulnar joint procedure and tenoplasty of the ECU to the ECRL or without the transfer. Patients with wrist arthroplasty, radiocarpal or intercarpal arthrodesis, wrist tendon transfers and less than six months of follow-up were excluded.

Demographic variables such as age and sex, affected side and duration of follow-up were recorded. Preoperative and postoperative AP radiographs of the hand were evaluated by measuring the Clayton angle.⁷ (Figure 1) defined as that formed between the axis of the second metacarpal and the radial inclination line on the articular surface of the wrist in the anteroposterior radiograph.

All had been operated on by the same team of upper limb surgeons. Caput ulnae syndrome has always been treated with Darrach's⁸ or Sauvé-Kapandji's⁹ inferior radioulnar arthroplasty, which involves relocating the ECU tendon in its sheath and reconstructing the sheath, reducing the tendon back to the ulna's dorsum in its proper canal. Furthermore, the ECU was strengthened in some cases with transfer from the ECRL to the ECU and not in others.

According to the technique, after the dorsoulnar wrist approach, inferior radioulnar arthroplasty, and reconstruction of the ECU sheath and its dorsal relocation, tendon transfer is performed in patients with radial deviation of the wrist. The transfer was performed according to the technique described by Clayton and Ferlic:⁷ through an approach at the base of the metacarpal, the ECRL tendon is sectioned at the insertion at its base; a second minimal incision is made on the same tendon about 5 cm proximal to the first one; the tendon is extracted through the second incision freeing it from the surrounding sheaths for its transfer; the ECRL tendon is passed under the cellular tissue and supra-aponeurotically and over the extensors of the fingers towards the dorsoulnar

approach to suture the ECU in a position of 30° of wrist extension, maximum pronation and ulnar deviation, proximal to the entrance of the ECU in its neosheath that was reconstructed in the same surgical procedure before the transfer (Figures 2 and 3).

Patients were divided into two groups: with transfer from ECRL to ECU (group A) and without transfer (group B). In each group, the correction of the metacarpal-radial angle (Clayton angle) was calculated by comparing the preoperative measurements and those of the last control, and the results obtained between the two groups were compared.



Figure 1. Radiographic measurement of the modified Clayton angle.



Figure 2. Pre-surgical clinical and radiographic imaging. Radial deviation of metacarpals and ulnar deviation of the fingers.



Figure 3. **A.** Tendon of the extensor carpi radialis longus prepared for transfer, already sectioned from the base of the metacarpal. **B.** Tendon of the extensor carpi radialis longus transferred to be sutured to the extensor carpi ulnaris through a dorsoulnar approach. **C.** Final correction of the deviation. **D.** Postoperative radiograph of the hand, AP view.

Statistical Analysis

Continuous variables are expressed as means with standard deviation or as median with interquartile range according to their normal or nonparametric distribution, respectively. Categorical variables are expressed as frequencies and percentages. Univariate analysis was performed between both groups according to their distribution using Student's t test and Mann-Whitney U test. The delta values between preoperative and final radiographic angles were compared with the t-test for paired samples. A p-value <0.05 was considered statistically significant. IBM SPSS v.26 (IBM Corp., Armonk, N.Y., USA) was used.

RESULTS

After applying the inclusion and exclusion criteria, 31 wrists in 31 patients were evaluated: 11 in group A (with ECRL transfer) and 20 in group B (without ECRL transfer). The demographic characteristics of the series and the univariate comparative analysis are detailed in Table 1. No statistically significant differences were found between the two groups for age, sex, side operated on and follow-up time (mean 28 months, standard deviation [SD] \pm 27.4).

Table 1. Demographic characteristics and univariate comparative analysis between the two groups

Variable	Series (n = 31)	Group A (with transfer; n = 11)	Group B (no transfer; n = 20)	p
Age (years)	52.97 (SD \pm 13)	57.36 (SD \pm 11.3)	50.55 (SD \pm 13.48)	0.166
Female sex	29 (93.5%)	10 (90.9%)	19 (95%)	1
Right side	18 (58.2%)	6 (54.5%)	12 (60%)	1
Follow-up time (months)	28.55 (SD \pm 27.44)	23 (SD \pm 20.24)	31.6 (SD \pm 30.75)	0.413
Preoperative Clayton angle ($^{\circ}$)	54.67 (SD \pm 13.14)	44.54 (SD \pm 7.52)	60.24 (SD \pm 12.28)	0.001

SD = standard deviation.

The preoperative Clayton angle measured, on average, 135.46° (SD \pm 7.52) in group A and 119.75° (SD \pm 12.28) in group B (p = 0.001). In group A, an average improvement of 6.57° (SD \pm 11.69) was achieved, with a postoperative angle of 128.89° (SD \pm 7.98). In group B, a correction of 0.95° (SD \pm 16.30) was obtained, with a postoperative angle of 118.8° (SD \pm 9.50) (Table 2).

Table 2. Comparison between preoperative and postoperative Clayton angle.

Grupo	Preoperative angle ($^{\circ}$)	Postoperative angle ($^{\circ}$)	p
Group A (with transfer)	44.54 (DS \pm 7.52)	51.11 (DS \pm 7.98)	0.092
Group B (without transfer)	60.24 (DS \pm 12.28)	61.2 (DS \pm 9.50)	0.796

DISCUSSION

Current treatment protocols for RA consist of an interdisciplinary clinical-surgical approach. Pharmacologic therapy has substantially decreased the incidence of hand deformities. However, surgery remains an essential therapeutic option to be considered for symptomatic patients, and it can be classified as preventive/prophylactic or reconstructive.¹⁰

Prophylactic procedures (synovectomy, tenosynovectomy, tendon balancing) aim to delay the development of deformities, while so-called reconstructive procedures (arthroplasty, tendon transfer/grafting) aim to correct already established deformities.¹¹

It is critical to note that the presence of a deformity is not an absolute indication for surgery, as many patients with hand deformities can still retain reasonable function. However, it is worth mentioning that the treatments proposed in this study have a window period to be indicated; radial deviation is usually irreversible in the presence of a substantial carpal collapse.

In the case of a Z deformity of the hand with radial deviation of the metacarpals, whether or not complicated with ulnar deviation of the fingers, the existing deformity causes an imbalance of forces in the tendon axes, resulting in progressive loss of function and normal anatomical axis and, thus, progressive functional inefficiency. In these circumstances, surgery should be performed as soon as the deformity is diagnosed to rebalance the traction and tensile forces of the wrist and fingers, preventing the Z deformity from worsening.

In this context, the surgery we evaluated is merely one component of a group of surgical treatments (inferior radioulnar arthroplasty, tenoplasty and ECU relocation, correction of dislocation of the extensors of the fingers, and so on) used to reconstruct and prevent abnormalities from worsening.

The main objective of this study was to compare the variation of radial metacarpal deviation achieved in patients operated with or without transfer from ECRL to ECU.

In our series, radial deviation correction was higher in the group with transfer from ECRL to ECU.

Although the literature on this subject is scarce, the results obtained using the transfer technique are comparable to those reported in other series. Clayton and Ferlic,² who originally described this technique, applied this procedure on a series of 14 wrists, and achieved a mean preoperative and postoperative variation close to 17°. Ito et al.¹² published a 10° improvement in radial deviation using the same technique in 28 wrists. These authors also compared whether these results were reproducible in the different stages of radiocarpal osteoarthritis, and concluded that radioulnar deviation after surgery was reduced even when the patient had radiocarpal joint ankylosis.

On the other hand, the correction achieved in group B (without transfer) was approximately 1°. The difference between the two groups could be attributable to a number of factors, including the surgical approach itself, which, as previously stated, aims to produce a better balance of forces and a larger correction of radial deviation when utilizing the ECRL. However, given that patients in this group start from lower preoperative values, i.e., with less metacarpal deviation from its normal axis, this could be a limitation to achieve greater postoperative variation. This difference between the two groups can probably be attributed to the surgeon's choice of technique, who, in order to correct larger deviations, opted for the transfer technique which, from a biomechanical point of view, seems to offer greater resistance.

This study has various limitations. First, as previously stated, the starting point of the preoperative values in radial deviation differed; nevertheless, the demographic characteristics did not differ.

Although the number of patients is not large enough to draw statistical conclusions, this case series contributes to a casuistry on a subject with limited published studies.

We believe that studies with homogeneous and long-term case series are necessary to improve the level of evidence.

CONCLUSIONS

Based on the results obtained, we consider that both techniques improved the Clayton angle. Although the degree of correction achieved in this series was greater with the ECRL transfer technique, the values could be contingent on the magnitude of the preoperative angle.

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REFERENCES

1. Smolen JS, Aletaha D, McInnes IB. Rheumatoid arthritis. *Lancet* 2016;388(10055):2023-38. [https://doi.org/10.1016/S0140-6736\(16\)30173-8](https://doi.org/10.1016/S0140-6736(16)30173-8)
2. Rizzo M, Cooney WP 3rd. Current concepts and treatment for the rheumatoid wrist. *Hand Clin* 2011;27(1):57-72. <https://doi.org/10.1016/j.hcl.2010.09.004>
3. Ilan DI, Rettig ME. Rheumatoid arthritis of the wrist. *Bull Hosp Jt Dis* 2003;61(3-4):179-85. PMID: 15156823
4. Backdahl M. The caput ulnae syndrome in rheumatoid arthritis. A study of the morphology, abnormal anatomy and clinical picture. *Acta Rheumatol Scand Suppl* 1963;5:1-75. PMID: 13965955
5. Kozlow JH, Chung KC. Current concepts in the surgical management of rheumatoid and osteoarthritic hands and wrists. *Hand Clin* 2011;27(1):31-41. <https://doi.org/10.1016/j.hcl.2010.09.003>
6. Papp SR, Athwal GS, Pichora DR. The rheumatoid wrist. *J Am Acad Orthop Surg* 2006;14(2):65-77. <https://doi.org/10.5435/00124635-200602000-00002>
7. Clayton ML, Ferlic DC. Tendon transfer for radial rotation of the wrist in rheumatoid arthritis. *Clin Orthop Relat Res* 1974;(100):176-85. PMID: 4838397
8. Darrach W. Habitual forward dislocation of the head of the ulna. *Ann Surg* 1913;57:928-30.
9. Sauvé LKIH. Nouvelle technique de traitement chirurgical des luxations récidivantes isolées de l'extrémité inférieure du cubitus. *J Chir (Paris)* 1936;47:589-94.
10. Blazar PE, Gancarczyk SM, Simmons BP. Rheumatoid hand and wrist surgery: Soft tissue principles and management of digital pathology. *J Am Acad Orthop Surg* 2019;27(21):785-93. <https://doi.org/10.5435/JAAOS-D-17-00608>
11. Ghattas L, Mascella F, Pomponio G. Hand surgery in rheumatoid arthritis: state of the art and suggestions for research. *Rheumatology (Oxford)* 2005;44(7):834-45. <https://doi.org/10.1093/rheumatology/keh608>
12. Ito J, Koshino T, Okamoto R, Saito T. Radiologic evaluation of the rheumatoid hand after synovectomy and extensor carpi radialis longus transfer to extensor carpi ulnaris. *J Hand Surg Am* 2003;28(4):585-90. [https://doi.org/10.1016/s0363-5023\(03\)00202-8](https://doi.org/10.1016/s0363-5023(03)00202-8)

Validation of the Classification of Leonetti and Tigani in Tibial Pilon Fractures Through Resident Doctors in Traumatology and Orthopedics and Foot and Ankle Fellows

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ABSTRACT

Objective: To validate the classification of Leonetti and Tigani with evaluators of different levels of expertise. **Materials and Methods:** 54 patients with 54 tibial pilon fractures were evaluated retrospectively. Patients were studied using AP and lateral radiography of the distal tibia, as well as CT scans (axial, coronal, and sagittal images with reconstruction). All subtypes of the Leonetti classification were included. The evaluators presented different levels of training: two Foot and Ankle fellows and two residents in their last year of training. To determine the interobserver agreement, each case was classified into types I, II, III and IV according to Leonetti. To determine the intraobserver agreement, the cases were analyzed by the same evaluator after 6 weeks. The kappa coefficient (k) was used to determine the degree of agreement between the evaluators, that value was expressed with a 95% confidence interval. **Results:** The intraobserver agreement between the first and second evaluation for fellows was moderate and very good. For the residents, it was good and very good. The interobserver agreement for the classification of tibial pilon fractures presented an overall kappa of 0.7156 (95%CI:0.60 to 0.83), which is a good value when all fractures are considered by all evaluators. **Conclusion:** This tibial pilon fracture classification system surpasses previous studies of other classifications in terms of agreement. These agreements were reached with physicians with varying levels of expertise. Our findings contribute to the external and independent validation of this new classification system.

Keywords: Tibial pilon fractures; tomographic classification; interobserver agreement.

Level of Evidence: IV

Clasificación de Leonetti y Tigani para fracturas del pilón tibial: validación con residentes de Traumatología y Ortopedia, y fellows en tobillo y pie

RESUMEN

Objetivo: Validar la clasificación de Leonetti y Tigani con evaluadores de diferentes niveles de experiencia. **Materiales y Métodos:** Se evaluó a 54 pacientes (54 fracturas del pilón tibial) en forma retrospectiva. Se tomaron radiografías de tibia distal, de frente y perfil, y una tomografía computarizada con cortes axiales, sagitales, coronales y reconstrucción 3D. Se incluyeron todos los subtipos de la clasificación de Leonetti y Tigani. Los evaluadores tenían diferentes niveles de entrenamientos: dos eran *fellows* en pie y tobillo, y dos, residentes del último año de formación. Para determinar la concordancia interobservador, cada caso fue clasificado en tipo I, II, III o IV, según Leonetti y Tigani. Para evaluar la concordancia intraobservador el mismo evaluador analizó los casos a las 6 semanas. Se utilizó el coeficiente kappa para determinar el grado de concordancia entre evaluadores y ese valor fue expresado con un intervalo de confianza del 95%. **Resultados:** La concordancia intraobservador fue moderada y muy buena para cada *fellows*, y buena y muy buena para los residentes, entre la primera y segunda evaluación. La concordancia interobservador arrojó un coeficiente kappa global de 0,7156 (IC95% 0,60-0,83), un valor bueno cuando se consideraron todas las fracturas por todos los evaluadores. **Conclusiones:** El sistema de clasificación de fracturas del pilón tibial alcanza concordancias superiores a las de estudios previos de otras clasificaciones. Dichas concordancias se lograron con médicos con diferentes niveles de experiencia y conocimiento. Nuestros hallazgos contribuyen a la validación externa e independiente de este nuevo sistema de clasificación.

Palabras clave: Fracturas del pilón tibial; clasificación tomográfica; acuerdo interobservador.

Nivel de Evidencia: IV

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INTRODUCTION

Tibial plafond or pilon fractures are one of the most complex injuries of the lower limb and represent a challenge for orthopedic surgeons, since their surgical resolution is technically demanding and the rate of sequelae with different disabilities is high. These injuries are generally caused by high-energy trauma.^{1,2}

These fractures are characterized by severe metaphyseal joint impaction and comminution and soft tissue involvement. Although the prognosis depends largely on the initial injury, it can be improved with proper management by early stabilization of the fracture through anatomical reduction of the joint and proper alignment.²

A classification for tibial plafond fractures should be easy to use, inclusive, reliable and reproducible, should provide a prognosis and assist the surgeon in decision making.

The AO and Ruedi-Allgower classifications are based on radiographs and are simple to understand, but their degree of agreement and reproducibility is moderate.^{3,4}

In 2017, Leonetti and Tigani⁵ published a new classification system that evaluates the number and displacement of articular fragments, the direction of the major fracture line and comminution. This system had excellent reliability and reproducibility in the original publication. However, there is only one publication that independently validates this classification.⁶ We believe that it is important for this classification to be independently validated and that it can be interpreted and understood by physicians of various levels of experience, residents in our specialty, as well as ankle and foot subspecialty fellows, as they are frequently the ones who receive patients with this type of emergency.

The objective of this study was to validate the Leonetti and Tigani classification using evaluators with varying expertise levels.

MATERIALS AND METHODS

Fifty-four patients (54 tibial plafond fractures) were evaluated retrospectively. Inclusion criteria were: patients with tibial plafond fractures and complete studies (AP and lateral distal tibia radiographs, and computed tomography [CT], axial, sagittal and coronal slices with 3D reconstruction). All cases were selected by an author who did not participate in the evaluation. All subtypes of the classification were included.⁵ The evaluators had varying levels of training: two ankle and foot fellows and two residents in their final year of residency. Each evaluator received a digital folder with the 54 cases and did not have access to the identity of the patient or the definitive treatment.

To determine interobserver agreement, each case was classified into types I, II, III or IV, according to Leonetti and Tigani. The evaluators had to analyze the number of articular fragments, their displacement, the direction of the main fracture line and the presence of comminution. To determine intraobserver agreement, the same evaluator analyzed the cases after six weeks.

The statistical analysis was performed with Epidat software version 4.2 (2016). The kappa coefficient was used to determine the degree of agreement between the evaluators, expressed with a 95% confidence interval. Agreement was measured for types I, II, III and IV, and for subtypes. Agreement levels (kappa coefficient) were those proposed by Landis and Koch.⁷ Table 1 details the interpretation of the kappa coefficient.

Table 1. Interpretation of the kappa coefficient

Kappa coefficient	Agreement strength
<0,20	Poor
0,21-0,40	Weak
0,41-0,60	Moderate
0,61-0,80	Good
0,81-1,00	Very Good

RESULTS

Intraobserver agreement between the first and second assessments was 0.5737, moderate (Fellow 1) and 0.8592, good (Fellow 2); and 0.639, good (Resident 1) and 0.85, very good (Resident 2) (Table 2).

Table 2. Intraobserver agreement (between the first and second assessment)

	Observed agreement	Kappa coefficient	95% confidence interval (kappa)	Statistical significance
Fellow 1*	72.22%	0.5737	[0.3894; 0.7580]	p <0.0001
Fellow 2*	90.74%	0.8592	[0.7418; 0.9767]	p <0.0001
Resident 1	57.41%	0.639	[0.2804; 0.6092]	p <0.0001
Resident 2	87.04%	0.859	[0.7112; 0.9486]	p <0.0001

*Physician attending sub-specialization in ankle and foot.

Interobserver agreement for the classification of tibial plafond fractures yielded an overall kappa coefficient of 0.7156 (95%CI 0.60-0.83) when all fractures were considered by all evaluators. Table 3 shows the interobserver agreement values.

The agreement obtained was 68.52% among ankle and foot fellows, and 74.07% among residents.

Table 3. Interobserver agreement

Type of fracture	Kappa coefficient	95% confidence interval
Type I	0.74	0.68-0.80
Type II	0.88	0.78-0.98
Type III	0.62	0.47-0.77
Type IV	0.65	0.49-0.81
Global kappa	0.71	0.60-0.83

DISCUSSION

There are multiple systems for classifying tibial plafond fractures, the most commonly used are the AO and Ruedi-Allgower classifications. Both are inclusive and easy to apply; however, some studies show certain limitations. These classification systems do not provide accurate information on fracture morphology and have poor to moderate interobserver agreement.^{5,8}

The Leonetti and Tigani classification is a simple tool that includes different fracture patterns of the tibial plafond and provides adequate information on fracture morphology based on CT. The use of CT is widely supported in the literature and is used in trauma centers for the management and surgical planning of tibial plafond fractures.⁹⁻¹¹

This tomographic classification system is based on the number of articular fragments and on the evaluation of the direction of the major sagittal or coronal fracture line.

The overall interobserver kappa coefficient of our study was lower than that of the original publication, 0.88.⁵

There is evidence that independent evaluations of grading systems yield lower levels of agreement¹¹⁻¹³ In our study, the evaluation was performed by ankle and foot fellows and residents in their final year of training; according to the literature, this could lead to lower levels of agreement.^{12,14-16}

The AO and Ruedi-Allgower classification systems have had moderate agreement, whereas, in the Leonetti and Tigani classification, the levels of agreement are better: kappa coefficient 0.696 and 0.885, or very good. One of the reasons could be that this new classification is tomographic. However, Ramappa et al.¹² published a moderate intraobserver and interobserver agreement comparing the AO, Ruedi-Allgower and Toplis classifications using CT. Therefore, what would allow a classification to have a better agreement is not the modality of the image, but the simplicity and its easy application.

Intraobserver agreement was good to very good for residents, and moderate to very good for ankle and foot fellows, between the first and second assessments. The residents had better agreement (74.07%) than the two fellows (68.52%) between the first and second assessments.

Interobserver agreement was good (0.71) when all fractures (types I-IV) were considered, but also when subtypes were considered. This could be due to the fact that this system has fewer categories than the rest of the classifications. The greater the number of categories, the greater the information, but the lower the confidence.

CONCLUSIONS

The pilon fracture classification system proposed by Leonetti and Tigani achieves higher agreement levels than those of previous studies of other classifications. These agreements were reached by physicians with different levels of experience and knowledge. Our findings contribute to the external and independent validation of this new classification system.

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REFERENCES

1. Helfet DL, Koval K, Pappas J, Sanders RW, DiPasquale T. Intraarticular “pilon” fracture of the tibia. *Clin Orthop Relat Res* 1994;(298):221-8. PMID: 8118979
2. Korkmaz A, Çiftdemir M, Özcan M, Çopuroglu C, Sarıdoğan K. The analysis of the variables, affecting outcome in surgically treated tibia pilon fractured patients. *Injury* 2013;44(10):1270-4. <https://doi.org/10.1016/j.injury.2013.06.016>
3. Martin JS, Marsh JL, Bonar SK, DeCoster TA, Found EM, Brandser EA. Assessment of the AO/ASIF fracture classification for the distal tibia. *J Orthop Trauma* 1997;11(7):477-83. <https://doi.org/10.1097/00005131-199710000-00004>
4. Dirschl DR, Adams GL. A critical assessment of factors influencing reliability in the classification of fractures, using fractures of the tibial plafond as a model. *J Orthop Trauma* 1997;11(7):471-76. <https://doi.org/10.1097/00005131-199710000-00003>
5. Leonetti D, Tigani D. Pilon fractures: A new classification system based on CT scan. *Injury* 2017(10);48:2311-7. <https://doi.org/10.1016/j.injury.2017.07.026>
6. Palma J, Villa A, Mery P, Abarca M, Mora A, Peña A, et al. A new classification system for pilon fractures based on CT scan: An independent interobserver and intraobserver agreement evaluation. *J Am Acad Orthop Surg* 2020;28(5):208-13. <https://doi.org/10.5435/JAAOS-D-19-00390>
7. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33(1):158-74. <https://doi.org/10.2307/2529310>
8. Swiontkowski MF, Sands AK, Agel J, Diab M, Schwappach JR, Kreder HJ. Interobserver variation in the AO/OTA fracture classification system for pilon fractures: Is there a problem? *J Orthop Trauma* 1997;11(7):467-70. <https://doi.org/10.1097/00005131-199710000-00002>

9. Topliss CJ, Jackson M, Atkins RM. Anatomy of pilon fractures of the distal tibia. *J Bone Joint Surg Br* 2005;87(5):692-7. <https://doi.org/10.1302/0301-620X.87B5.15982>
10. Krettek C, Bachmann S. [Pilon fractures. Part 1: Diagnostics, treatment strategies and approaches]. *Chirurg* 2015;86(1):87-101; quiz 102-4. <https://doi.org/10.1007/s00104-014-2895-7> [German]
11. Tornetta P, Gorup J. Axial computed tomography of pilon fractures. *Clin Orthop Relat Res* 1996;(323):273-6. <https://doi.org/10.1097/00003086-199602000-00037>
12. Ramappa M, Bajwa A, Singh A, Mackenney P, Hui A, Port A. Interobserver and intraobserver variations in tibial pilon fracture classification systems. *Foot* 2010;20(2-3):61-3. <https://doi.org/10.1016/j.foot.2010.06.002>
13. Urrutia J, Zamora T, Yurac R, Campos M, Palma J, Mobarec S, et al. An independent interobserver reliability and intraobserver reproducibility evaluation of the new AOSpine thoracolumbar spine injury classification system. *Spine (Phila Pa 1976)* 2015;40(1):E54-E58. <https://doi.org/10.1097/BRS.0000000000000656>
14. Millar SC, Arnold JB, Thewlis D, Fraysse F, Solomon LB. A systematic literature review of tibial plateau fractures: What classifications are used and how reliable and useful are they? *Injury* 2018;49(3):473-90. <https://doi.org/10.1016/j.injury.2018.01.025>
15. Urrutia J, Zamora T, Yurac R, Campos M, Palma J, Mobarec S, et al. An independent inter-and intraobserver agreement evaluation of the AOSpine subaxial cervical spine injury classification system. *Spine (Phila Pa 1976)* 2017;42(5):298-303. <https://doi.org/10.1097/BRS.0000000000001302>
16. Kristiansen B, Andersen UL, Olsen CA, Varmarken JE. The Neer classification of fractures of the proximal humerus. An assessment of interobserver variation. *Skeletal Radiol* 1988;17(6):420-2. 20. <https://doi.org/10.1007/BF00361661>

Experience in Managing War Trauma with a Damage Control Approach in the Hospital for Patients with Femur or Tibia Fractures

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ABSTRACT

Introduction: The Central Military Hospital of Bogotá, Colombia has a specialized team for treating war trauma patients. They conduct an initial assessment of patients and promptly manage potentially fatal injuries using a damage control approach that aims to save the patient's life, save the limb, and preserve its function. **Materials and Methods:** An observational, descriptive, cross-sectional study was conducted on patients from the Colombian armed forces who, between 2012 and 2020, had femur or tibia fractures as a result of war trauma; these patients were treated using external fixation by the orthopedics and traumatology service of the Central Military Hospital in Bogotá, Colombia. **Objectives:** To describe the complications associated with war trauma following a year of treatment for femur and/or tibia fractures under a damage control protocol at the Central Military Hospital, the nation's reference facility for this kind of trauma. **Results:** A retrospective review of war trauma patients between 2012 and 2020 with femoral or tibial fractures treated with DCO was performed. Fisher's Exact tests were used for comparisons. Seventy-two soldiers were selected, 96% of fractures were open, 91% (66 cases) had some type of complication such as nerve injury, vascular injury, coverage defect, infection, and nonunion. **Conclusions:** In our country, war trauma persists as one of the causes of polytrauma in young patients, which has significant clinical and financial implications. Bone injuries of severely affected extremities require staged management based on external fixation according to damage control principles.

Keywords: Trauma; damage control; fracture; tibia; femur.

Level of Evidence: IV

Experiencia en el manejo del trauma de guerra con un enfoque de control de daños en el hospital para pacientes con fracturas de fémur o tibia

RESUMEN

Introducción: El Hospital Militar Central cuenta con un grupo especial para la atención de pacientes con trauma de guerra que incluye una evaluación inicial y manejo urgente de las lesiones que amenacen la vida, mediante un enfoque de control de daños que busca preservar la vida del paciente, salvar la extremidad y conservar su función. **Materiales y Métodos:** Estudio observacional, descriptivo, transversal de pacientes de las fuerzas militares de Colombia, que sufrieron fracturas de fémur o tibia por trauma de guerra entre 2012 y 2020; y tratados mediante fijación externa en este Hospital. **Objetivos:** Describir las complicaciones del trauma de guerra tras un año de manejo de pacientes con fracturas de fémur o tibia utilizando un protocolo de control de daños en el Hospital Militar Central centro de referencia para este tipo de trauma en el país. **Resultados:** Se realizó una revisión retrospectiva de pacientes con fracturas femorales o tibiales por traumas de guerra entre 2012 y 2020, manejados con un protocolo de control de daños. Se seleccionaron 72 soldados, el 96% de las fracturas eran abiertas, el 91% (66 casos) sufrió alguna complicación, como lesión nerviosa, lesión vascular, defecto de cobertura, infección, falta de consolidación. **Conclusiones:** El trauma de guerra continúa representando una de las etiologías de politraumatismo en pacientes jóvenes de nuestro país que, a su vez, sigue teniendo grandes implicaciones clínicas y económicas. Las lesiones óseas de las extremidades requieren un manejo por etapas basado en la fijación externa según los principios de control de daños.

Palabras clave: Trauma; control de daños; fractura; tibia; fémur.

Nivel de Evidencia: IV

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INTRODUCTION

The conflict between political parties during the *La Violencia* period, the failed agrarian reform, and the actions of some strongholds that refused to surrender their weapons after General Gustavo Rojas Pinilla granted amnesty were fertile ground for the formation of guerrilla and paramilitary groups that sought to mitigate their actions. This armed confrontation, whose main sources of financing have been drug trafficking, illegal mining, extortion, kidnapping and selective homicides, has lasted for more than 50 years¹ and has affected more than 9,099,358 people through serious violations of International Humanitarian Law and international human rights norms, mainly through behaviors such as forced disappearance, forced displacement and homicide.² In short, it is a conflict characterized by periods of escalation that has sought to sow fear in the population through episodes of extreme cruelty, brutality and torture, especially in members of the security forces.¹

Although the State has attempted to reclaim territorial control, its efforts have been thwarted by reprisals against the population and security forces, which have resulted in the use of non-conventional weapons with greater destructive potential, such as cylinder bombs, incendiary bombs, Molotov bombs, gasoline-filled pots, fragmentation grenades, handmade tanks, *tatucos*, anti-personnel mines, and vehicle bombs.^{1,3,4} The usage of war materials explains why Colombia ranks second only to Afghanistan in the number of casualties of anti-personnel mines and explosive remnants of war, and first in the number of victims of security forces; it is the only country in America where these weapons are still utilized.⁴

Thus, when the course of the conflict required the State to reclaim territory controlled by terrorist groups, the Central Military Hospital served as a strategic reserve for the care of all wounded military personnel (Figure 1), where medical care strategies were developed that reduced deaths and increased the survival of all the wounded, an example of which was the implementation of the model of care for the war wounded through the “*Plan pantera*”.⁵ Thus, it is evident how the oldest conflict in Latin America has shaped the casuistry of all professionals responsible for the care of the wounded admitted to the Central Military Hospital.



Figure 1. The sculpture “Wounded Soldier” by José Eduardo Ordoñez was donated to the Central Military Hospital in 2003 and represents all the pride and invaluable effort of the medical and paramedical personnel of the Colombian Armed Forces during more than 60 years of conflict. Photo taken from HOMIL social network, 82nd anniversary. Date: April 18, 2021.

Regarding war trauma, it is well documented that the extremities are the main target;⁶⁻¹⁰ in some descriptions, such as that of Koržinek et al.,⁷ they account for 75% with respect to other parts of the body, and up to one third of them have bone involvement.

The initial approach to the combat wounded by an interdisciplinary group at the Central Military Hospital deserves special mention.^{5,11} As part of this approach, the orthopedics and traumatology group, which receives up to 40% of the combat wounded,⁸ is responsible for the initial evaluation of the affected extremity using some classifications, such as that of Gustilo and Anderson, 1976, with its subsequent modifications^{12,13} and the Mangled Extremity Severity Score,¹⁴ which are useful tools when used cautiously for decision making,^{15,16} to avoid permanent disability from amputation or increased mortality from a prolonged course of interventions in failed limb salvage.¹⁶ These high-energy injuries cause significant involvement of soft tissue, neurovascular structures and bone tissue.^{5,17,18} Therefore, rapid physiological restoration is critical, a premise based on *damage control surgery*, a term coined in 1940 in the navy and later applied to surgery. It has recently been extended to the field of orthopedics under the name of *damage control orthopedics*, aimed at preserving the patient's life, saving the limb, and preserving function¹⁹ with the use of external fixators. In particular, the use of external fixators constitutes a valuable measure in the easy and rapid stabilization of fractures, avoids complications associated with prolonged and definitive orthopedic treatments, a phenomenon known as *second hit* and under the premise of *do no further harm*,¹⁹⁻²¹ thus creating a favorable environment for bleeding control, pain management and for limiting further damage to soft tissues and neurovascular structures by free bone fragments.

Among the actions contemplated in this management approach is the damage inventory which includes a surgical exploration of the wound and its various planes, the removal of devitalized tissues and any foreign body, and abundant irrigation with saline solution and hydrogen peroxide for the subsequent taking of samples for cultures. This is due to the high potential of infection by materials such as soil, vegetation, clothing, tissues of other victims, and intentional contamination of war material with fecal matter by the enemy and the frequent presence of microorganisms such as *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, *Proteus mirabilis*, *Enterococcus faecalis*, *Candida albicans*, *Enterobacter cloacae* and *Serratia marcescens*.^{17,18} All of these microorganisms have significant resistance patterns and, in most cases, the infections are polymicrobial.

In this sense, although there are several publications on war trauma in multiple war confrontations throughout history, femur and tibia fractures are an area that lacks publications in Colombia and Latin America, so efforts to elucidate the lessons of the Colombian armed conflict in this area are valuable.

The purpose of this study was to describe the complications and outcomes observed during one year of management of combat-wounded patients of the Colombian military forces, aged 18 to 40 years, treated by external fixation and damage control protocols, at the Central Military Hospital, between 2012 and 2020.

Taking into account that the Central Military Hospital is a reference institution for this type of trauma in the country, it provides valuable experience in the management of these injuries that have particular characteristics, such as their association with polytrauma, the great comminution and bone contamination resulting from high-energy trauma caused by high-velocity firearms, anti-personnel mines, explosive devices, fragmentation grenades, cylinder bombs and all types of non-conventional weapons, interventions that are not exempt from complications (Figure 2).

In light of the above, this is an effort to share the lessons learned for the training of professionals at the national and international level, laying the groundwork for the development of new studies with a higher level of evidence that will allow the implementation of protocols in the care of other types of trauma.

Armed conflicts in the history of mankind have been the genesis of multiple advances in strategic, technological and scientific terms. Medicine is proof of this, since it has undergone ongoing change and innovation in an effort to handle the vast range of injuries sustained by soldiers as a result of the deployment of increasingly atrocious and ruthless weaponry. These advances have been developed from research and evidence-building processes aimed at identifying interventions that reduce mortality and sequelae, and augur a better prognosis for the victims of the conflict.



Figure 2. Excerpt from Oración patria: “To be your soldier is the greatest of my glories, my greatest ambition is to carry with honor the title of Colombian and, if necessary, die to defend you”. Photo taken from CGFM social network posted on September 30, 2019.

Thus, and taking into account the internal war context, characterized by the use of non-conventional weapons and the generation of injuries with special particularities, there is great interest in producing medical literature on the management of this group of patients and identifying injuries to improve protocols for the care of war trauma or extrapolate such management to other types of more everyday injuries.

Therefore, this study is of great value for the training of health professionals and initial trauma care groups, sowing the seeds for new interventions aimed at saving lives and reducing the social and economic cost of the care, management and rehabilitation of all combat wounded in our country.

MATERIALS AND METHODS

An observational, descriptive, cross-sectional study was carried out at the Central Military Hospital that included military forces personnel (Army, Navy and Air Force) in active service, with the rank of officer, non-commissioned officer, professional soldier or marine, between 18 and 40 years of age, who had suffered a femur or tibia fracture during acts of service, whatever the mechanism, by allied fire or by terrorist groups, treated by external fixation in this hospital.

Sample selection and size

A non-probability convenience sampling was performed. We selected the medical records of patients belonging to the military forces on active duty, aged between 18 and 40 years, with war trauma and who had suffered femur or tibia fractures between 2012 and 2020 during acts of service, whatever the mechanism, by allied fire

or by terrorist groups, and who had been treated with external fixation in the Orthopedics and Traumatology Service of the Central Military Hospital. The initial sample was subjected to inclusion and exclusion criteria, and the resulting sample was variable according to the search performed in the medical records and the evaluation at the time of the cohorts.

The study's descriptive characteristics do not necessitate sample calculation; however, all patients who meet the inclusion criteria between 2012 and 2020 must be included.

The inclusion criteria were:

- Patients admitted to the Central Military Hospital for war trauma between 2012 and 2020.
- Patients managed initially or during recovery at the Central Military Hospital under a damage control approach.
- Men between 18 and 40 years old.
- Patients who, during the study, were part of the military forces (Army, Navy and Air Force) on active duty, with the rank of officer, non-commissioned officer, professional soldier or marine.
- Patients with proximal, diaphyseal or distal closed or open fractures of the femur or tibia due to war trauma caused by conventional or non-conventional weapons in acts of service by allied or enemy fire.

The exclusion criteria were:

- Patients with less than one year of medical management.
- Patients who, during orthopedic treatment of war trauma injuries, would have required amputation at any level of amputation.
- Patients treated with a device other than an external fixator in the initial management of trauma.

Strategies to suppress threats to the validity of results.

- Information bias: to account for information bias, all patients' information was acquired from the unified electronic medical record registry Dinámica® and the Tharsis laboratory.
- Selection bias: patients were found using the Service's database, and patients were also found using the ICD10 code filter in Dinámica®.
- Classification bias: globally accepted definitions were considered for each of the variables, supported by the references of this publication.

Measurements and instruments used

- All variables were loaded into an Excel database, which was parameterized; the database was managed offline to ensure data security.
- Patients will only be accessible to research investigators or national authorities who require it. For security purposes, a unique identifier for the Central Military Hospital is used to guarantee the anonymity of the patients.

Procedures for data collection, instruments to be used and methods for data quality control

After obtaining authorization from the Ethics Committee, data were collected in two stages. In the first stage, data were extracted from databases that included all patients who had an external fixator placed between 2012 and 2020. Patients with femur or tibia trauma corresponding to war trauma and meeting the aforementioned inclusion criteria were selected. The information collected was entered into an Excel spreadsheet and stored under the supervision of the institutional research committee.

In the second stage, the medical records of the patients selected in the first stage were reviewed in order to record the variables to be evaluated in this study, with the values defined for each category to be evaluated, a procedure that was carried out by the principal and secondary investigators. At this stage, the costs for each of the surgical procedures and in-hospital and outpatient controls by orthopedic and traumatology specialists were also requested, as well as the current contract, fees, and modifications between the contracting Central Military Hospital and the contractor HELPEN SAS for "provision of comprehensive services in orthopedics and traumatology, neuromoni-

toring, ultrasound, virtual and 3D planning, supply of osteosynthesis material, medical devices, bone substitutes and custom-made prosthesis, surgical services (orthopedics, maxillofacial, plastic surgery, otorhinolaryngology, neurosurgery)...," which is publicly available in the transactional portal of state entities in the *Compra Eficiente* webpage.

The above information was confirmed under the consideration of another specialist to avoid bias and possible errors arising from this activity given the nature of the study.

After auditing the data for missing information, errors or extreme values and obtaining an error <3%, the data were analyzed. A descriptive analysis of the variables was performed taking into account their nature, measurement scale and categorization by applying measures of central tendency.

The data stored in Excel after the second stage were subjected to statistical analysis with this program. Subsequently, the relevant variables were analyzed together with a methodological advisor to draft the discussion and conclusions of the study.

The development of this study was in accordance with the principles of the Declaration of Helsinki of the World Medical Association, the Belmont Report and the CIOMS guidelines, and Resolution 8430 of 1993, which establishes the scientific, technical and administrative standards for health research and for this particular case, the protection of clinical data derived from the management of the clinical records regulated by Resolution 1995 of 1999 and the Statutory Law of Habeas Data 1581 of 2012 by which the general provisions for the protection of personal data are dictated and regulated by National Decree 1377 of 2013 that regulates the proper handling of sensitive data.

This is a non-risk investigation in accordance with Resolution 8430 of 1993. Non-risk research is defined as a study that uses retrospective documentary research techniques and methods and in which no intervention or intentional modification is made in the physiological, psychological, and social variables of the individuals who participate in it, including questionnaires, interviews, clinical record reviews, and others, in which no sensitive aspects of their behavior are identified or dealt with.

According to their risk profile and the sort of variables to be examined, it was determined that the study did not require informed consent, as specified in article 16 of the Ministry of Health's Resolution 8430 of 1993. This protocol was submitted to and approved by the Research Ethics Committee of the Hospital Militar Central.

RESULTS

From 2012 to 2020, 72 patients were admitted to the Central Military Hospital for trauma associated with combat injuries and met the inclusion criteria for the study analysis. The average age of the patients evaluated was 24 years (mode 19 years; min. 18, max. 37).

In no case did fracture fixation with external tutor exceed four days (2 cases) (average 0.9 days). The average hospital stay was 37 days and the average cost derived exclusively from the room for four people was 10,461,400 Colombian pesos; however, the duration of the stays was very different among the patients in the sample, with minimum periods of 2 days and maximum periods of 147 days, typical of the great variety of injuries.

Regarding outpatient follow-ups by orthopedic outpatient clinic, there was an average of five consultations (range 0-15). However, the three patients with 0 consultations were admitted multiple times to the emergency department for care, the same occurred with the nine patients with two outpatient consultations and five with one outpatient consultation, this may be due to limited economic resources for transportation from their cities of origin or due to follow-up in medical clinics of lower complexity (Table).

The most frequent type of weapon causing trauma were high-velocity projectiles (59 patients, 81%), followed by antipersonnel mines (7 patients, 9.7%) and explosive devices (6 patients, 9.2%).

Fifty-eight percent of the lesions (42 cases) were located on the left extremity and 41% (30 cases) on the right. Among the 39 cases of femoral fractures, distal and diaphyseal fractures accounted for 45% (33 cases). In the tibia, proximal and diaphyseal fractures predominated (27 cases, 37%), so that up to 41% of the sample (30 patients) had war trauma injuries with knee joint involvement (Figure 3).

Table. Average costs of medical and hospital care at the Central Military Hospital

	Number (mean, SD)	Cost per unit*	Average cost*
Hospital stay (days)	37 (27)	\$275,300	\$10,461,400
Orthopedic Controls	5 (3)	\$67,000	\$351,750

*In Colombian pesos. SD = standard deviation.

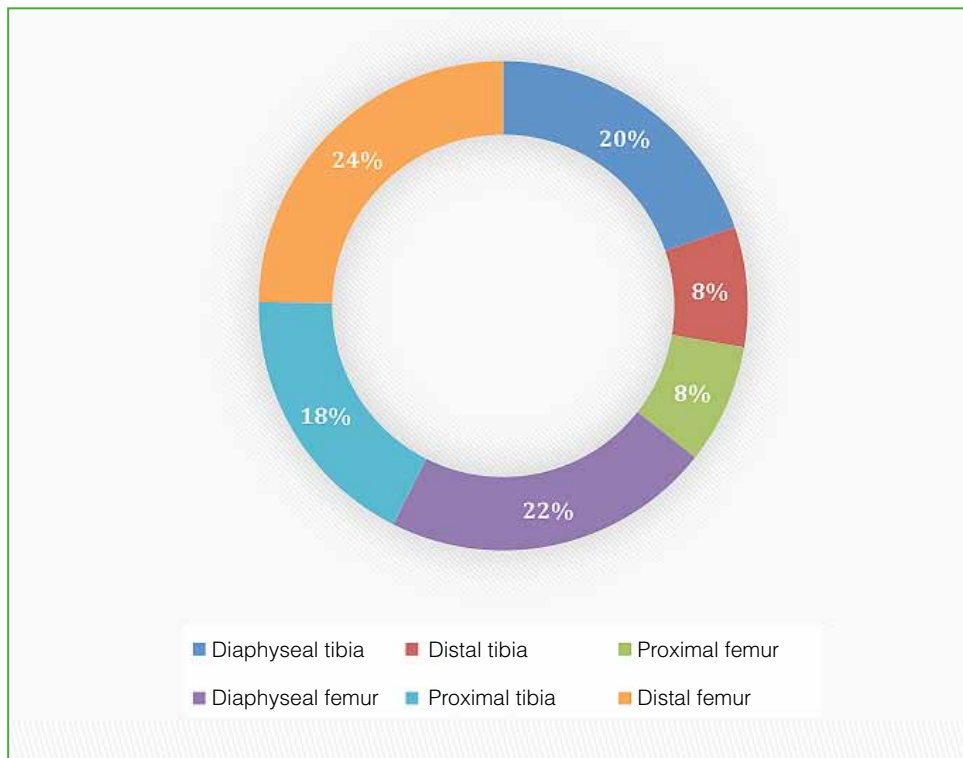


Figure 3. Location of fractures in patients seen at the Central Military Hospital, between 2012 and 2020.

Forty percent of the fractures were type IIIb of the Gustilo and Anderson classification, followed by type IIIa (33%) for a total of 53 of the 72 injured in the sample. Type IIIc fractures accounted for 16%; type II, 5%; three cases (4%) corresponded to closed fractures (Figure 4). In addition, the rate of bone loss increased with fracture severity (Figure 5).

All fractures were treated with external fixation: 40% with monolateral fixators for diaphyseal fractures and 59% with transarticular fixators for fractures of the proximal or distal thirds of the affected bone segments.

Ninety-one percent (66 cases) had some type of complication: nerve injury (9 cases, 12.5%), vascular injury (9 cases, 12.5%), coverage defect (39 cases, 54%), infection (55 cases, 76%) and nonunion (26 cases, 36%).

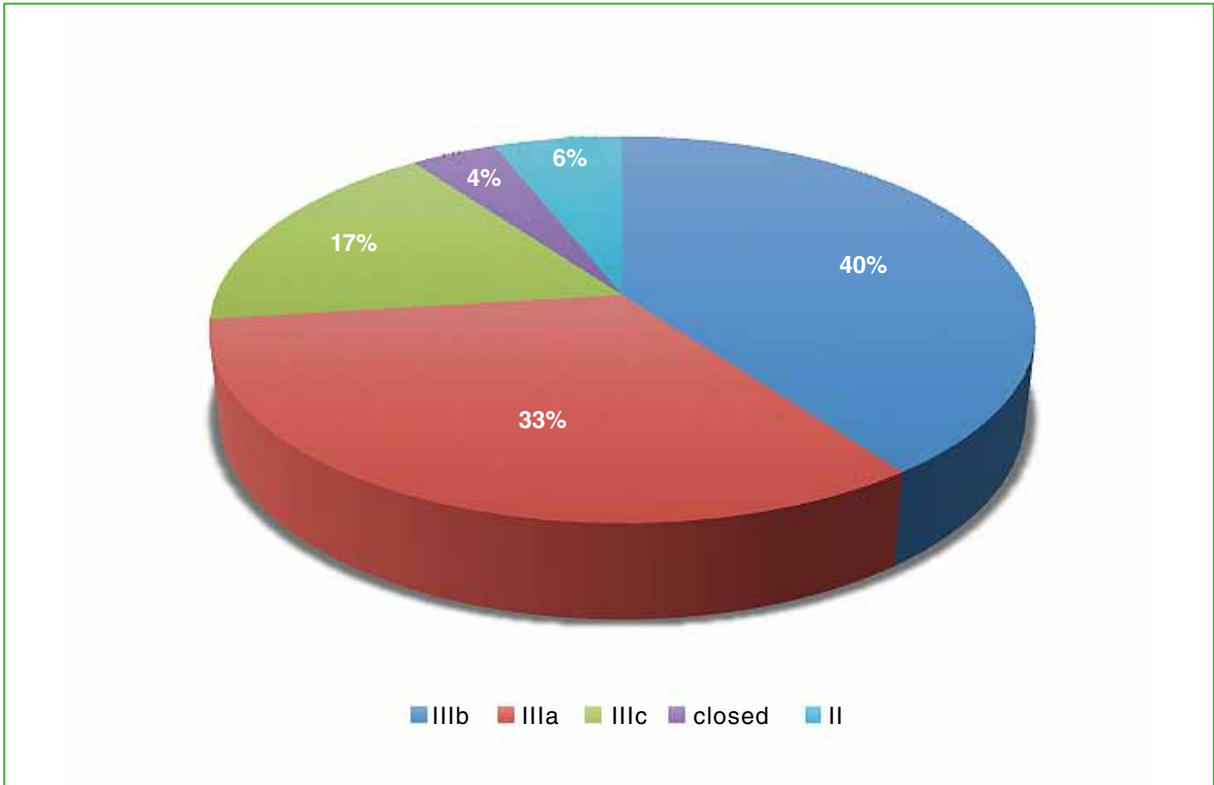


Figure 4. Gustilo and Anderson classification of patients seen at the Central Military Hospital between 2012 and 2020.

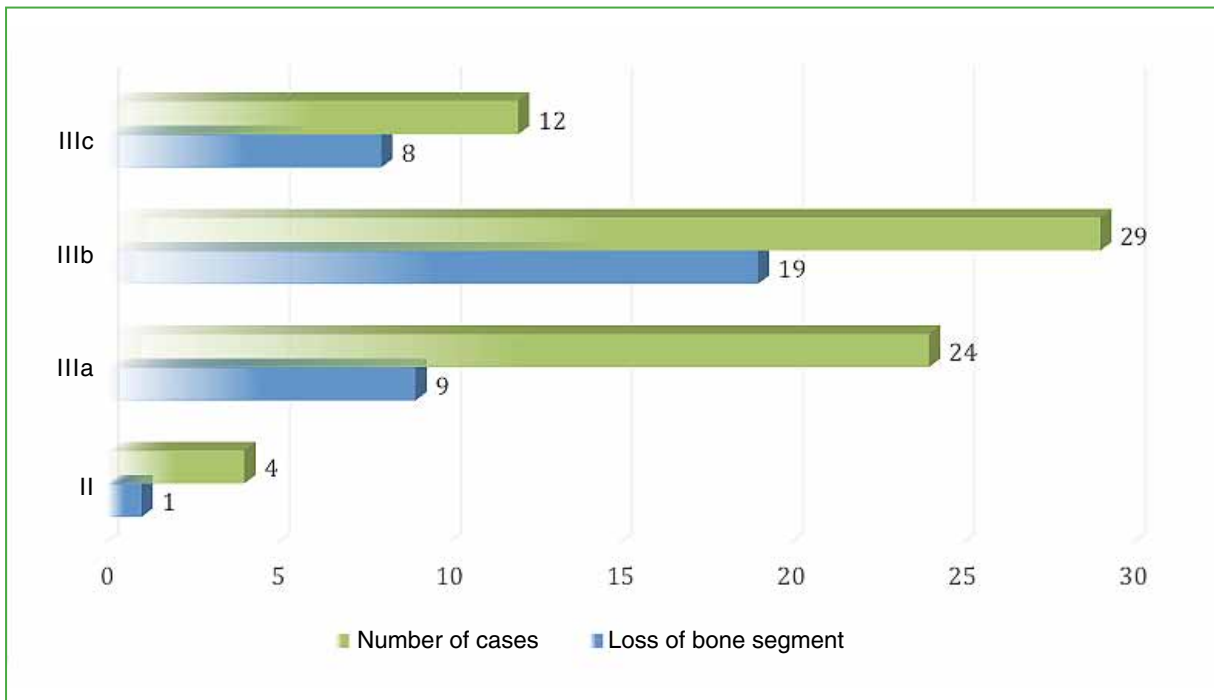


Figure 5. Patients who lost a bone segment as a result of war trauma injuries between 2012 and 2020.

Forty-four percent (32 cases) had superficial infection and 65% (47 cases) had deep infection; there were 24 cases (33%) of episodes of both superficial and deep infections. For the initial management of coverage defects and deep infections, surgical lavages were performed; more than half of the cases required more than three surgical lavages (56%). In addition, a germ was isolated in 63% of the cases. Gram-positive and gram-negative microorganisms and the number of cases are listed in Figure 6. In only eight patients, polymicrobial infections were documented.

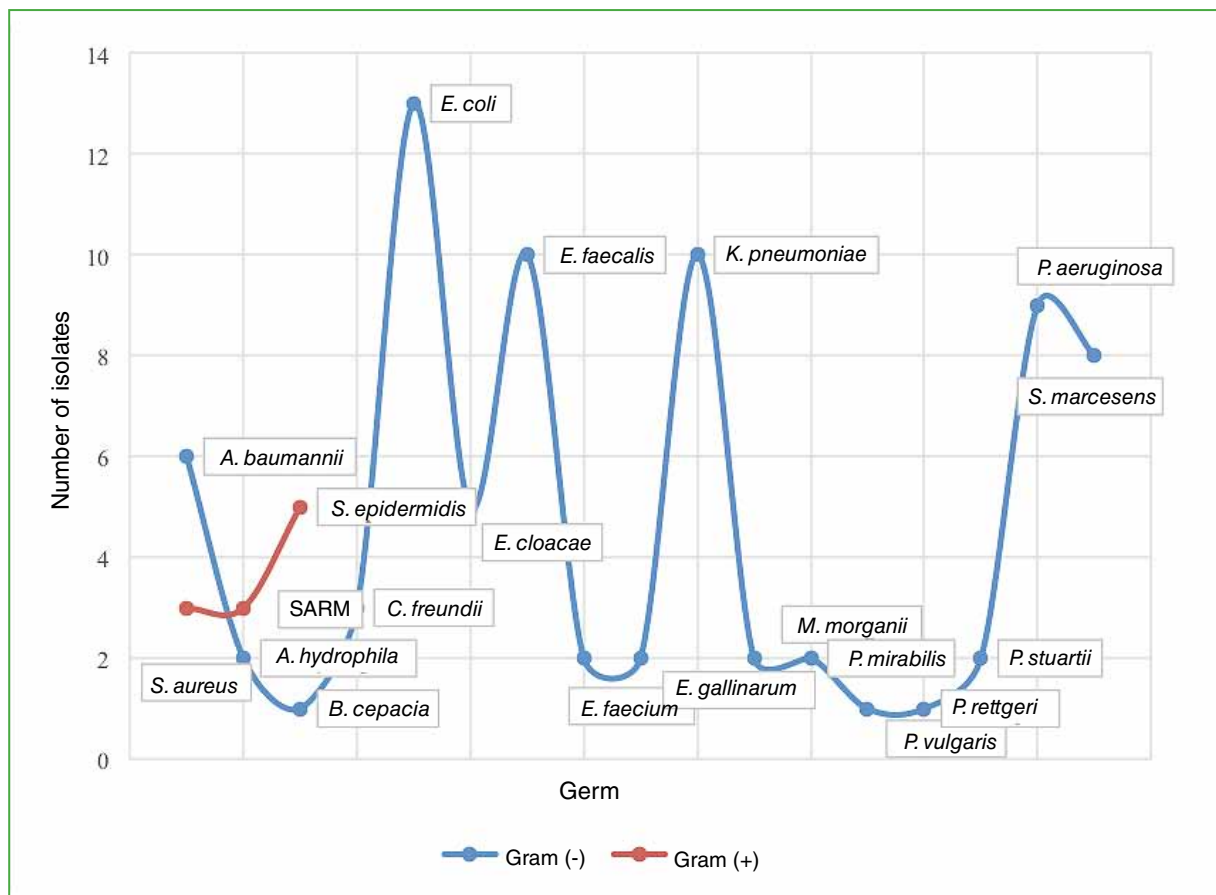


Figure 6. Gram-positive (red line) and gram-negative (blue line) microorganisms isolated from war trauma patients between 2012 and 2020.

DISCUSSION

Orthopedic damage control is not a new concept, it was developed from the management of polytraumatized patients with severe abdominal injuries, and highlighted the increased survival rate by temporarily controlling rather than definitively managing injuries leading to the lethal triad of hypothermia, acidosis and coagulopathy.

With over 80 years of service to all combat wounded of the Military Forces, the Central Military Hospital has shaped its casuistry under the premise of “do no more harm” by applying all the concepts of a damage control approach in the management of severely injured extremities by unconventional, intentionally contaminated, and high energy weaponry; all of this through rapid stabilization of fractures with external fixators up to physiological stabilization and definitive management.^{6,19-22,24}

The typical war wounded serviceman, as evidenced by the sample, is a young patient, with an average age of 24 years (min. 18, max. 37). Although high-velocity projectile trauma was the most common, it is not always the most common mechanism of injury, because patients injured by other weapons, such as mines and explosive devices, often die or require amputation of the limb, so they are not included in this study. Likewise, lesions predominated in the left lower limb and were more frequent in the femur (Case 1) (Figure 7).

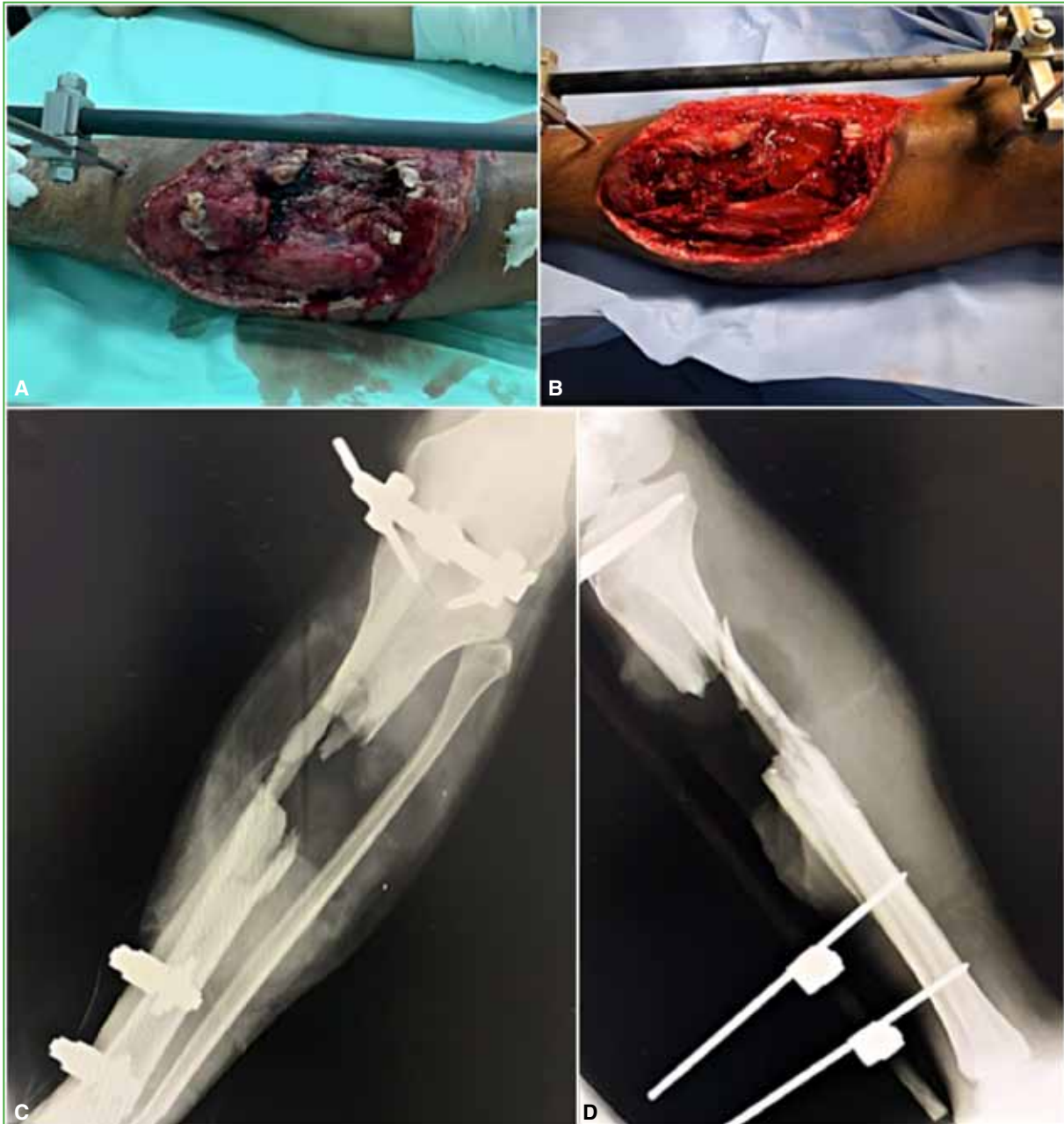


Figure 7. 19-year-old soldier with trauma secondary to a gunshot wound to the left leg. **A.** Clinical image on admission. **B.** Intraoperative image of the first surgical lavage. **C and D.** Anteroposterior and lateral radiographs of the left knee.

In our institution, victims of war trauma are admitted to the emergency department where they are comprehensively evaluated and antibiotic management is initiated to cover gram-positive and gram-negative bacteria, since it is evident that the vast majority of the microorganisms isolated in our sample are gram-negative bacteria. External fixation is preferred for orthopedic management, which corresponds to the global trend for the management of severe injuries and polytraumatized patients.^{23,24} The patient is routinely taken to surgery for a quick inventory of the injuries, regardless of their size. All are thoroughly explored, followed by surgical lavage and debridement of the devitalized tissue, taking into account the following evaluation criteria: color, muscle contractility, and bleeding. If the fracture has already been fixed with an external fixator, the stability and position of the fracture are assessed for future operations, therefore they frequently require fast adjustments. Preferably, monolateral fixation is performed in diaphyseal fractures and transarticular fixation when the bone lesion is metaphyseal or articular, always with modular systems (Case 2) (Figure 8).



Figure 8. 31-year-old soldier with trauma secondary to a gunshot wound to the right thigh. **A.** Clinical image on admission. **B.** Comparative radiography of the hip. **C.** Intraoperative imaging with external fixator. **D and E.** Anteroposterior radiographs of the right femur after surgery.

The concept of timely damage control is based on rapid stabilization for subsequent evacuation from the operating area or first level hospitals with insufficient resources and personnel, bleeding control, pain management, and avoiding additional damage to soft tissues and neurovascular structures by free bone fragments, as described by some authors.^{24,25} Although a correlation of musculoskeletal trauma with the involvement of other systems was not undertaken in this study, relationships with cranial, thoracic, and abdominal trauma were found in general. The use of mini-osteosynthesis with screws has been described to stabilize some fragments, especially articular fragments;⁹ we do not routinely perform this procedure. Furthermore, the use of osteosynthesis systems, such as plates or intramedullary systems, is not considered until any infectious process has been ruled out through serial cultures of secretion, soft tissues, bone, and until enough covering of the surrounding soft tissues has been achieved.

We use a multidisciplinary paradigm of treatment and management that is staged through early and rapid stabilization of the fracture with external fixation by orthopedics in order to control other life-threatening injuries or until physiological stability is established. Infections are treated with surgical lavage and antibiotics directed at isolated bacteria, with drug sensitivity evaluated using antibiograms and infectious diseases analyses. Simultaneously, soft tissue care is accomplished by dressings, and when there are coverage defects, vacuum-assisted closure and more complex plastic surgery methods are employed. Due to tissue conditions or recurrent infections in bone and soft tissues, conversion to plates or intramedullary systems is rarely performed. During this time, some fractures consolidate with the external tutor or are revised to revive the focus and apply either autologous bone graft, predominantly from the iliac crest, or allograft from the bone bank for subsequent consolidation.

Hospitalization and outpatient follow-up times are lengthy, and emergency readmissions occur frequently due to infectious complications; in our sample and during follow-up of all patients, more than 70% were readmitted for infection or pain. When an infectious process was documented, it was impossible to determine whether it was a recurrence of the original infection or a new infection caused by the fixator or previous surgical procedures.

During treatment and while they are active in the military, patients are provided with housing and transportation facilities at the expense of the force to which they belong. Follow-up of patients on leave or who have completed their service is often incomplete.

CONCLUSIONS

Extensively affected extremity bone injuries sustained during combat with various types of weaponry require comprehensive tiered therapeutic management based on damage control principles.

War trauma continues to represent one of the etiologies of polytrauma in young patients in our country, which, in turn, continues to cause great clinical and economic consequences, and affects the short and long-term quality of life of patients.

The characteristics and variables documented in our study make it possible to identify probable fields of action for future analytical studies that will allow us to compare populations and tools susceptible to improvements in the treatment and prevention of complications in patients with war trauma.

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

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REFERENCES

1. GMH. ¡BASTA YA! Colombia: Memorias de guerra y dignidad. Bogotá: Imprenta Nacional; 2013, p. 258-323.
2. Registro Único de Víctimas. Fecha de corte 31/12/2020. Available at: <https://cifras.unidadvictimas.gov.co/Cifras/#!/hechos> [Consulted: January 19, 2021]
3. Centro Nacional de Memoria Histórica (2016), Tomas y ataques guerrilleros (1965- 2013) CNMH-IEPRI, Bogotá. Available at: <https://centrodememoriahistorica.gov.co/tomas-y-ataques-guerrilleros-1965-2013/> [Consulted: January 19, 2021]
4. La guerra escondida: Minas antipersona y remanentes explosivos. Centro Nacional de Memoria Histórica 2020. Available at: [https://centrodememoriahistorica.gov.co/la-guerra-escondida-minas-antipersonal-y-remanentes-explosivos-en- /](https://centrodememoriahistorica.gov.co/la-guerra-escondida-minas-antipersonal-y-remanentes-explosivos-en-/) [Consulted: January 19, 2021]
5. Camargo J, Pérez LE, Franco C, Rodríguez E, Sánchez W. “Plan pantera”, trauma militar. *Rev Colomb Cir* 2011;29(4):293-304. Available at: http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S2011-75822014000400005
6. Nikolić D, Jovanović Z, Popović Z, Vulović R, Mladenović M. Primary surgical treatment of war injuries of major joints of the limbs. *Injury* 1999;30(2):129-34. [https://doi.org/10.1016/s0020-1383\(98\)00239-3](https://doi.org/10.1016/s0020-1383(98)00239-3)
7. Koržinek K, Delimar D, Tripković B. External fixator for war purposes: the CMC fixator. *Mil Med* 1999;164(5):358-60. PMID: 10332177
8. Segrt B. Particularities of the therapeutic procedures and success in treatment of combat-related lower extremities injuries. *Vojnosanit Pregl* 2014;71(3):239-44. <https://doi.org/10.2298/vsp1403239s>
9. Owens BD, Kragh JF Jr, Wenke JC, Macaitis J, Wade CE, Holcomb JB. Combat wounds in operation Iraqi Freedom and operation Enduring Freedom. *J Trauma* 2008;64(2):295-9. <https://doi.org/10.1097/TA.0b013e318163b875>
10. Chandler H, MacLeod K, Penn-Barwell JG; Severe Lower Extremity Combat Trauma (SeLECT) Study Group. Extremity injuries sustained by the UK military in the Iraq and Afghanistan conflicts: 2003-2014. *Injury* 2017;48(7):1439-43. <https://doi.org/10.1016/j.injury.2017.05.022>
11. Valencia C, Suárez J, Cogollos Á, Uribe R, Flores G. Heridos en combate, experiencia del Grupo de Trauma del Hospital Militar Central de Bogotá. *Rev Colomb Cir* 2015;30(1):18-23. Available at: http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S2011-75822015000100003&lng=en
12. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. *J Bone Joint Surg Am* 1976;58(4):453-8. PMID: 773941
13. Yim GH, Hardwicke JT. The evolution and interpretation of the Gustilo and Anderson classification. *J Bone Joint Surg Am* 2018;100(24):e152. <https://doi.org/10.2106/JBJS.18.00342>
14. Johansen K, Daines M, Howey T, Helfet D, Hansen ST Jr. Objective criteria accurately predict amputation following lower extremity trauma. *J Trauma* 1990;30(5):568-72; discussion 572-3. <https://doi.org/10.1097/00005373-199005000-00007>
15. Durrant CA, Mackey SP. Orthoplastic classification systems: the good, the bad, and the ungainly. *Ann Plast Surg* 2011;66(1):9-12. <https://doi.org/10.1097/SAP.0b013e3181f88ecf>
16. Doucet JJ, Galarneau MR, Potenza BM, Bansal V, Lee JG, Schwartz AK, et al. Combat versus civilian open tibia fractures: the effect of blast mechanism on limb salvage. *J Trauma* 2011;70(5):1241-7. <https://doi.org/10.1097/TA.0b013e3182095b52>
17. Suárez F, Satizábal C, Calderón O, Ramírez V, García A, Náquira L. Flora bacteriana en heridas de guerra. Experiencia de dos años en el Hospital Militar Central de Bogotá. *Revista Med* 2008;16(1):127-33. Available at: http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0121-52562008000100017
18. Méndez M, Ramírez A, Jiménez S, Vargas A, Gómez A, Bandera J, et al. Flora bacteriana en fracturas abiertas de grado III ocasionadas por traumatismo de guerra. *Rev Colomb Ortop Traumatol* 2018;32(1):38-42. <https://doi.org/10.1016/j.rccot.2017.07.006>
19. Mathieu L, Bertani A, Gaillard C, Chaudier P, Ollat D, Bauer B, et al. Surgical management of combat-related upper extremity injuries. *Chir Main* 2014;33(3):174-82. <https://doi.org/10.1016/j.main.2014.02.003>
20. Kalinterakis G, Koutras A, Syllaios A, Michalakeas N, Lytras D, Tsilikis I. The evolution and impact of the “damage control orthopedics” paradigm in combat surgery: a review. *Eur J Orthop Surg Traumatol* 2019;29(3):501-8. <https://doi.org/10.1007/s00590-018-2320-x>
21. Giannoudis PV. Surgical priorities in damage control in polytrauma. *J Bone Joint Surg Br* 2003;85(4):478-83. <https://doi.org/10.1302/0301-620x.85b4.14217>

22. Roberts CS, Pape HC, Jones AL, Malkani AL, Rodriguez JL, Giannoudis PV. Damage control orthopaedics: evolving concepts in the treatment of patients who have sustained orthopaedic trauma. En: Tornetta P III (ed). *Instructional Course Lecture Trauma*. Illinois: American Academy of Orthopaedic Surgeons; 2006, p. 319-34.
23. Pape HC, Hildebrand F, Pertschy S, Zelle B, Garapati R, Grimme K, et al. Changes in the management of femoral shaft fractures in polytrauma patients: From early total care to damage control orthopaedic surgery. *J Trauma* 2002;53(3):452-61; discussion 461-2. <https://doi.org/10.1097/00005373-200209000-00010>
24. Covey DC. Combat orthopaedics: a view from the trenches *J Am Acad Orthop Surg* 2006;14(1):10-7. <https://doi.org/10.5435/00124635-200600001-00004>
25. Rigal S, Tripon P, Rochat G. Le fixateur en chirurgie de guerre. In: *Cahiers d'enseignement de la SOFCOT* N° 58. Fixation externe du squelette. Paris: Expansion Scientifique Francaise; 1996, p. 277-9.

Biological Reconstruction of Large Bone Defects with Vascularized Fibular Autograft

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ABSTRACT

Background: Given its biological and structural qualities, vascular fibular autograft is a good option for the reconstruction of large defects in long bones. **Materials and Methods:** A descriptive and retrospective observational study was conducted. We included all cases of patients who underwent surgery in our hospital between January 1, 2014, and January 1, 2021, and who had a vascular fibula autograft either standalone or in combination with a structural graft (Capanna technique). **Results:** There were 26 documented vascular fibula autograft procedures. Eight of the procedures involved the reconstruction of a long bone defect. The bone defect was an average of 7.7 cm in length. In five of the cases, the origin of the bone defect was post-traumatic, and in the remaining cases, it was tumoral. In all cases, complete consolidation was achieved. Surgical procedures performed on the lower extremities yielded better clinical and functional outcomes. **Conclusions:** Vascular fibula autograft either on its own or in combination with a structural graft, as described in the Capanna technique, is an excellent alternative for the reconstruction of bone defects ≥ 5 cm. Radiological, clinical and functional outcomes are good, with an acceptable rate of complications.

Keywords: Autograft; free tissue flap; reconstruction; bone defect.

Level of Evidence: IV

Reconstrucción biológica de grandes defectos óseos con autoinjerto de peroné vascularizado en huesos largos

RESUMEN

Introducción: El autoinjerto vascular de peroné se presenta como una muy buena opción en la reconstrucción de grandes defectos óseos en huesos largos gracias a sus características estructurales y propiedades biológicas. **Materiales y Métodos:** Se realizó un estudio observacional descriptivo y retrospectivo que incluyó a todos los pacientes operados con un injerto vascular de peroné aislado o asociado a injerto estructural (técnica de Capanna) desde el 1 de enero de 2014 hasta el 1 de enero de 2021 en nuestro hospital. **Resultados:** Se realizaron 26 cirugías mediante un injerto vascular de peroné; en 8 de ellas, se utilizó el colgajo vascularizado de peroné para la reconstrucción del defecto óseo en hueso largo. El tamaño medio del defecto era de 7,7 cm. El origen del defecto era postraumático en 5 casos y tumoral en el resto. Se consiguió la consolidación completa en todos los pacientes. Los resultados clínicos y funcionales en las escalas de valoración fueron mejores en pacientes operados en el miembro inferior. **Conclusiones:** El uso de un colgajo vascularizado de peroné asociado o no a aloinjerto estructural es una estrategia útil en la reconstrucción de grandes defectos óseos (≥ 5 cm), independientemente de la causa de la lesión; la supervivencia del injerto y la función son buenas, con una tasa de complicaciones aceptable.

Palabras clave: Autoinjerto; colgajo libre; reconstrucción; defecto óseo.

Nivel de Evidencia: IV

INTRODUCTION

The reconstruction of large bone defects is a challenge for the orthopedic surgeon both because of the complexity of the patient and the technical difficulty of the surgery. This requires a high degree of specialization and involvement of the specialist who carries out the entire process, from early diagnosis to the patient's final discharge.

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The reconstruction of large bone defects can be performed by means of: mechanical systems (megaprosthesis), mixed systems (composite) and biological reconstructions (vascularized grafts).

Vascularized bone grafts have been proposed as an alternative in the reconstruction of long bones since Crock's studies in 1967 on vascular support in lower limb bones. In 1975, Taylor performed the first vascularized fibula flap (VFF) with a posterior approach. In 1979, Gilbert improved the technique with the lateral approach used today.¹

Reconstruction using vascularized versus non-vascularized grafts is proposed because, although they are more technically complex, they are especially indicated for defects >5 cm, have better long-term results and consolidation rates, and cause fewer complications due to their better biological properties.² Vascular anastomosis produces a revascularization of the graft that preserves the function of osteoblasts and osteoclasts facilitating remodeling and osseointegration of the graft in a more efficient manner.

The vascularized fibula graft, in particular, is the most extensively utilized microvascular bone flap due to its remarkable versatility for reconstructions, as it allows single or double-barreled assemblies or the association of musculocutaneous flaps to correct coverage defects.^{2,3} All of these alternatives allow it to be used in defects ranging in size from 5 cm to 25 cm, as long as the last 7 cm distal and 4 cm proximal of the fibula are spared to avoid complications in the donor area (Figure 1).



Figure 1. Anteroposterior radiograph of the donor area of the fibula. Radiographic control after fibula extraction.

For all these reasons, the main objective of our study was to review a series of patients operated on using this technique in our hospital. The secondary objective was to conduct a literature review on the subject to compare our results with those that have been published.

MATERIALS AND METHODS

A descriptive and retrospective observational study was conducted and included all operated patients in whom a vascularized fibula graft was used in isolation or associated with structural grafting (Capanna technique) from January 1, 2014 to January 1, 2021, at our Center. The objective was to evaluate the effectiveness of the vascularized free fibula flap in long bone reconstruction.

The vascular fibula graft is a highly complex surgical technique that two teams perform in the same operation. In the preoperative study, the length of the fibula needed to reconstruct the defect is planned and a computerized angiotomography is performed to visualize the vascular tree of the donor area. During surgery, one team prepares the recipient site (if treating an oncological patient, by en bloc tumor resection and, if treating a nonunion, by debridement and the necessary osteotomies for the subsequent attachment of the microvascular fibula), while the other team extracts the microvascular fibula flap in the donor site. Before proceeding to resection of the fibula, the size of the segment to be resected is verified again. A technical detail of special interest is that, to avoid flap ischemia, the flap must be kept in the donor area until the preparation of the recipient vascular area is completely finished. When the Capanna technique is used, the team working on the recipient bed prepares the structural graft (cadaveric tibia or femur allograft) by tunneling and creating a window for the passage of the fibula vascular pedicle. Once the recipient bed is prepared (and the structural graft if needed), the fibula flap with its vascular pedicle and the microvascular anastomosis in the recipient site is removed. Finally, the graft is fixed with the chosen osteosynthesis system. All flaps are monitored by Doppler ultrasound in the immediate postoperative period, including those requiring a skin island flap to cover the defect; this has been effective in assessing their clinical viability.

Patients having VFF reconstructions in areas other than the extremities, such as the mandible, were excluded, as were those with reconstructions managed with another type of graft or flap and those with insufficient medical records.

Depending on the patient's evolution, clinical and radiological follow-up took place monthly, quarterly, half-yearly, and yearly for a minimum of two years. After surgery, plain radiography was used to assess complete bone healing in both donor and recipient bones.

Demographic variables (sex and age), bone affected (femur, tibia, ulna and humerus), disease, defect size, number of previous operations, type of reconstructive procedure (isolated VFF or associated with structural graft), and complications were recorded, as well as the functional outcome of the donor site (American Orthopaedic Foot and Ankle Society (AOFAS) scale), the functional outcome of the recipient site (Musculoskeletal Tumor Society (MSTS) scale) (Table 1) for the lower limb and the QuickDASH questionnaire (Table 2) for the upper limb, among others.

Table 1. Musculoskeletal Tumor Society (MSTS) Lower Limb Function Scale (LLS)

Score	Pain	Function	Emotional component	Support	Walking	Gait	Final score
5	No pain	No restriction	Enthused	None	Unlimited	Normal	
4	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	
3	Modest	Recreational restriction	Satisfied	Brace	Limited	Minor cosmetic	
2	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	Intermediate	
1	Moderate	Partial restriction	Accepts	One cane or crutch	Inside only	Major cosmetic	
0	Severely disabling	Total restriction	Dislikes	Two canes or crutches	Not independent	Major handicap	

Taken from Arnal-Burró J, Calvo-Haro JA, Igualada-Blazquez C, Gil-Martínez P, Cuervo-Dehesa M, Vaquero-Martín J. Hemipelvectomía tras sarcomas de localización pélvica de alto grado: pronóstico en condrosarcomas frente a otros tipos histológicos. *Revista Española de Cirugía Ortopédica y Traumatología* 2016;60(1):67-74. <https://doi.org/10.1016/j.recot.2015.04.002>

Table 2. QuickDASH upper limb function scale

Quick DASH

Please rate your ability to do the following activities in the last week by circling the number below the appropriate response.

Category	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	Unable
1. Open a tight or new jar.	1	2	3	4	5
2. Do heavy household chores (e.g., wash walls, floors).	1	2	3	4	5
3. Carry a shopping bag or briefcase.	1	2	3	4	5
4. Wash your back.	1	2	3	4	5
5. Use a knife to cut food.	1	2	3	4	5
6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).	1	2	3	4	5

	No at all	Slightly	Moderate	Quite a bit	Extremely
7. During the past week, to what extent has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?	1	2	3	4	5

	Not limited at all	Slightly limited	Moderately limited	Very limited	Unable
8. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?	1	2	3	4	5

Please rate the severity of the following symptoms in the last week.	None	Mild	Moderate	Severe	Extreme
9. Arm, shoulder or hand pain.	1	2	3	4	5
10. Tingling (pins and needles) in your arm, shoulder or hand.	1	2	3	4	5

	No difficulty	Mild difficulty	Moderate difficulty	Severe difficulty	So much difficulty that I can't sleep
11. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand?	1	2	3	4	5

*Taken from Medicine Princeton Health at <https://www.princetonhcs.org/>

All these variables were analyzed from the patients' medical records and the results obtained were recorded in a data collection sheet in the SPSS 25 program where descriptive statistics were performed.

RESULTS

Between 2014 and 2021, 26 surgeries were performed with a fibula vascular graft and, in eight of them, VFF was used for the reconstruction of the bone defect in the Orthopedic Surgery and Traumatology Service of the Consorcio Hospital General Universitario de Valencia, Spain. Patients had a mean age of 42 ± 20 years, with a lower limit of 16 years and an upper limit of 72 years. The distribution according to sex, recipient bone, diagnosis and follow-up time is detailed in Table 3.

Table 3. Characteristics of study patients

Patient	Age	Sex	Diagnosis	Bone	Follow-up (months)
1	65	M	Atrophic pseudarthrosis	Femur	13
2	72	M	Atrophic pseudarthrosis	Femur	9
3	27	F	Atrophic pseudarthrosis	Ulna	12
4	56	M	Septic pseudarthrosis	Ulna	54
5	40	M	Atrophic pseudarthrosis	Humerus	42
6	37	M	Ewing's sarcoma	Tibia	54
7	25	M	Osteosarcoma	Tibia	42
8	16	M	Osteosarcoma	Tibia	96

M = male sex; F = female sex.

The average size of the defect was 7.7 cm, the smallest was 5 cm (septic pseudarthrosis of the ulna) and the largest was 17 cm (tibial osteosarcomas). Regarding the size of the VFF, on average, a longer fibula was used in the three tumor cases (21.33 ± 2.30 cm) than in the five non-tumor cases (5.30 ± 1.85 cm).

Isolated VFF was used in the upper limb and, for all lower limb cases, the Capanna technique was used, which consists of associating a structural allograft to the VFF (Figure 2).

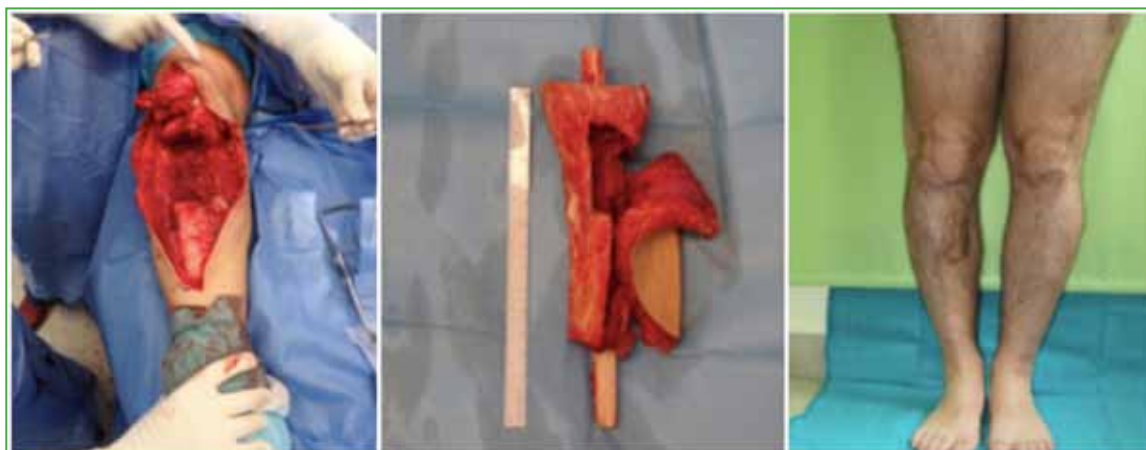


Figure 2. Resection of an osteosarcoma and preparation of the structural allograft to use the Capanna technique.

The mean time to complete radiographic consolidation was 7.16 months (standard deviation [SD] ± 0.75) (Figure 3). The mean time to consolidation was longer in the upper limb (8 months, SD ± 3) than in the lower limb (7 months, SD ± 0.70). In patients who had lower limb surgery, the average time to begin weight-bearing was 4.1 ± 1.47 months.

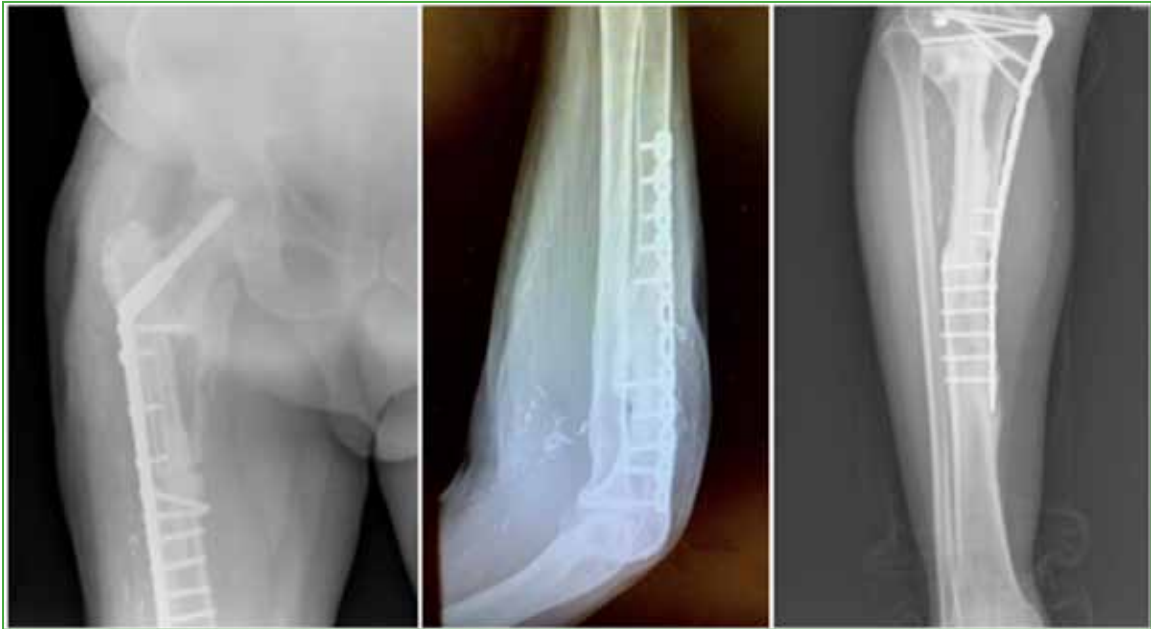


Figure 3. Anteroposterior radiographs of femur and tibia, and lateral radiographs of ulna after complete bone consolidation in radiographic controls.

The mean hospital stay was 7.12 ± 2.99 days. All remained at least one day in the intensive care unit. The mean estimated surgery time was 8 h and 40 min (SD ± 1 h and 32 min).

As for complications, given the diverse etiology for which surgery is indicated, complications were divided into three groups: medical, oncologic and surgical in both the donor and recipient sites. No medical cause of complication was recorded, understanding as such those derived indirectly from the surgery, such as respiratory failure, pulmonary thromboembolism or deep vein thrombosis, arrhythmias, heart failure, etcetera. There were also no oncologic complications in the patients operated on for this cause. None have metastasized and all are currently disease free.

Surgical complications in the recipient site were: one wound dehiscence, one breakage of the osteosynthesis material, one patient with malunion and subsequently a pathological fracture and two cases of pseudarthrosis.

Both the patient with septic pseudarthrosis of the ulna and the one with atrophic pseudarthrosis of the humerus were re-operated: the former after one year and the latter after nine months. In both cases, the focus of pseudarthrosis was in the distal pole of the graft and it was necessary to remove the original osteosynthesis material, refresh the focus, place an iliac crest graft with bone morphogenetic protein and use osteosynthesis material again.

The patient with varus malunion underwent, one year later, a corrective proximal tibial valgus osteotomy and screw plate fixation (Figure 4). The pathologic fracture occurred three years after the initial VFF operation and was treated with open reduction, bone autograft and a carbon plate.



Figure 4. Anteroposterior radiographs of the case of varus malunion.

In the donor site, there were only two cases of hallux flexus and one patient suffered a neurological sequela with allodynia and hyperesthesia that evolved favorably.

Finally, the functional score was 27 out of 30 ($n = 5$) on the MSTS scale for the lower limb, 43.93% mean ($n = 3$) on the QuickDASH questionnaire for the upper limb and 90% mean ($n = 8$) on the AOFAS scale for the donor site.

DISCUSSION

The reconstruction of large bone defects is a challenge for the orthopedic surgeon, in this field, the VFF is presented as a good technique for reconstruction in both the upper and lower limb, regardless of the etiology of the bone defect. Although few studies use standardized functional validation systems for reconstructive surgery of this type, we consider it appropriate to use specific validated scales that assess global function in the upper and lower limb, such as the QuickDASH questionnaire for the upper limb, the MSTS scale for the lower limb, and the AOFAS scale to assess the function of the foot and ankle in the donor site. In this context, it should be noted that the use of the MSTS scale for lower limb is limited because two of the five cases are not oncologic.

The results of the functional evaluations were very good, with a mean of 27 out of 30 points on the MSTS scale, similar to the score obtained by Houben et al. (26,3) in their systematic review.⁴ In the upper limb, the QuickDASH score was 43.93, considered an acceptable functional outcome. The average AOFAS score was 90 out of a potential 100 points. Therefore, VFF is shown to be a reconstructive method that achieves optimal functional outcomes, especially for treating large defects in the lower extremities. The difference between the results obtained in the upper limb and the lower limb could be due to the lower weight-bearing, which results in less graft hypertrophy, and the fact that the reconstruction of the radioulnar joint in particular is more complex due to its function (Figure 5).^{3,5-7}

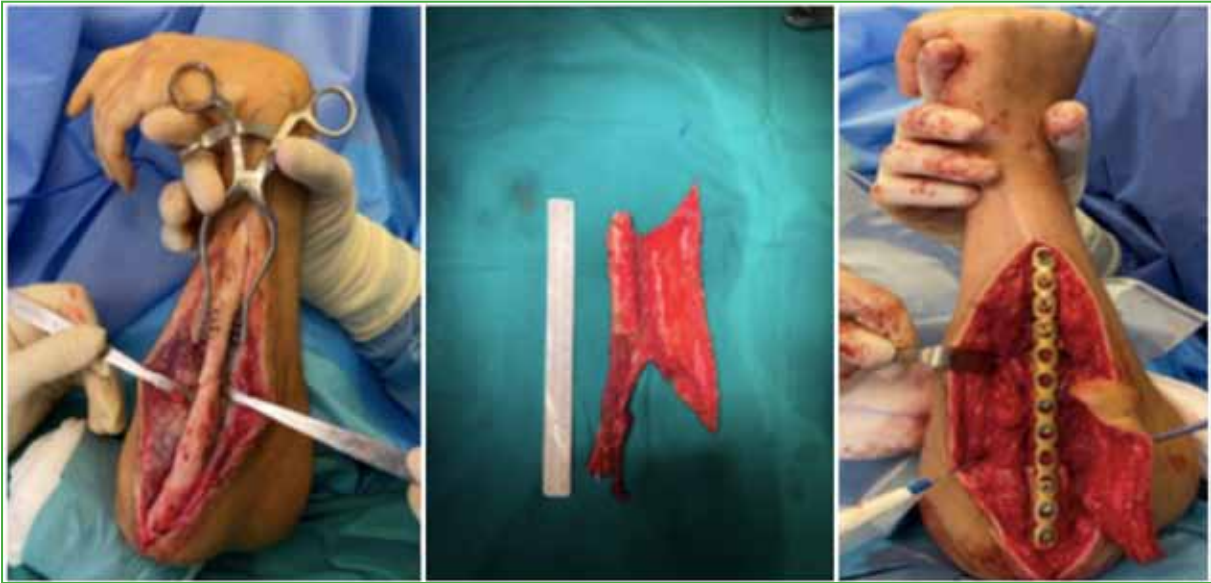


Figure 5. Fibula with its vascular pedicle fixed to the bony defect in the ulna by means of a screwed plate.

Other long bone reconstruction techniques, such as the Masquelet technique or intercalary grafts, have high complication rates, whereas FFF has a low complication rate and good long-term outcomes, though more comparative studies are needed to evaluate all of these techniques and confirm the superiority of any of them.⁸⁻¹¹ It should be noted that, with the advance of oncology, the survival of oncology patients has increased and, consequently, limb preservation treatments have had to evolve to allow limb function to be preserved. Local flaps and bone grafts often lead to insufficient reconstruction with high complication rates.^{9,10,12,13} In our study, the three patients with tibial tumors, one with Ewing's sarcoma and the other two with osteosarcomas, had a favorable evolution with great function and no recurrence up to the time of the study.

In contrast to bone allografts, the potential of rejection with VFF is negligible, and multiple studies show that the rate of consolidation in the recipient site is nearly 100% in timeframes ranging from 4 to 6 months.^{9,14,15} However, in our series, there were two cases of pseudarthrosis (25%) and the mean consolidation time was 7.17 months, slightly higher than those published. Both cases of pseudarthrosis (one of the humerus and one of the ulna) had proximal consolidation at 5 and 11 months, respectively, but not of the distal focus. After their respective reoperations, consolidation was achieved in both. The difference in our mean consolidation times compared to those of other series may be due to an interobserver discrepancy or to the diagnostic technique used to define this variable.^{15,16}

The most common complications described in the donor site are usually edema and leg weakness; however, in our study, the most frequent complication was hallux flexus. We can affirm that complications in the donor site are practically nonexistent or, at least, very easily approachable with outpatient surgery.

There were no cases of vascular permeability, all anastomoses were functional, and the rate of complications was comparable to previous studies. In our experience, reconstruction with the patient's own biological materials, such as the fibula bone flap, is a very effective procedure that provides the patient with very good long-term function of the operated limb, despite the fact that it is a highly complex technical surgery.^{2,3,6,16}

This research has several limitations and possible biases as it is a retrospective, non-randomized study with a small sample size. Potential confounding factors, such as the surgeon's surgical expertise, the various rehabilita-

tion therapies completed or not completed by the patients, and the subjective assessment provided by function scales, such as the MSTs, should be considered, as they may result in an overestimation of the results.

CONCLUSIONS

The use of a VFF associated or not with structural allograft is a useful strategy in the reconstruction of large bone defects (≥ 5 cm), regardless of the cause of the lesion. Graft survival and function are good, and the complication rate is acceptable.

As has been published, good outcomes are achieved with this technique, although, according to our experience, they are more satisfactory in the lower limb, this may be due to the fact that the association of VFF with structural allograft facilitates osseointegration in weight-bearing bones, such as the femur and tibia. It would be advisable to carry out more studies with larger samples, divided into subgroups, to corroborate this hypothesis.

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

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REFERENCES

1. Gilbert A. Vascularised transfer of the fibula shaft. *Int J Microsurg* 1979;1:100-2.
2. Sepúlveda S, Carolis FV, Andrades CP, Benítez SS, Danilla ES, Eranzo CC. Reconstrucción con colgajos libres: experiencia de 33 años. *Rev Chil Cir* 2013;65(6):502-8. <https://doi.org/10.4067/S0718-40262013000600005>
3. de la Parra-Márquez M, Zorola-Tellez O, Cárdenas-Rodríguez S, Rangel-Flores JM, Sánchez-Terrones G. Versatilidad del colgajo microvascular de peroné en reconstrucción de extremidades. *Cir Cir* 2016;84(3):213-9. <https://doi.org/10.1016/j.circir.2015.08.004>
4. Houben RH, Rots M, van den Heuvel SCM, Winters HAH. Combined massive allograft and intramedullary vascularized fibula as the primary reconstruction method for segmental bone loss in the lower extremity: A systematic review and meta-analysis. *JBJS Rev* 2019;7(8):e2. <https://doi.org/10.2106/JBJS.RVW.18.00166>
5. Tang CH. Reconstruction of the bones and joints of the upper extremity by vascularized free fibular graft: report of 46 cases. *J Reconstr Microsurg* 1992;8(4):285-92. <https://doi.org/10.1055/s-2007-1006709>
6. Capanna R, Campanacci DA, Belot N, Beltrami G, Manfrini M, Innocenti M, et al. A new reconstructive technique for intercalary defects of long bones: the association of massive allograft with vascularized fibular autograft. Long-term results and comparison with alternative techniques. *Orthop Clin North Am* 2007;38(1):51-60, vi. <https://doi.org/10.1016/j.ocl.2006.10.008>
7. Masquelet AC, Begue T. The concept of induced membrane for reconstruction of long bone defects. *Orthop Clin North Am* 2010;41(1):27-37; table of contents. <https://doi.org/10.1016/j.ocl.2009.07.011>
8. Kalra GS, Goel P, Kumar SP. Reconstruction of post-traumatic long bone defect with vascularised free fibula: A series of 28 cases. *Indian J Plast Surg* 2013;46(3):543-8. <https://doi.org/10.4103/0970-0358.122013>
9. DeCoster TA, Gehlert RJ, Mikola EA, Pirela-Cruz MA. Management of posttraumatic segmental bone defects. *J Am Acad Orthop Surg* 2004;12(1):28-38. <https://doi.org/10.5435/00124635-200401000-00005>
10. Zekry KM, Yamamoto N, Hayashi K, Takeuchi A, Alkhoody AZA, Abd-Elfattah AS, et al. Reconstruction of intercalary bone defect after resection of malignant bone tumor. *J Orthop Surg (Hong Kong)* 2019;27(1):2309499019832970. <https://doi.org/10.1177/2309499019832970>
11. Aktuglu K, Erol K, Vahabi A. Ilizarov bone transport and treatment of critical-sized tibial bone defects: a narrative review. *J Orthop Traumatol* 2019;20(1):22. <https://doi.org/10.1186/s10195-019-0527-1>
12. Jeys LM, Kulkarni A, Grimer RJ, Carter SR, Tillman RM, Abudu A. Endoprosthetic reconstruction for the treatment of musculoskeletal tumors of the appendicular skeleton and pelvis. *J Bone Joint Surg Am* 2008;90(6):1265-71. <https://doi.org/10.2106/JBJS.F.01324>

13. Landau MJ, Badash I, Yin C, Alluri RK, Patel KM. Free vascularized fibula grafting in the operative treatment of malignant bone tumors of the upper extremity: A systematic review of outcomes and complications. *J Surg Oncol* 2018;117(7):1432-9. <https://doi.org/10.1002/jso.25032>
14. Paulussen M, Ahrens S, Dunst J, Winkelmann W, Exner GU, Kotz R, et al. Localized Ewing tumor of bone: final results of the cooperative Ewing's Sarcoma Study CESS 86. *J Clin Oncol* 2001;19(6):1818-29. <https://doi.org/10.1200/JCO.2001.19.6.1818>
15. Liu S, Tao S, Tan J, Hu X, Liu H, Li Z. Long-term follow-up of fibular graft for the reconstruction of bone defects. *Medicine* 2018;97(40):2605. <https://doi.org/10.1097/md.00000000000012605>
16. Greenwald S, Boden S, Goldberg V, Khan Y, Laurencin C. Bone-graft substitutes: facts, fictions, and applications. *J Bone Joint Surg* 2001;83-A Suppl 2 Pt 2:98-103. <https://doi.org/10.2106/00004623-200100022-00007>

Knowledge about the Editorial Process of Scientific Journals: Cross-sectional Study among Orthopedic Surgeons

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ABSTRACT

Introduction: Our aim was to assess the level of knowledge of the editorial process of scientific journals among orthopedic surgeons. **Materials and Methods:** This is a cross-sectional study that evaluates participants' understanding of the editorial process of scientific journals. Between June and August 2022, a questionnaire was distributed to orthopedic surgeons who were members of the Argentinian Association of Orthopedics and Traumatology. Demographic data and variables on research experience and knowledge about the editorial process were recorded. **Results:** The survey had 130 respondents, 118 men (90.8%) and 12 women (9.2%), with a mean age of 48 years old (SD = 12). More than half of surveyed surgeons (n = 72; 55%) were from the Buenos Aires Metropolitan Area. In our study, 60% of orthopedic surgeons had a low or moderate understanding of the editorial process. A high level of knowledge of the editorial process was associated with having published more than 5 articles in indexed journals (p<0.001), in our association's journal (p<0.001), and in scientific congresses/seminars (p= 0.008). **Conclusions:** The majority of the orthopedic surgeons surveyed in our cross-sectional study had a low or moderate level of knowledge about the scientific manuscript editing process. On the other hand, having a high level of knowledge in this area was associated with more experience in the publication of scientific manuscripts in indexed journals.

Keywords: Scientific journal; peer review; knowledge; orthopedic surgeon.

Level of Evidence: IV

Conocimiento del proceso editorial de las revistas científicas: encuesta a médicos traumatólogos

RESUMEN

Introducción: El objetivo de nuestro estudio fue estimar el nivel de conocimiento de los médicos especialistas en Ortopedia y Traumatología sobre el proceso editorial de las revistas científicas. **Materiales y Métodos:** Estudio descriptivo, transversal sobre el nivel de conocimiento de los médicos traumatólogos respecto del proceso editorial de las revistas científicas, mediante un cuestionario entregado entre junio y agosto de 2022. Se registraron datos sociodemográficos y variables sobre la experiencia en investigación y el conocimiento del proceso editorial. **Resultados:** Se recibieron 130 encuestas completadas que correspondían a 118 hombres (90,8%) y 12 mujeres (9,2%) (media de la edad 48 años; DE = 12). Poco más de la mitad de la muestra (n = 72; 55%) eran traumatólogos que trabajaban en instituciones del Área Metropolitana de Buenos Aires. El 60% de los médicos encuestados poseía un conocimiento bajo o moderado del proceso editorial. Se halló una asociación estadísticamente significativa entre un nivel alto de conocimiento del proceso editorial y la publicación de más de 5 artículos en revistas indexadas (p <0,001), en la revista de nuestra Asociación (p <0,001) y en congresos o jornadas científicos (p = 0,008). **Conclusiones:** La mayoría de los traumatólogos encuestados tenía un conocimiento bajo o moderado del proceso editorial de manuscritos científicos. Por otra

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parte, un alto nivel de conocimiento al respecto tuvo una asociación estadísticamente significativa con una mayor experiencia en la publicación de manuscritos científicos en revistas indexadas.

Palabras clave: Revistas científicas; revisión por pares; conocimiento; traumatólogos.

Nivel de Evidencia: IV

INTRODUCTION

Scientific journals are the primary means of disseminating the results and advances in medicine.¹ Their main functions include permanent archiving, registration, dissemination, and certification of research.² They also provide prestige to authors and editors.³ The scientific nature of a journal is founded on two key pillars: manuscript evaluation through the peer review process and the originality of the published research.³ Peer review is the system used to evaluate the quality of scientific research before it is published. Researchers in the same field review the validity, relevance, and originality of articles to assist editors in deciding whether to publish research papers in their journal.⁴ It not only involves detecting errors, but it also provides feedback to the author throughout the final manuscript production process and aids in the selection of which study should receive more attention.^{3,4} This process allows for different types of review depending on the blinding of the authors and reviewers. We can distinguish three main types: blinded (anonymous author), double-blinded (anonymous author and reviewer) and open.⁵ Most Orthopedic and Traumatology journals adopt the double-blind mode.⁶

Authors are usually familiar with the complex and laborious task of preparing a scientific manuscript. However, what occurs after the work is submitted to the scientific journal raises a number of questions.⁶⁻⁸ The authors' knowledge of the peer review process and the functioning of the editorial flow will allow them to know how to deal with the process, interpret and adequately respond to reviewers' feedback, assimilate the results, and improve the quality of the final manuscript in pursuit of their main objective: to publish their research.⁶ Furthermore, it improves the process's transparency, optimizes its evolution, and encourages the researcher to adopt a critical attitude regarding the flaws and biases of peer review.^{5,6}

The purpose of this study was to determine the level of knowledge among physicians specializing in Orthopedics and Traumatology regarding the editorial process of scientific journals.

MATERIALS AND METHODS

A descriptive and cross-sectional study of the level of knowledge of physicians specializing in Orthopedics and Traumatology about the editorial process of scientific journals was carried out by means of a questionnaire for traumatologists who are members of the Argentine Association of Orthopedics and Traumatology (AAOT [in Spanish: *Asociación Argentina de Ortopedia y Traumatología*]), during the period from June to August 2022.

A sample was obtained according to the following eligibility criteria. Inclusion criteria: physicians certified in Orthopedics and Traumatology or in training (residents and fellows) who are members of the AAOT. Exclusion criteria: incomplete or duplicate questionnaires, members of the editorial board of scientific journals.

Variables from the study were recorded in the following categories: A) sociodemographic; B) research experience; and C) knowledge of the editorial process. To assess the understanding of the editorial process, the researchers selected a group of key concepts that are central to the operation of a scientific journal.³ The following were evaluated: perceived knowledge on the subject; the roles of authors, reviewers, and editors; the types of scientific papers and ethical conflicts of publication; and knowledge of the concepts of "peer review," "double-blind," and "indexing."

For the collection of data on the proposed variables, a questionnaire was designed and developed by researchers with experience in the editorial process of scientific manuscripts. The questions included were closed or semi-closed. The questions that estimated frequency were constructed with Likert-type scales to calculate the respondents' level of agreement or disagreement. The questionnaire was created in digital format using Google Forms and was distributed to the participants by telephone or e-mail. A pilot survey was conducted with the first 20 responses, not included in the final results, to evaluate the instrument and the response rate to the questions.

Respondents were grouped into two groups according to their level of knowledge about the editorial process (“low/moderate” vs. “high”) for comparison. Respondents who correctly answered 5 or more of 6 conceptual questions about indexing, peer review, double-blinding, and ethical conflicts of publication were classified as having “high” knowledge. The rest of the respondents were grouped in the “low/moderate knowledge” category.

Categorical variables are expressed in frequency and percentage; and numerical variables, in mean or median according to their distribution with their respective dispersion measure, standard deviation, or range. Categorical variables were compared with χ^2 or Fisher’s tests. For the comparison of continuous variables, the Student t test or the Mann-Whitney U test were used, according to the distribution expressed. A p-value <0.05 was considered statistically significant. SPSS Statistics 25 was used for the analysis.

The study was conducted in accordance with the ethical standards of the Declaration of Helsinki, preserving the anonymity of the professionals surveyed and their respective affiliations, as well as the confidentiality of the data. Consent to participate was requested.

RESULTS

A total of 130 completed surveys were received from 118 men (90.8%) and 12 women (9.2%), with a mean age of 48 years (standard deviation = 12; range 22-88). Just over half of the sample (n = 72; 55%) comprised orthopedic surgeons working in institutions in the Metropolitan Area of Buenos Aires (a region that includes the Autonomous City of Buenos Aires and 40 municipalities in the province of Buenos Aires) and 24% came from provinces in the central region of our country (24%). Figures 1 and 2 show the distribution of respondents by province and region.

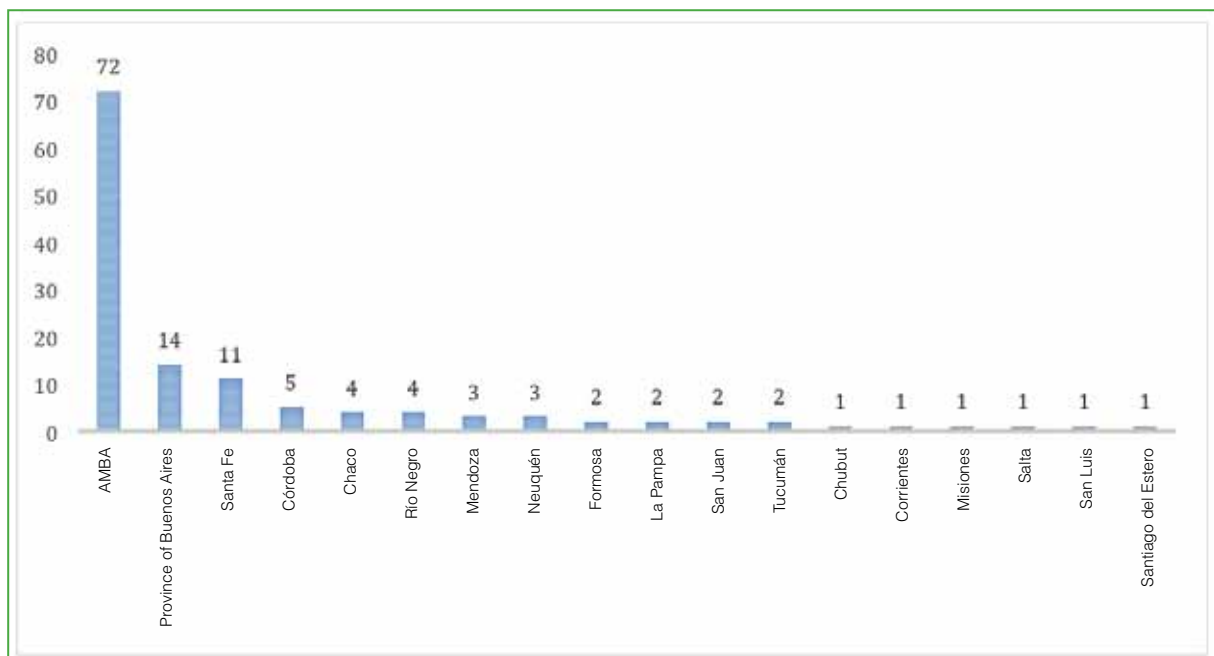


Figure 1. Bar chart: distribution of surveyed Argentinian orthopedic surgeons by province.

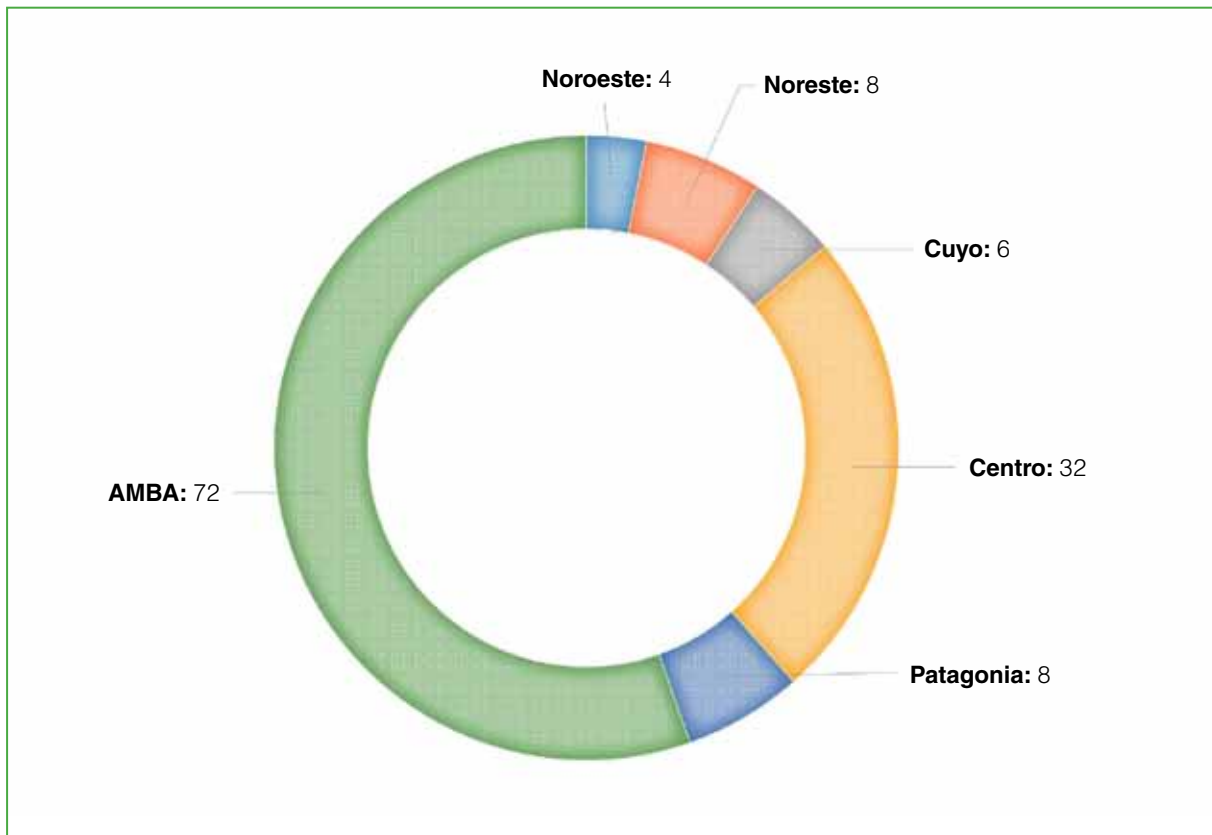


Figure 2. Pie chart: distribution of surveyed professionals by region of the country. The hospitals of the Autonomous City of Buenos Aires and the 40 neighboring municipalities of the province of Buenos Aires were grouped under the name AMBA and considered as a specific region.

Regarding the type of institution where they worked, 94% (n = 122) responded that they worked in the private sector only (n = 59; 45%) or in both private and public institutions (n = 63; 49%). Only 6% worked exclusively at a public institution. Specialist physicians (n = 124; 95%) with positions as Head of Team/Department/Unit, staff physicians, subspecialty fellows, and others predominated. Resident/trainee representation was low (n = 6; 5%). The characteristics of the sample are described in [Table 1](#).

Research experience and prior knowledge of the editorial process

Most of the trauma specialists surveyed reported having participated in research work (n = 112; 86%) and more than half of the sample (n = 79; 61%) reported having frequently (n = 62; 48%) or very frequently (n = 17; 13%) carried out activities related to the development of scientific work during their training as specialists. Only 19% (n = 24) said they have never published an article in an indexed journal; the most common response was “1-5 articles” (n = 53; 41%). The number of articles presented at congresses or conferences was higher (n = 124; 94%), with the most common response being “>10 scientific papers” (n = 62; 48%). More than half of the respondents answered that they had submitted at least one article to the AAOT journal (n = 74; 57%) ([Table 2](#)).

Regarding the editorial process, 41% (n = 54) of the trauma specialists responded that they rated their knowledge as “moderate,” followed by “extensive” (23%; n = 30). Fewer than 30% (n = 36) claimed to have little or no knowledge in this regard ([Table 3](#)).

Table 1. Sample characteristics

Variable		Results	
Age, mean (SD; range)		48	(12; 29-88)
Sex, n (%)	Female	12	(9.2%)
	Male	118	(90.8%)
Region, n (%)	Northwest	4	(3.1%)
	Northeast	8	(6.2%)
	Cuyo	6	(4.6%)
	Central	32	(24.6%)
	Patagonia	8	(6.2%)
	AMBA	72	(55.4%)
Institution, n (%)	Public	8	(6.2%)
	Private	59	(45.4%)
	Both	63	(48.5%)
Position, n (%)	Resident/Scholar/Trainee	6	(4.6%)
	Fellow	5	(3.8%)
	Staff Physician	66	(50.8%)
	Head of Team/Unit/Department	42	(32.3%)
	Other	11	(8.5%)

SD = standard deviation; AMBA = Metropolitan Area of Buenos Aires (Autonomous City of Buenos Aires and 40 municipalities of the province of Buenos Aires).

Table 2. Research experience

Variable		Results n (%)
Participation in research work		112 (86.2)
Activities related to the development of scientific work during residency/training.	Very often	17 (13.1)
	Frequently	62 (47.7)
	Occasionally	34 (26.2)
	Rarely	16 (12.3)
	Never	1 (0.8)
Scientific papers published in indexed journals	0	25 (19.2)
	1-5	53 (40.8)
	6-10	18 (13.8)
	>10	34 (26.2)
Scientific papers presented at congresses or conferences	0	8 (6.2)
	1-5	38 (29.2)
	6-10	22 (16.9)
	>10	62 (47.7)
Submissions to the AAOT Journal		74 (56.9)

AAOT = Argentine Association of Orthopedics and Traumatology.

Table 3. Assessment of respondents' baseline knowledge of the editorial process

Variable	Results n (%)	
How would you rate your level of knowledge about the editorial process of a scientific manuscript?	Very wide	9 (7.0)
	Wide	30 (23.3)
	Moderate	54 (41.9)
	Little	22 (17.1)
	Very little	14 (10.9)

Evaluation of the knowledge of the editorial process

In descending order, the percentage of correct answers for questions about editorial process knowledge were: “duplicate publication” (n = 102; 80%), “indexing of the scientific journal” (n = 81; 64%), “simultaneous submission” (n = 79; 61%), “peer review” (n = 78; 60%), “double blind” (n = 65; 50%).

The author's, reviewer's, and editor's roles in the editorial process were assessed. The most frequent errors were in the following functions: correction of the original manuscript, i.e., who can make modifications to the original text and images (n correct answers = 13; 10%); ethical assessment of the publication (n correct answers = 14; 10.8%); verifying that the manuscript complies with the regulations (n correct answers = 29; 22%); and assessment of plagiarism and duplication (n correct answers = 28; 21%). The results are summarized in Table 4.

Table 4. Evaluation of the knowledge of the editorial process

Variable	Results n (%)
Indexing	81 (64.3)
Simultaneous submission	79 (61.2)
Duplicate publication	102 (79.7)
Peer review	78 (60.5)
Double-blind peer review	65 (50.4)
Delegation of functions during the editorial process:	
Uploading submission documents	99 (76.2)
Uploading metadata	89 (68.5)
Verifying that the manuscript complies with the regulations	29 (22.3)
Proofreading the manuscript	13 (10)
Guiding the interaction	61 (46.9)
Providing a formal opinion on the manuscript	55 (42.3)
Adapting the format of images, tables and graphs	55 (42.3)
Assessing the ethics of the manuscript	14 (10.8)
Checking plagiarism and duplication	28 (21.5)

“Simultaneous submission” = submitting an article to two or more journals at the same time; “Duplicate publication” = when an author submits an article or some part of his or her own already published article to another journal, without disclosing previous submissions.

Comparison according to the level of knowledge of the publishing process

According to the proposed “level of knowledge” variable, two groups were formed: “high” (n = 51; 39.2%) and “Low/moderate”(n = 79; 60.8%). There were no statistically significant differences in age, sex, and position. From the bivariate analysis, a statistically significant association emerged between the “high” level of knowledge about the editorial process and the previous publication of more than 5 articles in indexed journals (p < 0.001), in congresses or conferences (p = 0.008) and the submission of manuscripts to the AAOT journal (p < 0.001). Participation in activities related to the development of scientific papers during the specialists’ training was higher for the categories grouped “very frequently/frequently” in those with “high” knowledge about the editorial process; however, this difference was not statistically significant (p = 0.065) (Table 5).

Table 5. Comparison according to the level of knowledge of the editorial process

Variable	Level		
	Low/moderate n = 79	High n = 51	p
Age, mean (SD; range)	47 (11; 29-80)	50 (14; 32-88)	0.141
Sex, n (%)			0.856
Male	72 (91)	46 (90)	
Female	7 (9)	5 (10)	
Province, n (%)			0.175
AMBA	40 (51)	32 (63)	
Other	39 (49)	19 (37)	
Position, n (%)			0.559
Head	24 (30)	18 (35)	
Other	55 (70)	33 (65)	
Participation in research work, n (%)			0.284
Yes	66 (84)	46 (90)	
No	13 (16)	5 (10)	
Activities related to the development of scientific work during training, n (%)			0.065
Very frequently/frequently	43 (54)	36 (71)	
Occasionally/rarely/never	36 (46)	15 (29)	
Scientific papers published in indexed journals, n (%)			<0.001
<5	57 (72)	21 (41)	
>5	22 (28)	30 (59)	
Scientific papers presented at congresses or conferences, n (%)			0.008
<5	35 (44)	11(22)	
>5	44 (56)	40 (78)	
Submissions to AAOT journal, n (%)			<0.001
Yes	34 (43)	40 (78)	
No	45 (57)	11 (22)	

SD = standard deviation; AAOT = Argentine Association of Orthopedics and Traumatology; AMBA = Metropolitan Area of Buenos Aires (Autonomous City of Buenos Aires and 40 municipalities of the province of Buenos Aires).

DISCUSSION

Peer review has existed for over a century as a mechanism of arbitration and the central axis of the editorial process of scientific articles. Its origin has been attributed to the publication of *Medical Essays and Observations* by the *Royal Society of Edinburgh* in 1731.⁹ It should be noted that the original process has undergone multiple modifications and is significantly different from its current version.^{9,10} On the other hand, the publication of scientific

articles in peer-reviewed journals is a fundamental milestone in the career of a physician, conferring prestige and academic legitimacy. Despite all this, there is great uncertainty in the medical community concerning the functioning and usefulness of the editorial process.^{10,11}

Accordingly, we discovered that 60% of the physicians evaluated in our survey in the field of Orthopedics and Traumatology in Argentina had a low or moderate level of knowledge about the editorial process. Correct answers predominated when initially analyzing fundamental principles of the editorial process (>50% for each concept). However, half of the respondents did not know the correct definition of the term “double-blind”. On the other hand, for the specific roles of editors, reviewers and authors, we found less encouraging results. Correct answers were less than 50% in 7 of 9 functions evaluated. The gap in knowledge about these functions appears to be greatest for: ethical assessment of the manuscript, correction of submission files (manuscript/tables/graphs), assessment of compliance with regulations, and estimation of plagiarism.

The literature reflects numerous concerns about the editorial process, including the ethical integrity of the review process and of the manuscript specifically, the timing of review and eventual publication of a manuscript, the critical lack of reviewers, the quality of reviews, publication bias, and the development of alternative options such as open review.^{5,11-16} All, in some way, reflect the imperative need for health professionals to delve into the core concepts of the editorial process and, more specifically, peer review. In the authors’ opinion, this would allow them to more efficiently satisfy each of the stages, from manuscript submission to publishing. Reviewers’ tasks, on the other hand, should be hierarchized, and they should participate in the quest for new approaches for critical evaluation of scientific texts that are fairer, more ethical, scientific, and less biased.

We were interested in developing a profile of a trauma specialist with understanding of the editorial process in the field of Orthopedics and Traumatology. In our sample, having published articles was related with a deeper understanding of the editorial process. A statistically significant association was found between respondents with greater knowledge in this regard and having published more than 5 articles in indexed journals or in scientific congresses and conferences, as well as having submitted articles to the AAOT journal. This result leads us to think, on the one hand, that one way to learn about a process is to participate in it. On the other hand, there is a need to incorporate these concepts during the training of specialists in Orthopedics and Traumatology so that their access is not limited to the fact of “actively” publishing scientific manuscripts. We believe that the latter is related to the environment in which we were trained as specialists and its academic tradition, which may disadvantage those who lack colleagues with experience in the subject or institutions that prioritize research as part of trauma physicians’ professional development.

Finally, it is worth mentioning the advent of predatory publishers, fictitious publishers that swindle researchers through spurious mechanisms. They are pseudo-publishers that offer the “successful publication” of scientific manuscripts exclusively for profit and limiting the possibility of a true dissemination of original research. Understanding the editorial process is an important tool for avoiding academic scams.^{17,18}

The weaknesses of this study are the low number of respondents, the low representation of female professionals and residents, its cross-sectional design, and the subject selection bias involved in non-probability sampling. Nevertheless, we believe that it provides new knowledge on a subject that has been little studied and published, especially in our field.

CONCLUSIONS

Most of the trauma specialists evaluated in our survey had a low or moderate level of knowledge about the editorial process of scientific manuscripts. On the other hand, a statistically significant association was found between a high level of knowledge in this regard and greater experience in the publication of manuscripts in indexed journals. The editorial process and especially peer review is the central axis of the evaluation of our academic-scientific production. The authors suggest the need to include aspects on the knowledge of the editorial process of scientific journals in the initial stages of the training of orthopedic and traumatology specialists.

Conflict of interest: The authors belong to the editorial team of the Journal of the Asociación Argentina de Ortopedia y Traumatología.

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REFERENCES

- Mendoza S, Paravic T. Origen, clasificación y desafíos de las revistas científicas. *Investigación y Postgrado* 2006;21(1):49-75. Available at: http://ve.scielo.org/scielo.php?script=sci_arttext&pid=S1316-00872006000100003&lng=es&nrm=iso. ISSN 1316-0087
- Priem J, Hemminger BM. Decoupling the scholarly journal. *Front Comput Neurosci* 2012;6:19. <https://doi.org/10.3389/fncom.2012.00019>
- Aparicio A, Banzato G, Liberatore G. *Manual de gestión editorial de revistas científicas de Ciencias Sociales y Humanas*. La Plata: CLACSO, CAICYT-CONICET y PISAC; 2016. Available at: http://sedici.unlp.edu.ar/bitstream/handle/10915/90378/Manual_de_gesti%C3%B3n_editorial_de_revistas_cient%C3%ADficas_de_ciencias_sociales_y_humanas.482.pdf-PDFA.pdf?sequence=1&isAllowed=y
- Standing up for Science 3. Peer Review: The nuts and bolts. A guide for early career researchers. Available at: <https://senseaboutscience.org/wp-content/uploads/2021/09/PEER-REVIEW-the-nuts-and-bolts.pdf> [Consulted: July 18, 2022]
- Tvina A, Spelley R, Palatnik A. Bias in the peer review process: Can we do better? *Obstet Gynecol* 2019;133(6):1081-3. <https://doi.org/10.1097/AOG.00000000000003260>
- Sprowson AP, Rankin KS, McNamara I, Costa ML, Rangan A. Improving the peer review process in orthopaedic journals. *Bone Joint Res* 2013;2(11):245-7. <https://doi.org/10.1302/2046-3758.211.20002>
- Saxe JP. Opening the black box of peer review. *Cell Stem Cell* 2019;24(6):843-8. <https://doi.org/10.1016/j.stem.2019.05.017>
- Likis FE, Swett B. Demystifying the journal submission, peer review, and publication process. *J Midwifery Womens Health* 2019;64(2):145-8. <https://doi.org/10.1111/jmwh.12978>
- Adler JR Jr. A new age of peer reviewed scientific journals. *Surg Neurol Int* 2012;3:145. <https://doi.org/10.4103/2152-7806.103889>
- Tennant JP, Ross-Hellauer T. The limitations to our understanding of peer review. *Res Integr Peer Rev* 2020;5:6. <https://doi.org/10.1186/s41073-020-00092-1>
- Huisman J, Smits J. Duration and quality of the peer review process: the author's perspective. *Scientometrics* 2017;113(1):633-50. <https://doi.org/10.1007/s11192-017-2310-5>
- Das AK. 'Peer review' for scientific manuscripts: Emerging issues, potential threats, and possible remedies. *Med J Armed Forces India* 2016;72(2):172-4. <https://doi.org/10.1016/j.mjafi.2016.02.014>
- Bunner C, Larson EL. Assessing the quality of the peer review process: author and editorial board member perspectives. *Am J Infect Control* 2012;40(8):701-4. <https://doi.org/10.1016/j.ajic.2012.05.012>
- Fernandez-Llimos F; Pharmacy Practice 2018 peer reviewers. Peer review and publication delay. *Pharm Pract (Granada)* 2019;17(1):1502. <https://doi.org/10.18549/PharmPract.2019.1.1502>
- O'Brien BC, Artino AR Jr, Costello JA, Driessen E, Maggio LA. Transparency in peer review: Exploring the content and tone of reviewers' confidential comments to editors. *PLoS One* 2021;16(11):e0260558. <https://doi.org/10.1371/journal.pone.0260558>
- Schmidt B, Ross-Hellauer T, van Edig X, Moylan EC. Ten considerations for open peer review. *FI000Res* 2018;7:969. <https://doi.org/10.12688/f1000research.15334.1>
- Wiechert K, Wang JC, Chapman JR. Predator journals: An urgent and global problem. *Global Spine J* 2019;9(3):253. <https://doi.org/10.1177/2192568219836129>
- Bersusky E. Las editoriales predatoras. [Predatory publishers]. *Rev Asoc Argent Ortop Traumatol* 2017;82(2):89-90. <https://doi.org/10.15417/696>

Complications of the Anterior Approach to Lumbar Spine in a Series of 197 Patients

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ABSTRACT

Objective: To analyze complications related to the anterior approach to the lumbar spine. **Materials and Methods:** Descriptive and retrospective study of a series of patients who underwent surgery by an anterior approach to the lumbar spine between 2006 and 2019. The study population was 197 patients. The variables considered were age, gender, diagnosis, surgical plan, lumbar levels involved, and the presence of immediate, early or late complications. The Clavien-Dindo classification was used for surgical complications. **Results:** 197 patients were evaluated. The average age was 53.39 years, and there were 106 women (53.81%) and 91 men (46.19%). The most frequent diagnosis was degenerative disc disease in 51 patients (25.89%). 34 patients presented complications (17.26%): 4 immediate complications (2.03%), 22 early complications (11.16%), and 9 late complications (4.57%). The most frequent immediate complication was arterial injury (2 patients). The most frequent early complication was vertebral endplate injury (5 patients). The most frequent late complication was vertebral body fracture (4 patients). Two patients died as a consequence of their complications. **Conclusion:** In our series of patients, the most frequent complications were vascular injury (intraoperative), vertebral endplate injury (early), and vertebral body fracture (late). The author considers that the anterior approach to the lumbar spine performed by a team trained in this type of approach is a safe technique, with a low rate of complications.

Keywords: Anterior lumbar approach; surgical complications; anterior arthrodesis; instrumented anterior arthrodesis; vascular injury.

Level of Evidence: IV

Complicaciones del abordaje anterior de columna lumbar en una serie de 197 pacientes

RESUMEN

Objetivo: Analizar las complicaciones relacionadas con la cirugía de columna lumbar por vía anterior. **Materiales y Métodos:** Estudio descriptivo y retrospectivo de una serie de pacientes operados por abordaje anterior de la columna lumbar entre 2006 y 2019. La población estaba formada por 197 pacientes. Las variables consideradas fueron: edad, sexo, diagnóstico, plan quirúrgico (artrodesis anterior, doble vía combinada, revisión anterior, extracción del implante), niveles lumbares involucrados, complicaciones intraquirúrgicas inmediatas, tempranas o tardías. Se utilizó la clasificación de Clavien-Dindo para las complicaciones quirúrgicas. **Resultados:** Se evaluó a 197 pacientes, con una edad promedio de 53.39 años (106 mujeres, 53,81% y 91 hombres, 46,19%). El diagnóstico más frecuente fue discopatía degenerativa en 51 pacientes (25,89%). Treinta y cuatro (17,26%) sufrieron complicaciones: 4 inmediatas (2,03%), 22 (11,16%) tempranas y 9 (4,57%) tardías. La complicación inmediata más frecuente fue la lesión arterial (2 pacientes). La complicación temprana más frecuente fue la lesión del platillo vertebral (5 pacientes). La complicación tardía más frecuente fue la fractura del cuerpo vertebral (4 pacientes), dos pacientes fallecieron como consecuencia de las complicaciones. **Conclusión:** En nuestra serie, las complicaciones más frecuentes fueron: lesión vascular (inmediata), lesión del platillo vertebral (temprana) y fractura del cuerpo vertebral (tardía).

Palabras clave: Abordaje lumbar anterior; complicaciones quirúrgicas; artrodesis anterior; artrodesis anterior instrumentada; lesión vascular.

Nivel de Evidencia: IV

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INTRODUCTION

Anterior spine surgery was first described by Capener¹ in 1932, for the treatment of spondylolisthesis, and shortly thereafter by Ito² in 1934, for the treatment of Pott's disease. In his 1932 description, Capener discussed anterior treatment of high-grade spondylolisthesis. He referred to the possibility of placing a bone graft to fix the body of L5 to the sacrum, forming a buttress. According to the researchers, this would be the oldest bibliographic reference related to lumbar spine surgery and the anterior approach.¹ Since then, this technique has been perfected and has improved in stability, safety and indications.³

Currently, indications for the anterior approach include: degenerative, tumor, traumatic and infectious diseases.⁴

Complications of the anterior approach are different from those mentioned for the posterior approach, including vascular and visceral injuries.⁴ Some of them are life-threatening if not treated by a team trained in this type of approach.

The objective of this study was to describe and analyze the complications related to anterior lumbar spine surgery.

MATERIALS AND METHODS

A descriptive and retrospective study was performed on a series of patients operated on by the same surgical team, using an anterior approach to the lumbar spine, between 2006 and 2019. Patients who participated in the study provided written consent.

A non-probabilistic sample was selected from all patients operated consecutively, by anterior approach, according to the surgical records of the treating team. The inclusion criteria were: 1) patients operated by the surgical team, between 2006 and 2019, through an anterior approach to the lumbar spine, either as the only approach or as part of a surgical treatment that included some other type of approach (lateral or posterior approach); 2) patients operated through an anterior approach as the first stage of surgical treatment or as a revision of a surgery through another approach; 3) patients with a history of abdominal surgeries (cesarean section, cholecystectomy, appendectomy, among others).

A total of 226 medical records were found. Patients with incomplete clinical records or loss to follow-up before completion of six months after surgery were excluded. The study population consisted of 197 patients.

The data corresponding to the study variables were recorded from medical records and image files. The following variables were considered: age, sex, diagnosis, surgical plan (anterior arthrodesis, combined double approach, anterior revision, implant extraction), lumbar levels involved, presence of intraoperative or immediate complications (intraoperative or immediate complications were defined as events occurring during surgery and up to 48 h later), early complications (defined as events occurring after 48 h of surgery up to 0+6 months), late complications ($\geq 0+6$ months after surgery).

In addition, the Clavien-Dindo classification was used for surgical complications.⁵

Surgical technique

All patients were operated on by the same surgical team, consisting of one or two spinal surgeons plus a general surgeon with training in anterior spinal approaches and vascular disease.

For high lumbar levels (L2-L3 and L3-L4), the access surgeon is positioned to the patient's right and the spinal surgeon to the left; for low lumbar levels (L4-L5 and L5-S1), the positions are reversed (the access surgeon stands to the patient's left and the spinal surgeon stands to the right).⁶

The skin incision can be medial (supraumbilical or infraumbilical) or transverse, Pfannenstiel type,⁷ depending on the levels to be operated on.

The abdominal contents are carefully mobilized towards the midline. The spine is approached medially to the iliac psoas muscle. It is essential to detect and, when appropriate, ligate the left iliolumbar vein in a safe manner, depending on the level to be operated. In the first cases of the series, a linen thread ligature was used, but, after one episode of ligature dehiscence, this step was replaced by a metal clip (Ligaclip®, Ethicon Inc., Johnson & Johnson, NJ, USA).

After performing a discectomy of the affected level, a non-locking PEEK (polyether-ether-ketone) implant was placed for anterior arthrodesis, using a small fragment plate to avoid anterior subsidence of the implant.

At the time of closure, the anterior rectus sheaths are approximated with separate absorbable sutures (Vicryl®, Ethicon Inc., Johnson & Johnson, NJ, USA). The fascia is closed with continuous absorbable sutures and the skin is closed with an intradermal monofilament suture (Ethilon® Nylon, Ethicon Inc., Johnson & Johnson, NJ, USA). No drains are left in the bed.

All medical records and surgical records were evaluated by the author of the paper.

Statistical Analysis

Categorical variables are expressed as number and percentage, and quantitative variables as mean and its respective dispersion measure and standard deviation (SD), according to their distribution.

To compare the proportions of each variable, the χ^2 test was used. A p value <0.05 was considered significant. Analyses were performed with the IBM® SPSS version 21 statistical software (SPSS Inc., Chicago, IL, USA).

RESULTS

Initially, a total of 226 patients were obtained. Twenty-nine were excluded because they had incomplete data or did not meet the inclusion criteria.

The records of 197 patients who had undergone surgery for a previous lumbar spine approach, between 2006 and 2019, were evaluated. The average age was 53.39 years (SD 14.61). 53.81% were women (106 cases) and 46.19% were men (91 cases), these differences were not statistically significant ($p = 0.285$).

The most frequent diagnoses were: degenerative disc disease (51 patients, 25.89%), followed by spondylolisthesis (26 patients, 13.20%), lumbar spinal stenosis (25 patients, 12.69%), symptomatic disc protrusion/extrusion (24 patients, 12.18%). The remaining diagnoses are listed in [Table 1](#).

Table 1. Pre-surgical diagnosis

Pre-surgical diagnosis	Patients	%
Degenerative disc disease	51	25.89
Spondylolisthesis	26	13.20
Lumbar spinal stenosis	25	12.69
Symptomatic disc protrusion/extrusion	24	12.18
Other	20	10.15
Lumbar spinal stenosis + spondylolisthesis	15	7.61
Nonunion	11	5.58
Degenerative lumbar scoliosis	5	2.54
Degenerative disc disease + lumbar spinal stenosis	5	2.54
Degenerative disc disease + spondylolisthesis	5	2.54
Degenerative disc disease + symptomatic disc protrusion/extrusion	4	2.03
Lumbar spinal stenosis + lumbar degenerative scoliosis	3	1.52
Discarthrosis	3	1.52
Total	197	100

Regarding the surgical plan, an anterior approach was performed as the only access in 143 (73%) patients, followed by an anterior approach plus a posterior approach in 36 (18%) patients. In 12 cases (6.09%), the anterior surgery was a revision of a previous operation. **Table 2** shows the details of all the approaches.

Table 2. Surgical plan

Surgical plan	Patients	%
Anterior approach	143	72.59
Anterior + posterior approach	36	18.27
Revision of anterior approach	12	6.09
Anterior approach + other	6	3.05
Total	197	100

The most frequently affected levels were: L4-L5, L5-S1 in 66 patients (33.50%); L5-S1 in 65 (32.99%) and L4-L5 in 31 (15.74%). **Table 3** lists all affected levels.

Table 3. Involved levels

Involved levels	Patients	%
L4-L5, L5-S1	66	33.50
L5-S1	65	32.99
L4-L5	31	15.74
L3-L4, L4-L5, L5-S1	13	6.60
L3-L4, L4-L5	7	3.55
Other	6	3.05
L2-L3, L3-L4, L4-L5, L5-S1	6	3.05
L3-L4	3	1.52
Total	197	100

Thirty-four patients (17.26%) had surgery-related complications ($p < 0.001$). Four intraoperative or immediate (2.03%), 22 (11.16%) early, and nine (4.57%) late complications were recorded. Only one patient suffered both early and late complications: an infection that became chronic.

The most frequent immediate complications were: vascular injury (75%) (2 cases of iliac artery injury and one of ileolumbar vein dehiscence) and perforation of the cecum (one case, 25%). Two patients who suffered immediate complications (arterial injury and perforation of the cecum) died of causes directly related to the surgical procedure.

The most frequent early complications were: vertebral plate injury (5 patients, 23%) and vertebral body injury (3 patients, 13.63%), followed by implant subsidence (2 cases, 9.09%), foreign body granuloma (2 cases, 9.09%) and infection (2 cases, 9.09%). Early complications are detailed in [Table 4](#) ($p = 0.758$).

Table 4. Early complications

Early complications	Patients	%
Fracture of the vertebral plate	5	22.73
Vertebral body injury	3	13.64
Subsidence of the implant	2	9.09
Foreign body granuloma	2	9.09
Infection	2	9.09
Hospital-acquired pneumonia	1	4.55
Residual lumbosciatica / deep vein thrombosis / L5-S1 spondylolysis	1	4.55
Nonunion	1	4.55
Subcutaneous hematoma	1	4.55
Implant repositioning	1	4.55
Wound infection	1	4.55
Pleural effusion	1	4.55
Urinary tract infection	1	4.55
Total	22	100%

The most frequent late complication was vertebral body fracture (4 patients, 44.44%). Late complications are detailed in [Table 5](#) ($p = 0.416$).

Table 5. Late complications

Late complications	Patients	%
Vertebral body fracture	4	44.44
Subsidence of the implant	1	11.11
Chronic infection, antibiotic treatment	1	11.11
Untreated fall	1	11.11
Loosening of plate screws	1	11.11
Abdominal eventration	1	11.11
Total	9	100

According to the Clavien-Dindo classification, 35 patients had complications: nine were grade I, seven were grade II, 14 were grade IIIA, one was grade IIIB, two were grade IVA, and two were grade V (Table 6).

Table 6. Complications according to Clavien-Dindo classification

Clavien-Dindo classification			Total	
Grade			n	%
I		Normal postoperative deviation without the need for pharmacological or surgical treatment.	9	26
II		Requirement for pharmacological treatment with drugs	7	20
III		Requirement for surgical, endoscopic or radiographic intervention		
	IIIA	Intervention without the need for anesthesia	14	40
	IIIB	Procedure under general anesthesia	1	2.8
IV		Life-threatening complication, requiring intensive care unit management		
	IVA	Simple organic dysfunction	2	5.71
	IVB	Multiple organ dysfunction		
V		Death	2	5.71

DISCUSSION

In 1997, Mayer published a series of patients operated on by an anterior approach which he called *minilaparotomy* for the lumbar spine, retroperitoneal for L2-L3, L3-L4 and L4-L5 segments, and transperitoneal for L5-S1, and reported that the approach is atraumatic.³ The retroperitoneal approach with a minimal skin incision allowed standardization of the approach and minimization of related visceral complications. This surgical technique with variants of the authors was the one used to treat the operated patients in this series.

In 2017, Phan et al. published a meta-analysis in which they concluded that complications are similar regardless of whether the surgical team has an “access” surgeon or not. Nevertheless, they mentioned that the access surgeon should be available if needed.⁸ In our experience, the eventual availability of a general surgeon with training in spinal anatomy was impractical and difficult to coordinate. It was decided that the general surgeon with training in the approach route should form a stable part of the surgical team.

The complication rate of the series (17.26%) is comparable with the results obtained by Brewster et al. in 2008 (15.5%)⁹ and by Baker et al. in 1993 (15.6%).¹⁰

Brewster et al. reported that vascular injury was the most frequent complication in their series (5.3%), and that venous injury was more common than arterial injury. In our series, there were two cases of arterial vascular lesions and one case of dehiscence of iliolumbar vein ligation in the immediate postoperative period. This injury rate could be explained by the presence of a vascular surgeon trained in previous approaches within the team or by the lack of recording of vascular lesions that resolved satisfactorily during the procedure without the need for reintervention or active behavior in the postoperative period.

One of the patients with arterial injury suffered an acute arterial obstruction that was detected in the immediate postoperative period. Surgical reperfusion maneuvers were performed (<6 h), without positive outcomes. Amputation of the left lower limb was necessary, and the patient was successfully fitted with an orthosis. The other patient had bilateral acute arterial ischemia, required bilateral supracondylar amputation, and died postoperatively from complications associated with the arterial injury.

One patient suffered a dehiscence of the iliolumbar vein ligation, requiring emergency surgery, a new ligation of the iliolumbar vein. His evolution was favorable with no associated complications. Following this event, it was decided to change the procedure of iliolumbar vein hemostasis; surgical ligation with surgical linen was discontinued and vascular clips were used instead.

One patient suffered a cecal perforation in the context of a long-standing appendicular surgery complicated by an abdominal bridging cecal abscess. During the immediate postoperative period, he evolved with ileus and then suffered from a perforated viscus. Postoperatively, a cecostomy and a subsequent right colectomy were performed. The patient died from complications associated with the surgery.

In our series, the most frequent early complication was vertebral plate injury (5 patients, 23%), followed by vertebral body fracture (3 patients, 13.63%). Although both complications involve the state of the vertebra, it is clear from the medical records that the vertebral plate injuries were related to the patients' degree of osteoporosis, the type of implant, and the surgical technique, whereas the vertebral body fractures were related to trauma or falls from the patients' own height. For this reason, it was decided to differentiate one type of lesion from the other and to list them separately as independent lesions.

In patients >80 years with documented osteoporosis, the vertebral body was augmented with direct anterior kyphoplasty cement (polymethylmethacrylate).

The two patients (9.09%) who had foreign body granulomas did not require surgical treatment and the condition healed on its own.

Two patients suffered infections (9.09%) that were treated with antibiotics. One of them evolved favorably in the short term. The other had had a previous infection after the posterior approach and required prolonged antibiotic treatment, which improved his symptoms.

There was one case (4.54%) of hospital-acquired pneumonia that was treated with antibiotics in the general ward, with a favorable evolution.

The most frequent late complication was vertebral body fracture (4 patients, 44.44%), associated with low-energy falls or falls from one's own height.

Implant subsidence was detected in one patient (11.11%). The implant was monitored with radiographs, and did not require active management.

One patient (11.11%) was diagnosed with a chronic infection in the context of an infection following posterior surgery. He required prolonged antibiotic treatment.

None of the men (91, 46.19%) reported altered ejaculation, retrograde ejaculation or any other type of sexual dysfunction. Retrograde ejaculation is the result of injury to the presacral neural plexus and consequent sympathetic dysfunction. This injury usually occurs during the dissection of the anterior periosteum of the lumbosacral junction.¹¹ The absence of a previously described complication in up to 45% of patients^{12,13} could be interpreted as a result of a less traumatic surgical approach, the use of blunt elements to manipulate the presacral neural plexus and the surgical team's experience with this type of approach, or as an underreporting of this complication. This finding should be studied further in future research, as should alternative causes.

This research classifies complications according to the time of their onset, using a temporality criterion. The use of an alternative classification, such as the one proposed by Clavien-Dindo, makes it possible to analyze complications according to the complexity of the treatment performed for their resolution, providing a complementary view to the analysis of surgical complications.

Among the patients with complications, nine had grade I complications (defined as any deviation from the normal postoperative course without the need for treatment); in these cases, only the complication was recorded in the clinical record without further action by the treating team; seven had grade II complications (requiring pharmacological treatment); 14 had grade IIIA complications (requiring surgery, endoscopic or radiological), the most frequent type of complication in this series. In this group of complications, spinal lesions are mentioned: body fractures and lesions of the vertebral plate; in these cases, treatment consisted of radiological control of the lesion. One patient had a grade IIIB complication (requiring surgery under general anesthesia); the two patients with grade IVA complications (simple organ dysfunction) are mentioned under early complications; two deaths occurred (grade V).

The weaknesses of this study are its descriptive and retrospective design, the fact that it was performed in a single site and with a single surgical team, the sample with a heterogeneous group of diseases and the unregulated follow-up time.

The strengths are: the number of patients, the study of a type of approach currently used in surgical practice, the contribution from the local area with useful information from our region compared to what is reported in the international literature.

CONCLUSIONS

In our series of patients who underwent anterior lumbar spine surgery, the most frequent complications were: vascular injury (immediate), vertebral plate or vertebral body injury (early) and vertebral body fractures (late).

The anterior approach to the lumbar spine in the hands of a team trained in this type of approach is a safe technique, with a low rate of complications.

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REFERENCES

1. Capener N. Spondylolisthesis. *Br J Surg* 1932;19(75):374-86. <https://doi.org/10.1002/bjs.1800197505>
2. Ito H, Tsuchiya J, Asami G. A new radical operation for Pott's disease. *J Bone Joint Surg* 1934;16(3):499-515.
3. Mayer MH. A new microsurgical technique for minimally invasive anterior lumbar interbody fusion. *Spine* 1997;22(6):691-9. <https://doi.org/10.1097/00007632-199703150-00023>
4. Mobbs RJ, Phan K, Daly D, Rao PJ, Lennox A. Approach related complications of anterior lumbar interbody fusion: results of a combined spine and vascular surgical team. *Global Spine J* 2016;6(2):147-54. <https://doi.org/10.1055/s-0035-1557141>
5. Camino Willhuber G, Elizondo C, Slullitel P. Analysis of postoperative complications in spinal surgery, hospital length of stay, and unplanned readmission: application of Dindo-Clavien classification to spine surgery. *Global Spine J* 2019;9(3):279-86. <https://doi.org/10.1177/2192568218792053>
6. Lazanec JY, del Vecchio R, Ramare S, Mora N, Pouzet B, Saillant G. Revisión y simplificación del abordaje anterior mínimo de la columna lumbar. *Rev Ortop Traumatol* 2001;3:195-205. Available at: <https://www.elsevier.es/es-revista-revista-espanola-cirugia-ortopedica-traumatologia-129-pdf-13015922>
7. Pfannenstiel J. Über die Vortheile des suprasymphysären Fascienquerschnitts für die gynäkologischen Köliotomien, zugleich ein Beitrag zu der Indikationsstellung der Operationswege. Breitkopf und Härtel; 1900.
8. Phan K, Hu J, Scherman DB, Rao PJ, Mobbs RJ. Anterior lumbar interbody fusion with and without an "access surgeon": a systematic review and meta-analysis. *Spine (Phila PA 1976)* 2017;42(10): E592-E601. <https://doi.org/10.1097/BRS.0000000000001905>
9. Brewster L, Trueger N, Schermer C, Ghanayem A, Santaniello J. Infraumbilical anterior retroperitoneal exposure of the lumbar spine in 128 consecutive patients. *World J Surg* 2008;32(7):1414-9. <https://doi.org/10.1007/s00268-007-9433-4>
10. Baker JK, Reardon PR, Reardon MJ, Heggeness MH. Vascular injury in anterior lumbar surgery. *Spine (Phila PA 1976)* 1993;18(15):2227-30. <https://doi.org/10.1097/00007632-199311000-00014>
11. Aryan HE, Berven SH, Ames CP. Anterior lumbar interbody fusion (ALIF). En: Ozgur B, Benzel E, Garfin S (eds). *Minimally Invasive Spine Surgery*. New York, NY: Springer; 2009:143-8. https://doi.org/10.1007/978-0-387-89831-5_17
12. Kaiser MG, Haid Jr RW, Subach BR, Miller JS, Smith CD, Rodts GE Jr. Comparison of the mini-open versus laparoscopic approach for anterior lumbar interbody fusion: a retrospective review. *Neurosurgery* 2002;51(1):97-105. <https://doi.org/10.1227/01.NEU.0000017312.04526.92>
13. Regan JJ, Hansen Y, McAfee PC. Laparoscopic fusion of the lumbar spine: minimally invasive spine surgery: a prospective multicenter study evaluating open and laparoscopic lumbar fusion. *Spine (Phila PA 1976)* 1999;24(4):402-11. <https://doi.org/10.1097/00007632-199902150-00023>

Total Hip Arthroplasty in Adults with Legg-Calvé-Perthes Disease

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ABSTRACT

Background and objective: To review the number of total hip replacements (THA) performed in our hospital, determine their aetiology and identify how many of them were performed for hip osteoarthritis secondary to Legg-Calvé-Perthes disease (LCPD). **Materials and Methods:** We conducted a retrospective study reviewing all THA surgeries from 2008 to December 2021. We studied the pre-operative radiographs, determining the aetiology of the osteoarthritis, laterality, sex and age of the patient at the time of surgery. **Results:** We reviewed a total of 1103 hips in 935 patients. Primary hip osteoarthritis accounted for 81% of the cases. We gathered a total of 11 hips from 10 individuals (1%), with a mean age of 61 years, for hip osteoarthritis secondary to LCPD. **Conclusions:** There is evidence that femoro-acetabular impingement (FAI), which results in early secondary hip osteoarthritis, may be influenced by changes in the growth of the proximal femoral physis or overgrowth of the greater trochanter, which are characteristics of LCPD. We believe that certain cases of “misclassified” primary hip osteoarthritis may have been incorrectly identified since no additional information was found to support the diagnosis of secondary hip osteoarthritis, hiding the potential of an alternate, evolved aetiology. Furthermore, we suggest monitoring young patients with LCPD after their growth is complete in order to detect early FAI and provide arthroscopic therapeutic options.

Keywords: Secondary hip osteoarthritis; Perthes disease; total hip arthroplasty; femoro-acetabular impingement.

Level of Evidence: III

Cirugía de prótesis de cadera en el adulto con enfermedad de Legg-Calvé-Perthes

RESUMEN

Objetivos: Revisar las cirugías de prótesis totales de cadera realizadas en nuestro hospital, determinar el origen de la artrosis e identificar cuántas se colocaron por coxartrosis secundarias a enfermedad de Legg-Calvé-Perthes. **Materiales y Métodos:** Se realizó un estudio retrospectivo en el que se revisaron todas las cirugías de prótesis totales de cadera desde 2008 hasta diciembre 2021. Se evaluaron las radiografías prequirúrgicas para determinar la etiología de la artrosis, y se consideraron variables, como lateralidad, sexo y edad en el momento de la intervención. **Resultados:** Se revisaron 1103 caderas en 935 pacientes. El 81% correspondía a coxartrosis primaria. En 11 caderas de 10 pacientes (1%), se detectó coxartrosis secundaria a la enfermedad de Legg-Calvé-Perthes. La media de la edad de estos pacientes era de 61 años. **Conclusiones:** Hay evidencia de que las alteraciones del crecimiento de la fisis femoral proximal o el sobrecrecimiento del trocánter mayor, propias de la enfermedad de Legg-Calvé-Perthes, pueden contribuir a la aparición de un choque femoroacetabular, con su consiguiente coxartrosis precoz. Es posible que algunas “mal clasificadas” coxartrosis primarias fueran identificadas así porque no existía otro dato sugerente de coxartrosis secundarias, y escondieran otra etiología evolucionada. Asimismo, proponemos el seguimiento del paciente joven con enfermedad de Legg-Calvé-Perthes, más allá del crecimiento, para identificar el choque femoroacetabular en sus inicios y poder ofrecer opciones terapéuticas artroscópicas.

Palabras clave: Coxartrosis secundaria; enfermedad de Legg-Calvé-Perthes; prótesis total de cadera; choque femoroacetabular.

Nivel de Evidencia: III

INTRODUCTION

Legg-Calvé-Perthes disease (LCPD) is a hip entity characterized by osteonecrosis of the proximal femoral epiphysis in infancy.¹ Treatment of this condition during infancy aims at restoring spherical congruency and total recovery, i.e., restoring the patient's original hip condition.

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Some residual deformities, such as a non-spherical femoral head, overgrowth of the greater trochanter and its overlap with the short femoral neck, and secondary remodeling of the acetabulum, can alter the functional regime of the hip joint and contribute to the development of early secondary hip osteoarthritis.²

The objectives of this study were to evaluate a series of patients who had undergone total hip arthroplasty (THA), determine their etiology, and identify how many of them were treated for hip osteoarthritis secondary to LCPD. We analyzed whether there was any radiographic aspect of sufficient relevance that negatively affected the biomechanics of the hip joint, beyond the deformity and prognosis established by Stulberg, using our own experience and the contributions of the updated literature.

MATERIALS AND METHODS

A retrospective study was performed in which all THAs performed from 2008 to December 2021, in the Orthopedic Surgery and Traumatology Service of our hospital, were reviewed. Patients undergoing primary total hip arthroplasty during the period studied were included, regardless of indication, age or sex. Another inclusion criterion was that the patient had anteroposterior radiographs of the pelvis, and anteroposterior and axial radiographs of the hip. Patients with no previous radiographs were excluded, given the impossibility of confirming the indication for prosthetic surgery and those with partial hip prostheses.

Pre-surgical radiographs were evaluated to determine the origin of the osteoarthritis, and laterality, sex and age at the time of surgery were also analyzed.

The radiographic criteria applied to etiologically diagnose secondary osteoarthritis due to LCPD were: 1) coxa plana and coxa magna, 2) short femoral neck, and 3) ascending greater trochanter, i.e., when it is located above the center of rotation of the femoral head (Figures 1 and 2).

Likewise, a literature search was carried out in databases such as PubMed, Medline, Cochrane, Clinical Key, with keywords such as “total hip arthroplasty”, “Perthes disease” and “secondary hip osteoarthritis”.



Figure 1. Anteroposterior and axial radiographs of the hip showing residual deformities of Legg-Calvé-Perthes disease.



Figure 2. Anteroposterior and axial radiographs of the hip showing hip osteoarthritis secondary to Legg-Calvé-Perthes disease.

RESULTS

A total of 935 patients were included, with a total of 1103 THAs and 168 cases operated bilaterally. Fifty-four percent of the patients were women and 46% were men.

The main diagnosis of patients undergoing THA was primary hip osteoarthritis (81%). In patients with secondary hip osteoarthritis, 9% of the surgeries were due to avascular necrosis of the hip; 7%, due to hip fracture; 1%, due to developmental dysplasia of the hip; 1%, due to LCPD (**Figure 3**) and the remaining 1%, due to various etiologies, such as metastases, acetabular fractures or rheumatoid arthritis.

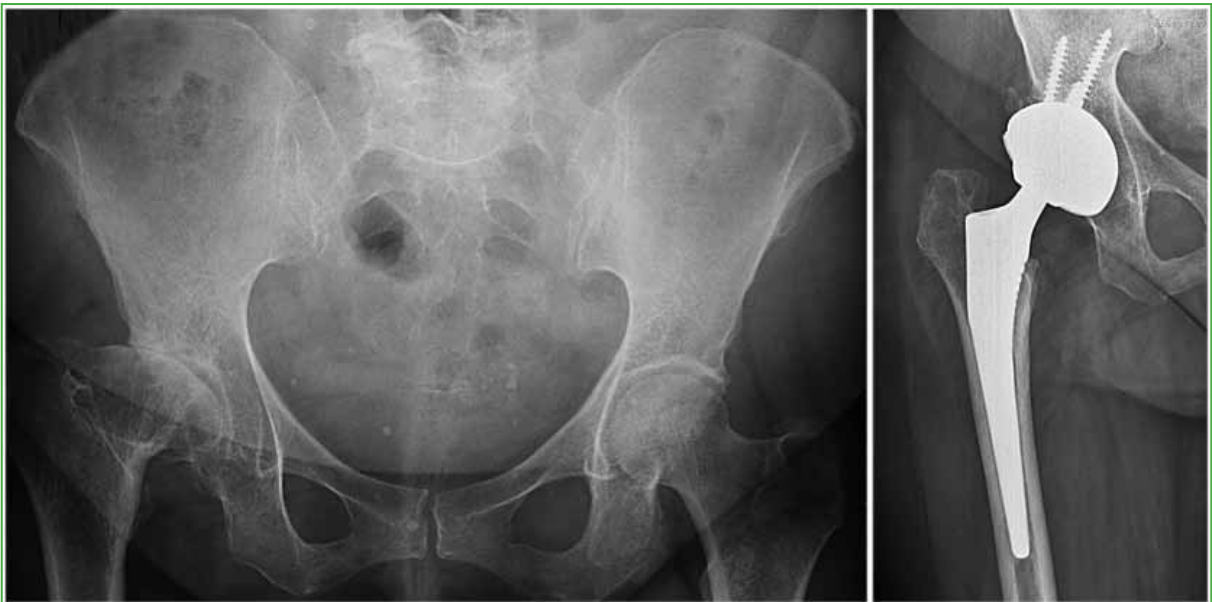


Figure 3. Anteroposterior radiographs of the pelvis and hip showing a total hip prosthesis in a patient with sequelae of Legg-Calvé-Perthes disease.

According to age distribution, the group with the youngest mean age corresponded to patients operated on for developmental dysplasia of the hip (41 years), followed by patients with avascular necrosis (58 years), LCPD (61 years) and hip fracture (71 years).

In the 1% corresponding to THA due to hip osteoarthritis secondary to LCPD (11 THAs in 10 patients), the age range was 40 to 82 years (mean 61), four of them had been operated on before the age of 50. In terms of gender distribution, there were four women (40%) and six men (60%). Five of these 10 patients had undergone surgery on the right hip and four on the left hip, and one case on both (at 45 and 46 years of age).

On all preoperative radiographs, coxa magna and coxa plana were detected. Forty percent had ascending greater trochanter and 70% had a short femoral neck. Three had undergone surgery: one tectoplasty and two valgus osteotomies.

The mean follow-up of these patients was 8.1 years (range 4-13). All of them are followed up annually, except for two who died during the process for reasons unrelated to the study.

DISCUSSION

The specific literature on the incidence of THA due to hip osteoarthritis secondary to LCPD is scarce.

Uluçay et al. reviewed the causes of secondary hip osteoarthritis in 935 operated hips and reported that the rate of THA due to LCPD is 1.7% in females and 4.2% in males. These rates are slightly higher than those in our series, with a similar number of patients.³

Recent studies state that 50% of patients with LCPD will have hip osteoarthritis between the fourth and fifth decade of life⁴ and that 5% will require THA 20 years after initial treatment.⁵

Likewise, in 2016, Shohat et al.⁶ reported that the mean age at the moment of THA due to LCPD is 50.2 years, 10 years younger than our mean.

However, as previously stated, a substantial proportion of prosthetic hips in our hospital are classified as primary etiology. They were so identified because there was no other data suggestive of secondary hip osteoarthritis. This is because, from a radiographic standpoint, it is exceedingly difficult to establish its origin in very advanced stages and in the absence of a previous evolutionary radiography follow-up. In their last arthritic stages, avascular necrosis, acetabular dysplasia, and the already well-consensual femoroacetabular impingement are difficult to identify.

In 2008, Ganz et al.⁷ already questioned many of the primary hip osteoarthritis, which might not be idiopathic, and assumed the existence of some underlying articular cartilage abnormality. These authors put forward the current hypothesis that many of these are actually secondary to subtle anomalies in anatomical development that result in femoroacetabular impingement at a site of excessive contact stress. The most frequent location is the anterosuperior border area and the critical movement is internal rotation of the hip in 90° flexion. Precisely, the degenerative osteoarthritic lesion begins in this area where, on many occasions, avascular necrosis or acetabular dysplasia also begin.⁷

In our review, we were unable to identify these patients with subtle defects in the regeneration and final remodeling of LCPD, who appeared to have had a good result according to the Stulberg classification, but who, despite discharge at the end of growth, consulted for hip joint pain.

In 2011, Kim and Novais² reported their observations on the diagnosis and treatment of femoroacetabular impingement specifically in LCPD. In their article, they explain the origin of residual hip deformities secondary to the disease. On the one hand, LCPD produces an altered growth of the proximal femoral physis with a short femoral neck. On the other hand, overgrowth of the greater trochanter causes mechanical alterations with imbalance in the abduction and rotation forces of the hip. Finally, ossification of the cephalic nucleus results in a non-spherical femoral head and secondary remodeling of the acetabulum. All of these determine the Stulberg stages.²

Sometimes, the loss of sphericity of the femoral head and the modifications of physeal growth are very subtle, they can change the mechanical function of the hip joint contributing to femoroacetabular impingement, without reaching a severe Stulberg stage.

It is necessary to recognize all these deformities and understand their contribution to the patient's symptoms before a therapeutic strategy can be planned.

Lee et al.⁸ also addressed this eventuality and stated that residual hip deformities after LCPD cause mechanical symptoms and are associated with a pathomechanical setting that may present with femoroacetabular impinge-

ment. In these patients, arthroscopy relieved symptoms and improved range of motion, making arthroscopic treatment a good option for LCPD sequelae.⁸

Arthroscopic treatment can resolve symptomatology and limit osteoarthritis progression, as stated in articles published by Amanatullah et al.⁹ in 2015 or, more recently, by Nepple et al.¹⁰ in 2021, and by Chiari et al.¹¹ in early 2022. Prevention is the solution to a more serious evolution. In 2021, Vahedi et al.¹² advocated for early therapeutic arthroscopy in femoroacetabular impingement rather than waiting until advanced age, a prolonged symptomatic period, or radiographic evidence of joint space narrowing, because these are all risk factors for arthroscopy failure and subsequent progression to hip osteoarthritis.⁹⁻¹³

CONCLUSIONS

The current hypothesis, as stated by Ganz et al., is that certain cases of secondary hip osteoarthritis are due to subtle developmental abnormalities that result in femoroacetabular impingement and, in turn, a site of excessive contact stress. The sphericity of the femoral head is a prognostic factor for the development of osteoarthritis.

The results of our study allow us to conclude that THA is rare in the young adult with hip osteoarthritis secondary to LCPD, but it is true that these patients are at increased risk of undergoing prosthetic placement surgery at a young age.

Similarly, we anticipate that these cases may be greater than expected, because an uncertain number of patients appear to have obtained good radiographic outcomes but may develop femoroacetabular impingement in a relatively short period of time.

The natural evolution of some hips with LCPD appears to be the development of femoroacetabular impingement as a consequence of abnormal support at the edge of the acetabulum or overcoverage of the acetabulum, resulting in early hip osteoarthritis.

In the absence of reviews on the evolution of LCPD with a good final radiographic outcome, we propose systematically following up on young patients with closed growth plates after they have reached the end of growth, including periodic clinical and radiographic evaluations to detect early femoroacetabular impingement and offer therapeutic options (e.g., arthroscopic), which may prevent the progression of hip osteoarthritis and thus delay or avoid prosthetic surgery.

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REFERENCES

1. Stulberg SD, Cooperman DR, Wallensten R. The natural history of Legg-Calvé-Perthes disease. *J Bone Joint Surg Am* 1981;63(7):1095-108. PMID: 7276045
2. Kim YJ, Novais EN. Diagnosis and treatment of femoroacetabular impingement in Legg-Calvé-Perthes disease. *J Pediatr Orthop* 2011;31(2 Suppl):S235-40. <https://doi.org/10.1097/BPO.0b013e3182260252>
3. Uluçay C, Ozler T, Güven M, Akman B, Kocadal AO, Altıntaş F. Etiology of coxarthrosis in patients with total hip replacement. *Acta Orthop Traumatol Turc* 2013;47(5):330-3. <https://doi.org/10.3944/aott.2013.3103>
4. Heesakkers N, van Kempen R, Feith R, Hendriks J, Schreurs W. The long-term prognosis of Legg-Calvé-Perthes disease: a historical prospective study with a median follow-up of forty-one years. *Int Orthop* 2015;39(5):859-63. <https://doi.org/10.1007/s00264-014-2589-2>
5. Hanna SA, Sarraf KM, Ramachandran M, Achan P. Systematic review of the outcome of total hip arthroplasty in patients with sequelae of Legg-Calvé-Perthes disease. *Arch Orthop Trauma Surg* 2017;137(8):1149-54. <https://doi.org/10.1007/s00402-017-2741-8>

6. Shohat N, Copeliovitch L, Smorgick Y, Atzmon R, Mirovsky Y, Shabshin N, et al. The Long-Term outcome after varus derotational osteotomy for Legg-Calvé-Perthes disease: A mean follow-up of 42 years. *J Bone Joint Surg Am* 2016;98(15):1277-85. <https://doi.org/10.2106/JBJS.15.01349>
7. Ganz R, Leunig M, Leunig-Ganz K, Harris WH. The etiology of osteoarthritis of the hip: an integrated mechanical concept. *Clin Orthop Relat Res* 2008;466(2):264-72. <https://doi.org/10.1007/s11999-007-0060-z>
8. Lee WY, Hwang DS, Ha YC, Kim PS, Zheng L. Outcomes in patients with late sequelae (healed stage) of Legg-Calvé-Perthes disease undergoing arthroscopic treatment: retrospective case series. *Hip Int* 2018;28(3):302-8. <https://doi.org/10.5301/hipint.5000563>
9. Amanatullah DF, Antkowiak T, Pillay K, Patel J, Refaat M, Toupadakis CA, et al. Femoroacetabular impingement: current concepts in diagnosis and treatment. *Orthopedics* 2015;38(3):185-99. <https://doi.org/10.3928/01477447-20150305-07>
10. Nepple JJ, Fowler LM, Larson CM. Decision-making in the borderline hip. *Sports Med Arthrosc Rev* 2021;29(1):15-21. <https://doi.org/10.1097/JSA.0000000000000298>
11. Chiari C, Lutschounig MC, Nöbauer-Huhmann I, Windhager R. Femoroacetabuläres Impingement-Syndrom bei Adoleszenten – Wie beraten? Wie behandeln? [Femoroacetabular impingement syndrome in adolescents - How to advise? How to treat?]. *Orthopäde* 2022;51(3):211-8. [German] <https://doi.org/10.1007/s00132-022-04214-z>
12. Vahedi H, Yacovelli S, Diaz C, Parvizi J. Surgical treatment of femoroacetabular impingement: Minimum 10-year outcome and risk factors for failure. *JB JS Open Access* 2021;6(4):e20.00176. <https://doi.org/10.2106/JBJS.OA.20.00176>
13. Masrouha KZ, Callaghan JJ, Morcuende JA. Primary total hip arthroplasty for Legg-Calvé-Perthes syndrome: 20 year follow-up study. *Iowa Orthop J* 2018;38:197-202. PMID: 30104945

Measuring Tumor Aggressiveness Through Artificial Intelligence

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ABSTRACT

Objective: To determine the degree of tumor aggressiveness by means of artificial intelligence techniques using magnetic resonance images of sarcomas with proven histological grade. **Materials and Methods:** Two independent cohorts of patients with soft tissue sarcomas (STS) were retrospectively collected. For each patient in the two cohorts, three types of imaging sequences were acquired as indicated by the clinical protocols: T1-weighted (T1), fat-suppressed T2-weighted (FST2) and STIR. For the development of the artificial intelligence model, 134 images were used, both high-grade and low-grade T1 and T2 images, taking the most representative image of the tumor at any slice. This translated into more than 36 million pixels that were analyzed by the Landing AI program. **Results:** To determine the degree of tumor aggressiveness by means of artificial intelligence techniques using magnetic resonance The model's average accuracy was 84.3%, and its sensitivity was 73.3%, with a confidence threshold of 0.66, indicating that a good quality model was generated for predicting the grade of aggressiveness of an STS prior to biopsy using MRI scans.

Conclusions: A novel approach is presented to address a rare pathology using artificial intelligence techniques to determine the tumor grade based on nuclear magnetic resonance images. Based on the results of our model, it can be considered as a second expert opinion when performing imaging studies prior to biopsy.

Keywords: Soft tissue sarcoma; artificial intelligence; histological grade; deep learning; automated machine learning; machine vision.

Level of Evidence: III

Determinación del grado de agresividad tumoral mediante técnicas de inteligencia artificial aplicadas a imágenes de resonancia magnética

RESUMEN

Objetivo: Determinar el grado de agresividad tumoral mediante técnicas de inteligencia artificial utilizando imágenes de resonancia magnética de sarcomas con grado histológico comprobado. **Materiales y Métodos:** Dos cohortes retrospectivas independientes de pacientes con sarcomas de partes blandas. Para cada paciente de las dos cohortes se adquirieron tres tipos de secuencias de imágenes como indican los protocolos clínicos: potenciadas en T1, en T2 con supresión grasa (T2FS) y STIR. A fin de desarrollar el modelo de inteligencia artificial, se utilizaron 134 imágenes, tanto las de alto grado como las de bajo grado, en T1 y T2 tomando la imagen más representativa del tumor en cualquier corte. Esto se traduce en 36 millones de píxeles que serán analizados por el programa Landing AI. **Resultados:** La precisión promedio del modelo fue del 84,3% y la sensibilidad, del 73,3%, con un umbral de confianza de 0,66, lo que demuestra inicialmente que se obtuvo un modelo de buena calidad para predecir con imágenes de resonancia magnética el grado de agresividad de un sarcoma de partes blandas antes de la biopsia. **Conclusiones:** Se presenta un enfoque novedoso para abordar un tipo de enfermedad infrecuente usando técnicas de inteligencia artificial para determinar el grado tumoral en imágenes de resonancia magnética. Según los resultados de nuestro modelo, se lo puede considerar como una segunda opinión experta al realizar los estudios por imágenes antes de la biopsia.

Palabras clave: Sarcoma de partes blandas; grado histológico; inteligencia artificial; aprendizaje automático; visión artificial.

Nivel de Evidencia: III

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INTRODUCTION

60 years ago, John McCarthy originally defined artificial intelligence (AI) as “the science and engineering to make intelligent machines”, and he predicted that these machines would one day be capable of performing feats that were previously thought to be the exclusive domain of human intelligence, such as advanced problem solving.¹ Jerrold S. Maxmen, professor of psychiatry at Columbia University, predicted that AI would bring with it the “post-medical era” for the 21st century, describing change as “possible, inevitable and desirable.”²

Computer vision is a function of AI through which machine learning techniques and complex neural networks can be applied to allow computers to capture, analyze and interpret information from clinical images, using algorithms that are trained to make classifications and predictions based on patterns provided by the data.³ In the field of Orthopedics and Traumatology, the use of these techniques is expanding rapidly. Computer vision has made significant progress in the analysis of medical images in a variety of modalities commonly used in orthopedics, including radiography, computed tomography and magnetic resonance imaging (MRI). Automated machine learning (AutoML) is of great help to do this. In this case, we refer to the process of automating an action by applying common machine learning to solve real problems.⁴ The high degree of automation in AutoML allows those who are not experts in AI to make use of machine learning models without the need for advanced experience in that field.⁵

Soft tissue sarcomas (STS) represent a rare and heterogeneous disease that comprises 1% of all malignant tumors in adults. In 2019, about 13,500 people were diagnosed with STS in the United States.⁶ They encompass at least 100 different histological and molecular subtypes, and each subtype shows a variable clinical behavior.⁷ Rare cases, together with the heterogeneity of the disease and its complex treatment, highlight the importance of the interdisciplinary management of these injuries, involving teams specialized in diagnostic imaging, pathological anatomy, radiation therapy, oncologists and orthopedic surgeons with experience in the management of STS.

When faced with a patient with STS, decision-making regarding the optimal treatment of the tumor depends, to a large extent, on the size and location of the STS, and on the outcome of the pathological anatomy study that evaluates the aggressiveness of the tumor.

Currently, the system we use to classify the histological grade of STS is the one proposed by the *French Fédération Nationale des Centres de Lutte Contre le Cancer (FNCLCC)* of France. The FNCLCC system evaluates only three parameters: tumor differentiation, mitotic index and amount of tumor necrosis (Table 1).⁸

The grade of the tumor is the most important factor in making the best therapeutic decision. The biopsy of the lesion is essential to determine the degree and establish the diagnosis with certainty. By analyzing MRI images and using AI techniques based on deep learning, it is possible to propose an alternative way of determining the degree of aggressiveness of STSs.

The objective of this study was to classify STSs, in a non-invasive way, into: low-grade (G1) and high-grade (G2/G3) using MRI images of sarcomas with histological grade proven by AutoML.

MATERIALS AND METHODS

Two independent retrospective cohorts of patients were formed. The inclusion criteria were: STS with proven histological grade with available information on the classification of tumors from the FNCLCC. The exclusion criteria were: MRI artifacts, previous radiation therapy, primary bone sarcoma or Ewing sarcoma.

The first cohort consisted of the publicly available *The Cancer Image Archive (TCIA)* dataset. This dataset contains computed/positron emission tomography images with fluorine-18-fluorodeoxyglucose and MRI (T1-weighted, T2-weighted with fat suppression [T2FS]) of 51 patients with histologically proven soft-tissue sarcomas in the extremities. All had undergone computed tomography/positron emission explorations with fluorine-18-fluorodeoxyglucose and MRI before treatment, between November 2004 and November 2011. In addition, the dataset contains the demographic data of all the patients analyzed.

The second cohort included images from the Private Center for Safe Orthopedics and Traumatology database. In this case, images were taken of 22 patients with STS with a proven histological grade, operated between 2020 and 2022.

Table 1. Degree of malignancy of soft tissue sarcomas

Parameter	Criterion	
	Tumor differentiation	
1 point	The sarcoma closely resembles normal adult mesenchymal tissue	
2 points	The histological type of sarcoma is defined	
3 points	Embryonic or dedifferentiated sarcomas, synovial sarcoma and sarcoma of the uncertain type	
	Mitotic Index	
1 point	0-9 by 10 high-power fields	
2 points	10-19 by 10 high-power fields	
3 points	>20 by 10 high-power fields	
	Tumor necrosis	
1 point	No necrosis	
2 points	≤50%	
3 points	≥50%	
Tumor grade		
Grade 1: Low	Total points	2, 3
Grade 2: Intermediate	Total points	4, 5
Grade 3: High	Total points	6, 7, 8

Score from 1 to 3 depending on the degree of tumor differentiation, the mitotic index and the percentage of tumor necrosis. A total minimum value <3 indicates low grade; between 3 and 6, intermediate grade; and >6, high grade.

In each patient of the two cohorts, three types of image sequences used as indicated by clinical protocols were acquired: T1-weighted, T2FS and STIR, which allows the signal of certain elements or tissues to be suppressed in a specific way (fat, water). The T1 sequences were acquired in the axial plane, while the T2FS and STIR sequences were taken in different orientations (axial, sagittal and coronal). In addition, the slice thickness was 5.5 mm for the T1-weighted sequence and 5 mm for the T2FS sequence. The in-plane resolution was 0.63 mm²; 0.74 mm² and 0.86 mm² for the T2FS, T1 and STIR sequences, respectively.⁹ From each complete MRI study of the patient, the most representative image was extracted in T1 and T2, this was the image where the largest diameter of the tumor was observed.

In total, 37 images of high-grade sarcomas were obtained in the T1 sequence and 37 images in the T2 sequence. For intermediate-grade sarcomas, 15 images were obtained in the T1 sequence and 15 images in the T2 sequence. The images of low-grade sarcomas were 20 for both the T1 sequence and the T2 sequence.

Grade 2 injuries have an uncertain prognosis and are therefore not useful for decision-making.¹⁰ Taking into account that both high-grade and intermediate-grade sarcomas have similar pre-surgical and post-surgical development, prognosis, and treatment, for the purposes of this project, high-grade and intermediate-grade sarcomas were unified in the same dataset, leaving low-grade sarcomas separately.¹¹

The analysis of the evaluated patients was performed using Google Colab using the Python language with the Numpy, Pandas, Matplotlib and Seaborn libraries to graph the results obtained. The implementation of the project's predictive model was carried out with the Landing Lens tool, an AI platform on the Landing.ai website. Before the data training stage, data augmentation techniques were used to increase the number of images to be analyzed. In this case, the image size was changed to a height of 1000 and a width of 1000 pixels. As an augmentation technique, a horizontal and vertical flip was performed with a 0.5 probability of being applied to each image.

The lesions in the MRI images were manually classified as high or low grade, with red indicating high-grade lesions and light blue indicating low-grade lesions.

Assessment

We discuss the most significant metrics to consider when evaluating the performance of a machine learning model in the context of a binary classification.¹²

Confusion matrix: it is used to have a more complete view when evaluating the performance of a model. It is a tool that allows the visualization of the performance of an algorithm, in this case, the analysis of millions of pixels that the model uses to learn.

Precision: The ratio of correct predictions with a test dataset. It is the ratio between the number of correct predictions and the total number of input examples. Practically speaking, it is the percentage of positive cases detected.

Recall: It is the proportion of positive cases that were correctly identified by the algorithm. It is represented as the fraction of true positives. It is also known as the true positive rate.

Precision and recall by confidence threshold: the model will decide whether the classification is high-grade or low-grade if the value returned by the model exceeds a decision threshold. If we increase this value, we will be increasing precision and, conversely, if we decrease it, we increase recall.

RESULTS

The first analysis was carried out on the distribution of the population and the disease. The average age in both groups was 54.82 years (± 16.98) (range 16-83). The distribution of the population by sex was similar (female gender 52.9%, male gender 47.1% [Z-statistic: 0.594, p 0.552]).

Figure 1 details the cases analyzed according to the pathological analysis result.

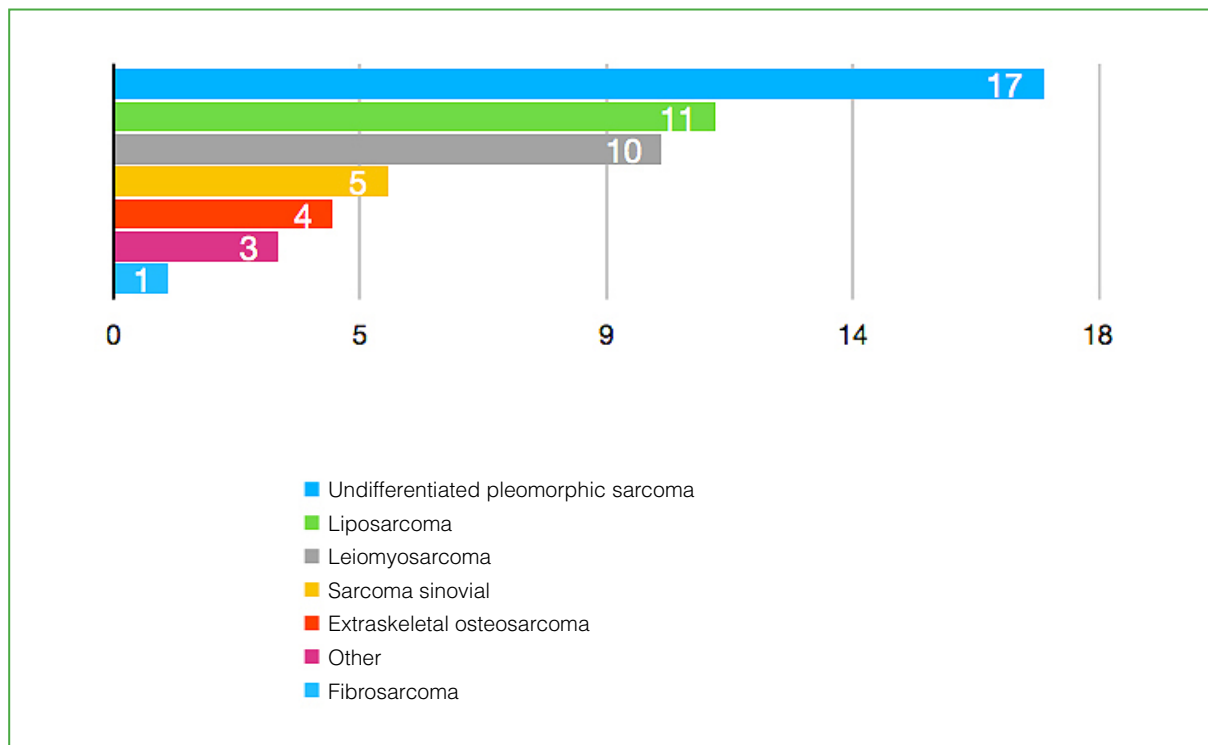


Figure 1. Distribution of cases according to the results of the pathology study.

Figures 2 and 3 show the distribution of the degree of aggressiveness of each type of tumor, as well as the distribution of the grade according to its location.

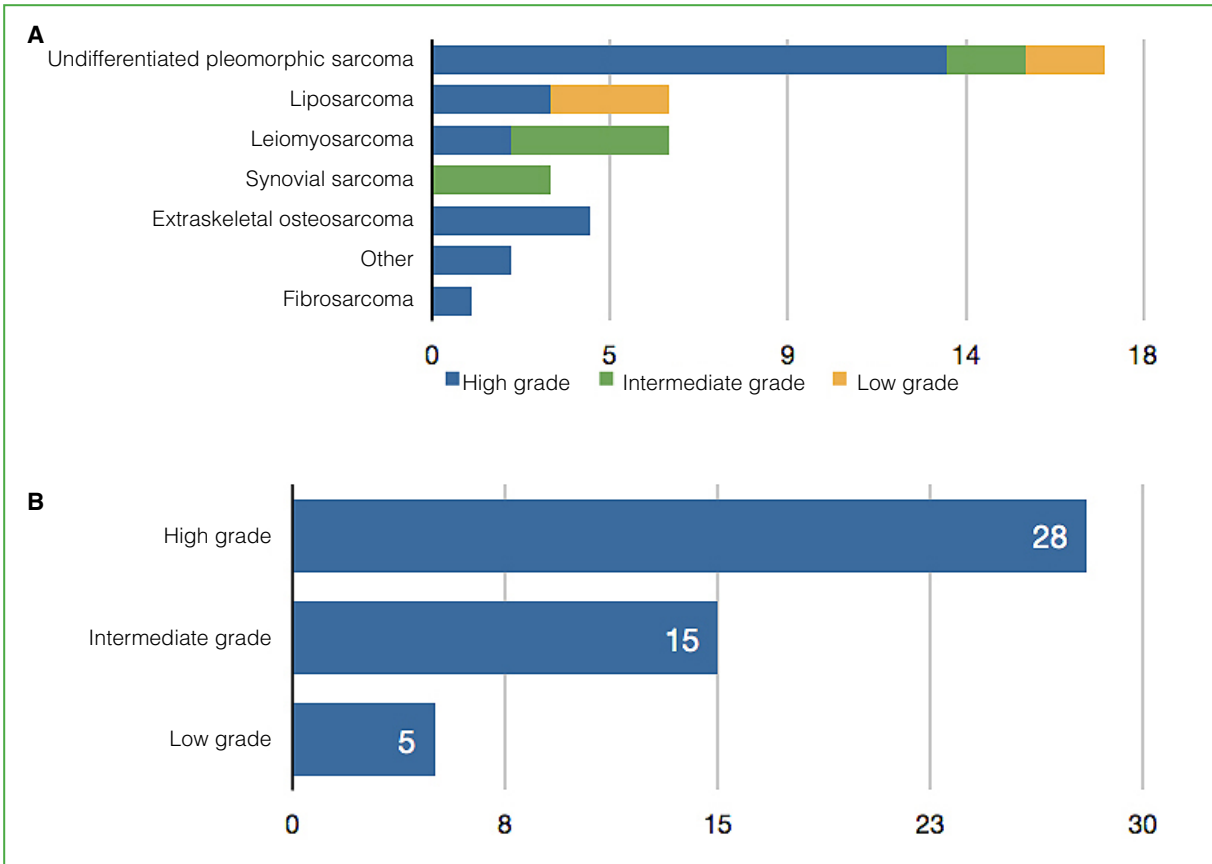


Figure 2. Distribution of soft-tissue sarcomas according to the degree of aggressiveness and their location.

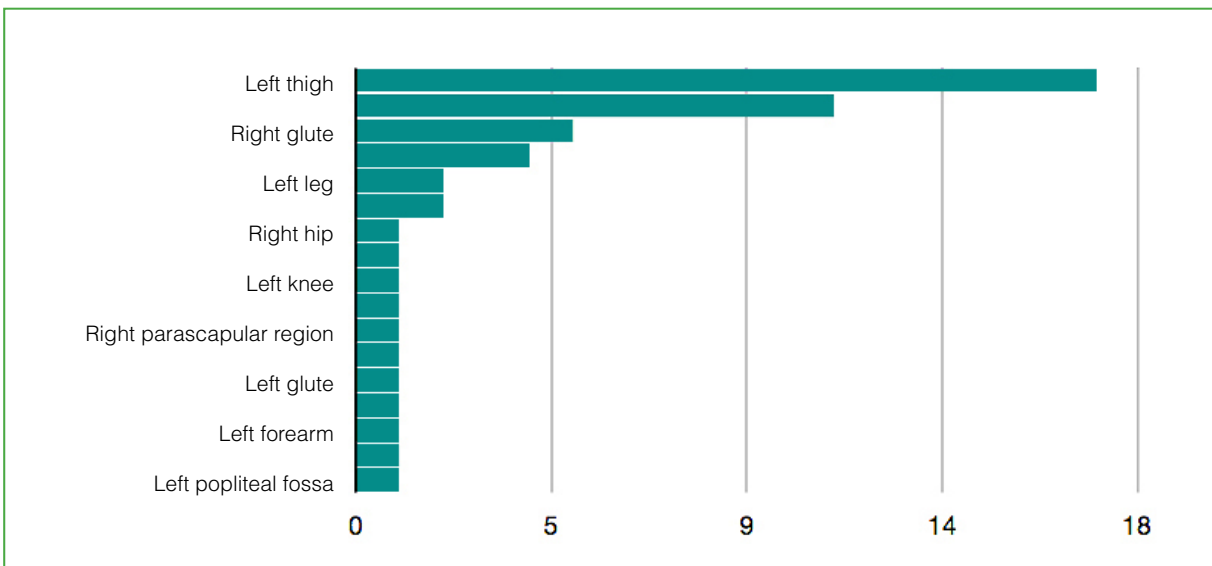


Figure 3. Distribution of lesions according to their location.

In a second analysis, to develop the AI model, 134 images available in the dataset were used, both high-grade and low-grade, and in T1 and T2 sequences according to the image study performed, taking the most representative image of the tumor in any section (Figure 4).

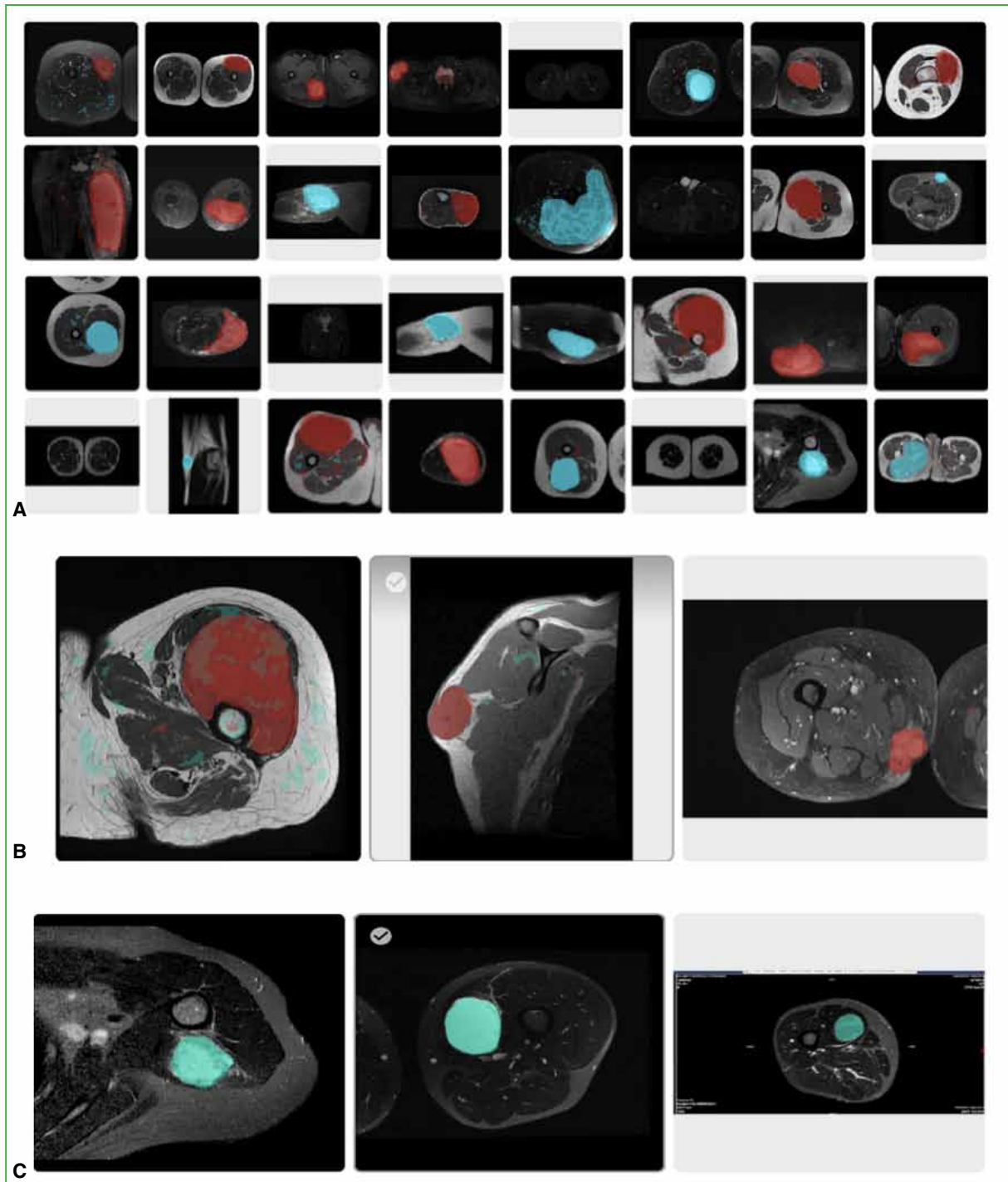


Figure 4. **A.** Labeling of images of high-grade (red) and low-grade (light blue) soft-tissue sarcomas. **B.** Labeling of high-grade injuries (red). This process must be done meticulously without marking the image outside of the tumor, as it can alter the final results. **C.** The same procedure for low-grade injuries (light blue).

The lesions were properly and meticulously labeled by ‘coloring’ them within the edges, because neural networks assess images based on the pixels assigned. Therefore, an incorrect marking of injuries can alter the final results.

Of the total, 95 were used as training samples (70.9%); 26 (19.4%), as validation images and 13, as test images (9.7%) for both groups of patients (Figure 5).

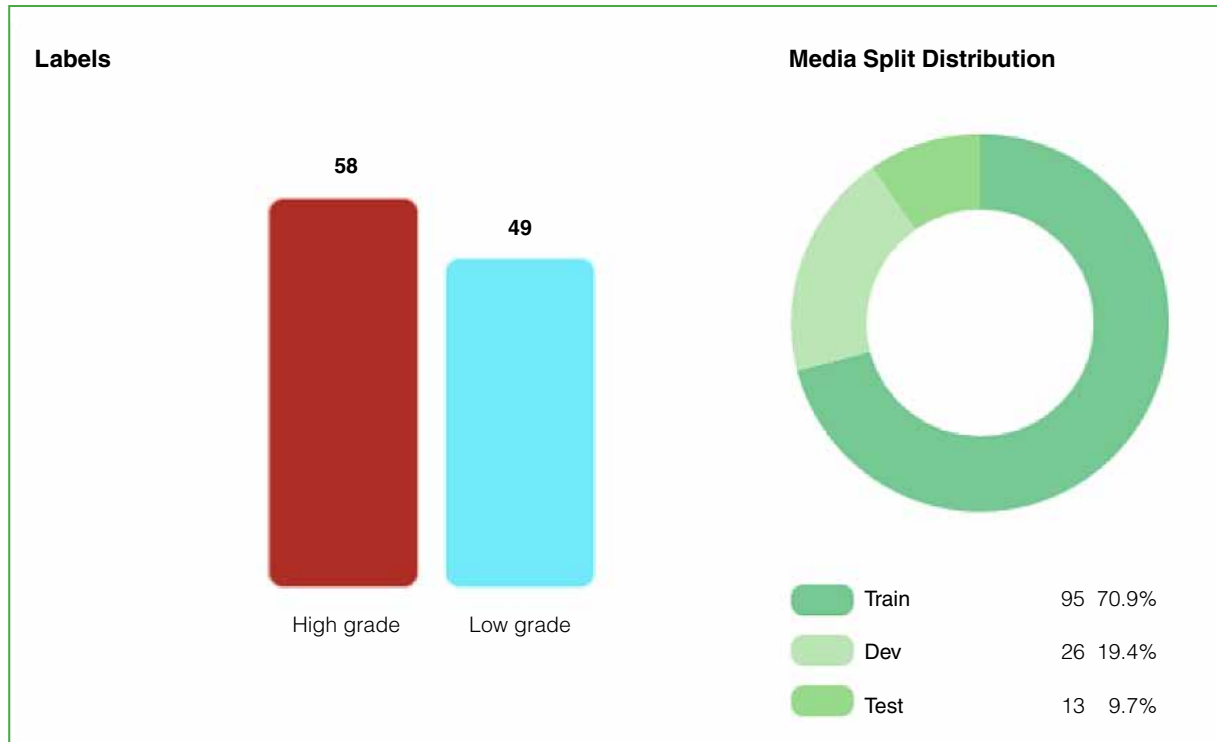


Figure 5. Labeling of the images and division into training group, validation group, and testing group. It is important to note that the precision and recall values are performed on the testing group.

The total number of pixels that will be used by the model for the 134 images is 36 million. The confusion matrix allows us to initially evaluate the performance of our model. The results are detailed in Table 2. In segmentation projects, the objective is to minimize the number of false positives and false negatives, and to maximize the number of true positives and true negatives.

The average precision of the model was 84.3% and the recall was 73.3%, with a confidence threshold of 0.66, which initially shows that a good-quality model was obtained with MRI images (Figure 6).

Table 2. Confusion matrix with the analysis of the 36 million pixels that the neural network analyzed

True positives	False positives
1,096,183	175,493
False negatives	True negatives
315,394	34,830,034

The confusion matrix allows us to initially evaluate the performance of our model. In image segmentation projects, the objective is to minimize the number of false positives and false negatives, and to maximize the number of true positives and true negatives.

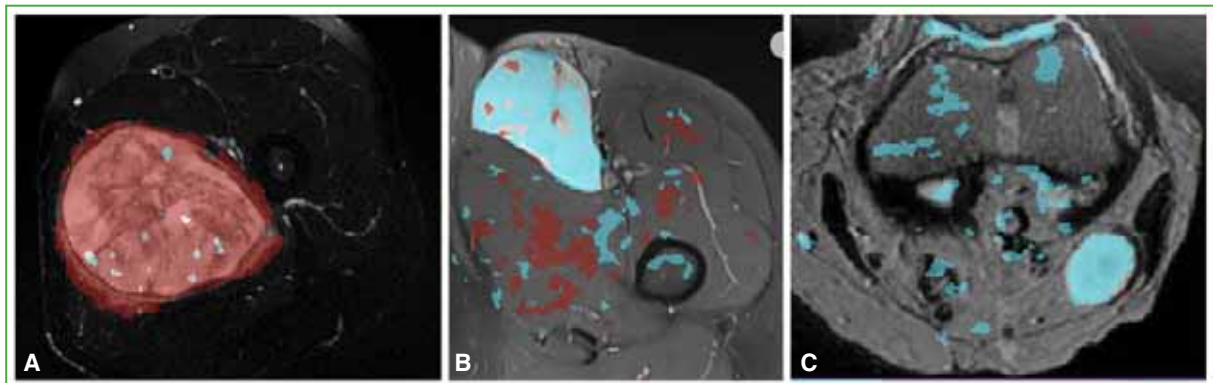


Figure 6. With a precision of 84.3% and a recall of 73.3% on images never seen by the program previously, the model can correctly classify: **A.** High-grade sarcoma (red). **B and C.** Low-grade sarcomas (light blue).

DISCUSSION

Due to the heterogeneity of this disease, the initial degree of aggressiveness of the biopsy may be underestimating the final degree of aggressiveness identified in the pathology analysis. This may lead to the need to search for accurate preoperative diagnostic tools to classify STS.¹³

STS is a rare type of cancer. For this reason, its treatment requires specialized interdisciplinary centers with professionals who are experts in the field, since a wrong diagnosis or a delay can have catastrophic consequences for the patient. In this case, the help of AutoML can be essential when imaging studies are being performed, as they allow the treating team to have a second qualified opinion on the degree of tumor malignancy in a short time, before the biopsy and the pathology analysis result.

The best AutoML model using Landing AI Landing Lens achieved a precision of 84.3% and a recall of 73.3%, based on MRI images in axial slices over the larger diameter of the lesion in T1 and T2 sequences.

Image analysis programs (e.g., Landing Lens from Landing AI; Vertex AI from Google Cloud Platform) allow professionals who are just starting out in data science and who still have flaws in implementing programming code, greater ease of use when implementing machine learning models, in addition to saving time on basic tasks. In our specialty, this is fundamental.

The study has its limitations. This is a retrospective study by a single center, which could have led to selection bias. However, the epidemiological characteristics of the series are comparable to those of other published articles.¹⁴ In addition, as this is a rare disease, the number of images used by the model is still low. Although augmentation techniques can help to have a more robust data set, the contribution and collaboration of centers specialized in the treatment of sarcomas would be essential in order to increase the number of images for the study, trying to improve the results of the models (data sharing).

CONCLUSIONS

This study presents a novel approach to address a rare type of disease using automated deep learning techniques for the purpose of determining tumor grade based on MRI images. Although the true impact of AI in Orthopedics and Traumatology has yet to be demonstrated, there is much evidence to support the use of these technologies to generate value in healthcare. To the extent that these tools are easier to use, there will be more and more machine learning models built and implemented, allowing for new research and new results, with the aim of improving the early diagnosis of patients with this disease and others. These technologies should be seen as helping professionals, becoming a tool that can increase the capabilities of a doctor instead of replacing their responsibilities. In this case, with the results obtained, we could consider our AI model as a second expert opinion when performing imaging studies on patients with STS before the biopsy.

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

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REFERENCES

1. McCarthy J, Minsky ML, Rochester N, Shannon CE. A proposal for the Dartmouth Summer Research Project on Artificial Intelligence, August 31, 1955. *AI Magazine* 2006;27(4):12-4. <https://doi.org/10.1609/aimag.v27i4.1904>
2. Maxmen JS. *The post-physician era: Medicine in the 21st century*. Hoboken, New Jersey: Wiley; 1976, p. 2336-7.
3. Scarlet A. *A machine learning primer for clinicians—part 1*. HlStalk. 2018. Available at: <https://histalk2.com/2018/10/17/a-machine-learningprimer-for-clinicianspart-1/> [Consulted: August 5, 2019]
4. Chollet F. *Deep learning with Python*. Shelter Island, New York: Manning Publications; 2018.
5. Bini SA. Artificial intelligence, machine learning, deep learning, and cognitive computing: what do these terms mean and how will they impact health care? *J Arthroplasty* 2018;33(8):2358-61. <https://doi.org/10.1016/j.arth.2018.02.067>
6. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2019. *CA Cancer J Clin* 2019;69(1):7-34. <https://doi.org/10.3322/caac.21551>
7. Fletcher CDM, Bridge JA, Hogendoorn P, Mertens F. *WHO Classification of Tumors of Soft Tissue and Bone*. 4th ed., WHO Press; 2013, vol. 3.
8. Trojani M, Contesso G, Coindre JM, Rouesse J, Bui NB, de Mascarel A, et al. Soft tissue sarcomas in adults; study of pathological prognostic variables and definition of histopathological grading systems. *Int J Cancer* 1984;33(1):37-42. <https://doi.org/10.1002/ijc.2910330108>
9. Vallières M, Freeman CR, Skamene SR, El Naqa I. A radiomics model from joint FDG-PET and MRI texture features for the prediction of lung metastases in soft-tissue sarcomas of the extremities. *Phys Med Biol* 2015;60(14):5471-96. <https://doi.org/10.1088/0031-9155/60/14/5471>
10. Refai F. The histopathological grading of soft tissue sarcomas: A review. *Saudi J Pathol Microbiol* 2019;4(8):581-5. <https://doi.org/10.21276/sjpm.2019.4.8.2>
11. Deyrup AT, Weiss SW. Grading of soft tissue sarcomas: the challenge of providing precise information in an imprecise world. *Histopathology* 2006;48(1):42-50. <https://doi.org/10.1111/j.1365-2559.2005.02288.x>
12. Amidi A, Amidi S. Hoja de referencia de consejos y trucos sobre Aprendizaje Automático. Métricas de clasificación. 2021. Available at: <https://stanford.edu/~shervine/l/es/teaching/cs-229/hoja-referencia-aprendizaje-automaEco-consejos-trucos>
13. Navarro F, Dapper H, Asadpour R, Knebel C, Spraker MB, Schwarze V, et al. Development and external validation of deep-learning-based tumor grading models in soft-tissue sarcoma patients using MR imaging. *Cancers (Basel)* 2021;13(12):2866. <https://doi.org/10.3390/cancers13122866>
14. Coindre JM, Terrier P, Guillou L, Le Doussal V, Collin F, Ranchère D, et al. Predictive value of grade for metastasis development in the main histologic types of adult soft tissue sarcomas: a study of 1240 patients from the French Federation of Cancer Centers Sarcoma Group. *Cancer* 2001;91(10):1914-26. [https://doi.org/10.1002/1097-0142\(20010515\)91:10<1914::aid-cnrc1214>3.0.co;2-3](https://doi.org/10.1002/1097-0142(20010515)91:10<1914::aid-cnrc1214>3.0.co;2-3)

Snapping Scapula Syndrome Resulting from a Subscapular Osteochondroma: Case Report and Literature Review

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ABSTRACT

Snapping scapula syndrome is a rare pathology first described by Boinet in 1867. Its pathogenesis is caused by an incongruity in the thoracic scapular joint, associated with multiple causes including bursitis, exostosis, bone mass, fibrotic tissue or muscular abnormalities, defective consolidation of fractures or anatomical rib or scapular fractures. The purpose of this article is to present a clinical case of an adolescent with incapacitating clinical pain in the right scapular region, as well as a deformity at this level that had evolved for more than 4 years, and which, when diagnostic tests were performed, revealed a subscapular bone mass suggestive of a single large osteochondroma measuring more than 2.5 cm x 4 cm x 4 cm.. A review and update of the literature on the diagnosis and current treatment of this pathology is made.

Keywords: Exostosis; osteochondroma; snapping scapula syndrome; scapulothoracic pathology.

Level of Evidence: III

Síndrome de fricción escapulotorácica por un osteocondroma subescapular: presentación de un caso y revisión bibliográfica

RESUMEN

El síndrome de fricción escapulotorácica, resalto o chasquido escapular es un cuadro poco frecuente, descrito, por primera vez, por Boinet, en 1867. Se produce por una incongruencia en la articulación escapulotorácica, asociada a múltiples causas, como bursitis, exostosis, masas óseas, tejidos fibrótico o muscular anómalos, consolidación defectuosa de fracturas o variaciones de la anatomía costal o escapular. El propósito de este artículo es comunicar un caso clínico de una adolescente con dolor incapacitante y deformidad en la región escapular derecha, de más de cuatro años de evolución. Los estudios diagnósticos revelaron una masa ósea única subescapular sugestiva de un osteocondroma de gran tamaño, más de 2,5 cm x 4 cm x 4 cm. También, se presenta una revisión y actualización de la bibliografía sobre el diagnóstico y el tratamiento actual de esta enfermedad.

Palabras clave: Exostosis; osteocondroma; síndrome de fricción escapulotorácica; enfermedad escapulotorácica.

Nivel de Evidencia: III

INTRODUCTION

The scapulothoracic joint is a complex anatomical structure that plays an important role in overall shoulder function. It is given by the coordination of muscles located in different planes, in addition to bursae located between the subscapularis muscle, the serratus anterior muscle, and the chest wall that allow a smooth and sliding movement.¹⁻⁴ Any disruption in this sliding process might create bursae inflammation, causing any direct movement or pressure on it to cause pain.

The purpose of this article is to report the case of an adolescent girl with disabling pain and deformity in the right scapular region, of more than four years of evolution. Diagnostic studies revealed a unique subscapular bone mass suggestive of a large osteochondroma (2.5 cm x 4 cm x 4 cm). The patient underwent resection through an open approach.

In addition, a literature review is presented.

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PATHOGENICS

Snapping scapula syndrome is a rare condition first described by Boinet in 1867.⁵ Any disruption in the sliding process might create bursae inflammation, causing any direct movement or pressure on it to cause pain. It is caused by excessive joint wear, infectious diseases, or trauma.⁶ In most cases, bursitis or pain is considered to occur from repetitive movement of the scapula over the chest wall,⁶⁻⁸ or abnormal fibrotic or muscle tissue,⁸⁻¹⁰ fracture malunion,^{5,11,12} or variations in scapular bone anatomy or exostosis (solitary and multiple osteochondroma). Osteochondroma is the most common benign bone mass,^{8,10} it has a slow growth and symptoms are insidious.⁵ In this case, its location in the scapula is unusual, its frequency is less than 5%,^{1,8-10,13} and it gives the appearance of a winged scapula.^{4,6,14,15}

Cadaver studies suggest that approximately 6% of scapulae may show some degree of superomedial snagging and 8.6% of scapular specimens have a superomedial angulation of $\geq 35^\circ$.¹⁶ Sometimes, a similar bone abnormality is identified along the underside of the scapular angle that appears to be the second most common site of symptoms.¹⁶ An osteochondroma or Luschka's tubercle (a bone protrusion at the superomedial edge of the scapula) may also cause persistent symptoms.^{6-8,17}

CLINICAL APPROACH

As a common denominator, patients report pain that increases with the use of the glenohumeral joint associated with audible or palpable crepitation,⁵ which may be accompanied by muscle dysfunction, protective posture against muscle pain and weakness, pain not attributable to a history of trauma or recent interventions,⁴ as well as clinical symptoms of scapular deformity.

When the patient reaches a degree of chronic bursitis, symptoms rarely go away on their own without rest or physical therapy.

Another aspect to consider is the practice of sports activities with overuse of the joint, such as swimming or throwing, gymnastics or weightlifting.

With all these data, an adequate approach is made differentiating soft tissue lesions, such as muscular atrophy, muscle fibrosis, abnormal muscle insertions, subscapular elastofibroma, cervical spondylosis and radiculopathy, sprained periscapular muscles, glenohumeral pictures,¹⁸ and winged scapula,¹⁴ an entity with nerve involvement, identified by various maneuvers to differentiate the true winging from a compensating pseudowinging secondary to a painful scapulothoracic joint.

DIAGNOSTIC AND IMAGING STUDIES

Scapula disorders should initially be evaluated with radiographs to identify bone abnormalities in both the scapula and rib cage. They can be supplemented with a CT scan with 3D reconstruction to improve the definition of bone abnormalities. Additionally, MRI can be used to identify the location of inflammation and the size of the bursae. Each study is useful to identify the different causes of snapping scapula syndrome (bone involvement in both the scapula and the rib cage, as well as inflammation of the different subscapular bursae). Nerve conduction studies and electromyography help distinguish it from a winged scapula or neurological lesions.^{2,4,8,18}

TREATMENT

Initial management includes conservative methods of decreasing sports activity, muscle strengthening and analgesia, physical therapy, and even corticosteroid infiltration, although these bursae can be difficult to inject accurately.^{4,18-21} Surgery is indicated if conservative management has not achieved clinical improvement in six months or more,^{4,17} although there is no consensus as to time; or before six months for patients undergoing compression by bone protrusions.^{2,13} Surgical treatment depends on the causes and may consist of an open or arthroscopic bursectomy, resection of the superomedial or inferomedial edge of the scapula, or osteotomy of the osteochondroma.^{5,9,14,17,18,22-28}

CLINICAL CASE

The patient is an adolescent with disabling pain and deformity in the right scapular region of more than four years of evolution. Elevation of the right scapula was found during the clinical examination, with no limitation of the arcs of motion, but with constant moderate pain both at rest and during mobilization (Figure 1).



Figure 1. Clinical image showing pseudowinging and right scapula deformity.

The patient underwent radiographic and tomographic studies with 3D reconstruction in which a single subscapular bone mass suggestive of an osteochondroma of more than 3 cm was observed (Figure 2). The patient underwent surgery with an open technique under direct vision. Histopathological examination of the sample confirmed an osteochondroma.

During surgery, bursitis secondary to chronic friction was detected, without rib deformity, even though the condition had begun in childhood. Analgesic control was administered and the use of a sling was indicated for two weeks, with subsequent rehabilitation. The recovery of the range of motion was complete, with a QuickDASH score of 4.5.

Surgical technique

General anesthesia is administered and the patient is placed in the prone position, in the chicken-wing position (Figure 3) with a homolateral snap on the chest, to increase the subscapular space. The structures are marked (scapula, scapular spine, rhomboid major and minor, trapezoids) and a 4 cm long incision is made in the middle third of the scapula, less than 1 cm from the medial edge, respecting the neurovascular structures (when creating the portals, both arthroscopic and open incisions, special care must be taken with the branches of the nerve and the dorsal scapular artery that descend by the medial edge of the scapula 1 cm from it). Precautions should also be taken not to head over the scapular spine because of the risk of injury to the accessory spinal nerve.²⁹

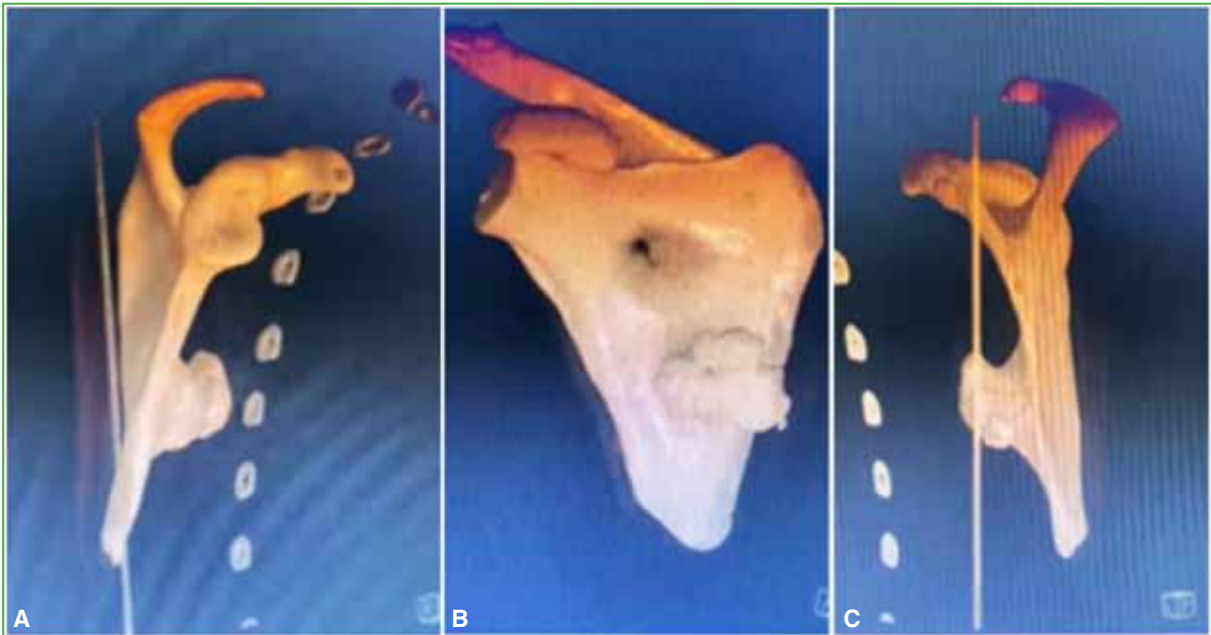


Figure 2. CT scan with 3D reconstruction of the right scapula showing exostosis. **A.** Lateral view. **B.** Anterior view. **C.** Medial view.



Figure 3. Patient in the operating room in the prone, “chicken-wing” position.

The muscle structures are identified, and the trapezius muscle is rebuted upwardly and medially, while the larger rhomboid muscle is partially disinserted from the medial edge of the scapula. The serratus anterior is then partially disinserted 4 cm from the medial edge of the scapula and the subscapularis muscle until the bone tumor mass is identified. The tumor is then excised with an oscillating saw, hemostasis is carried out, muscles are reinserted through transosseous tunnels with fixation by super sutures, and proper scapular stability is verified. The wound is closed. The procedure was carried out without complications (Figure 4).



Figure 4. Exostosis measuring 4 cm length x 2.5 cm height x 2.5 cm width.

DISCUSSION

Poor scapulothoracic congruence triggers a cycle of inflammation and scarring of the bursae that leads to impingement and thus perpetuation of inflammation and pain. The result is fibrosis of the bursa with secondary scarring, pain and snaps. The various causes of shoulder pain, particularly in the scapula, should suggest a possible snapping scapula syndrome, guiding clinical evaluation, selecting complementing research, and indicating behaviors that favor rehabilitation.^{3,5,17}

There are different causes that try to explain the etiology. They can be classified into three main groups that correlate: scapulothoracic bursitis, muscle abnormalities and bone abnormalities.⁵ Consequently, different treatments are indicated, such as conservative management (physical therapy), open or arthroscopic surgery by resection of the superomedial angle and scapula plus bursectomy,^{4,17,22-28} and, in some cases, bursectomy only.

The revised literature, which includes mostly case series, generally reports an improvement in the symptoms of arthroscopically treated patients, with satisfaction rates of 85-90%.^{2,17,26,28,29}

Pearse et al.²⁵ published a retrospective study of 13 patients and lower success rates after arthroscopic treatment (66% satisfaction); however, only three of these 13 patients underwent angle scapulectomy. We did not find any surgical description on osteochondroma resection with arthroscopic technique; the large mass size made us decide to opt for the conventional open approach.

CONCLUSIONS

Although snapping scapula syndrome is an uncommon condition, our understanding about it allows us to suspect it in patients who have pain that is not related to glenohumeral joint or rotator cuff injuries, allowing us to make an accurate diagnosis and recommend appropriate conservative and surgical treatment.

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REFERENCES

- Williams GR Jr, Shakil M, Klimkiewicz J, Iannotti JP. Anatomy of the scapulothoracic articulation. *Clin Orthop Relat Res* 1999;359(359):237-46. <https://doi.org/10.1097/00003086-199902000-00027>
- Osias W, Matcuk GR Jr, Skalski MR, Patel DB, Schein AJ, Hatch GFR, et al. Scapulothoracic pathology: review of anatomy, pathophysiology, imaging findings, and an approach to management. *Skeletal Radiol* 2018;47(2):161-71. <https://doi.org/10.1007/s00256-017-2791-6>
- de Carvalho SC, Castro A do AE, Rodrigues JC, Cerqueira WS, Santos D do CB, Rosemberg LA. Snapping scapula syndrome: pictorial essay. *Radiol Bras* 2019;52(4):262-7. <https://doi.org/10.1590/0100-3984.2017.0226>
- Frank RM, Ramirez J, Chalmers PN, McCormick FM, Romeo AA. Scapulothoracic anatomy and snapping scapula syndrome. *Anat Res Int* 2013;2013:635628. <https://doi.org/10.1155/2013/635628>
- Gaskill T, Millett PJ. Snapping scapula syndrome: diagnosis and management. *J Am Acad Orthop Surg* 2013;21(4):214-24. <https://doi.org/10.5435/JAAOS-21-04-214>
- Williams CH, Jamal Z, Sternard. BT. Bursitis [Internet]. StatPearls; 2022. Available at: <https://www.ncbi.nlm.nih.gov/books/NBK513340/>
- Srikumaran U, Wells JH, Freehill MT, Tan EW, Higgins LD, Warner JJP. Scapular winging: A great masquerader of shoulder disorders: AAOS exhibit selection: AAOS exhibit selection. *J Bone Joint Surg Am* 2014;96(14):e122. <https://doi.org/10.2106/JBJS.M.01031>

8. Tepelenis K, Papathanakos G, Kitsouli A, Troupis T, Barbouti A, Vlachos K, et al. Osteochondromas: An updated review of epidemiology, pathogenesis, clinical presentation, radiological features, and treatment options. *In Vivo* 2021;35(2):681-91. <https://doi.org/10.21873/invivo.12308>
9. Ngongang FO, Fodjeu G, Fon AC, Fonkoue L, Guifo ML, Bitang A, et al. Surgical treatment of rare case of scapula osteochondroma in a resource limited setting: A case report. *Int J Surg Case Rep* 2019;61:130-4. <https://doi.org/10.1016/j.ijscr.2019.07.015>
10. Kaiser CL, Yeung CM, Raskin K, Gebhardt MC, Anderson ME, Lozano-Calderón SA. Tumors of the scapula: A retrospective analysis identifying predictors of malignancy. *Surg Oncol* 2020;32:18-22. <https://doi.org/10.1016/j.suronc.2019.10.020>
11. Khan Z, Gerrish AM, Grimer RJ. An epidemiological survey of tumour or tumour like conditions in the scapula and periscapular region. *SICOT J* 2016;2:34. <https://doi.org/10.1051/sicotj/2016023>
12. Boinet J. Snapping scapula. *Bulletin Societe Imperiale Chirurgie* 1867;8:458.
13. Song Y, Liu J, Cao L, Yu B-H, Sun T, Shi L, et al. Clinical and imaging features of tumors in the scapula. *Curr Med Imaging Rev* 2022;18(6):674-83. <https://doi.org/10.2174/1573405617666210901144924>
14. Park SB, Ramage. JL. Winging of the scapula. StatPearls; 2022. Available at: <https://www.ncbi.nlm.nih.gov/books/NBK541005/>
15. Gooding BWT, Geoghegan JM, Wallace WA, Manning PA. Scapular winging. *Shoulder Elbow* 2014;6(1):4-11. <https://doi.org/10.1111/sae.12033>
16. Edelson JG. Variations in the anatomy of the scapula with reference to the snapping scapula. *Clin Orthop Relat Res* 1996;322(322):111-5. <https://doi.org/10.1097/00003086-199601000-00013>
17. Lehtinen JT, Macy JC, Cassinelli E, Warner JJP. The painful scapulothoracic articulation: Surgical management. *Clin Orthop Relat Res* 2004;423:99-105. <https://doi.org/10.1097/01.blo.0000128647.38363.8e>
18. Williams GR, Ramsey ML, Wiesel SW. *Técnicas quirúrgicas en hombro y codo*. Baltimore, MD: Wolters Kluwer Health; 2011.
19. Lazar MA, Kwon YW, Rokito AS. Snapping scapula syndrome. *J Bone Joint Surg Am* 2009;91(9):2251-62. <https://doi.org/10.2106/JBJS.H.01347>
20. Kuhn JE, Plancher K, Hawkins RJ. Symptomatic scapulothoracic crepitus and bursitis. *J Am Acad Orthop Surg* 1998;6(5):267-73. <https://doi.org/10.5435/00124635-199809000-00001>
21. Kuhne M, Boniquit N, Ghodadra N, Romeo AA, Provencher MT. The snapping scapula: diagnosis and treatment. *Arthroscopy* 2009;25(11):1298-311. <https://doi.org/10.1016/j.arthro.2008.12.022>
22. Chan BK, Chakrabarti AJ, Bell SN. An alternative portal for scapulothoracic arthroscopy. *J Shoulder Elbow Surg* 2002;11(3):235-8. <https://doi.org/10.1067/mse.2002.121767>
23. Millett PJ, Gaskill TR, Horan MP, van der Meijden OA. Technique and outcomes of arthroscopic scapulothoracic bursectomy and partial scapulectomy. *Arthroscopy* 2012;28(12):1776-83. <https://doi.org/10.1016/j.arthro.2012.05.889>
24. Conduah AH, Baker CL 3rd, Baker CL Jr. Clinical management of scapulothoracic bursitis and the snapping scapula. *Sports Health* 2010;2(2):147-55. <https://doi.org/10.1177/1941738109338359>
25. Pearse EO, Bruguera J, Massoud SN, Sforza G, Copeland SA, Levy O. Arthroscopic management of the painful snapping scapula. *Arthroscopy* 2006;22(7):755-61. <https://doi.org/10.1016/j.arthro.2006.04.079>
26. Pavlik A, Ang K, Coghlan J, Bell S. Arthroscopic treatment of painful snapping of the scapula by using a new superior portal. *Arthroscopy* 2003;19(6):608-12. [https://doi.org/10.1016/s0749-8063\(03\)00171-3](https://doi.org/10.1016/s0749-8063(03)00171-3)
27. Nicholson GP, Duckworth MA. Scapulothoracic bursectomy for snapping scapula syndrome. *J Shoulder Elbow Surg* 2002;11(1):80-5. <https://doi.org/10.1067/mse.2002.120807>
28. Harper GD, Mellroy S, Bayley JII, Calvert PT. Arthroscopic partial resection of the scapula for snapping scapula: A new technique. *J Shoulder Elbow Surg* 1999;8(1):53-7. [https://doi.org/10.1016/s1058-2746\(99\)90056-3](https://doi.org/10.1016/s1058-2746(99)90056-3)
29. Trueba Sánchez L, Pérez Carro L, Fernández Escajadillo H. Tratamiento artroscópico de la escápula saltante. Resultados a largo plazo en nuestro medio, descripción de la técnica quirúrgica y revisión de la literatura. *Rev Esp Artroc Cir Articul* 2017;24(3). <https://doi.org/10.24129/j.reaca.24360.fs17>

Obturator Pyomyositis in a Pediatric Patient Resolved by Ultrasound-Guided Percutaneous Drainage. Case Report

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ABSTRACT

The objective of this case report is to present the management of a case of pyogenic myositis of the obturator muscle in a pediatric patient using ultrasound-guided percutaneous drainage. The patient is a 5-year-old pediatric patient with clinical and laboratory manifestations of deep muscular infection at the obturator level, an area of difficult surgical access, for which the least invasive treatment possible was used to drain purulent content from the affected area. The use of magnetic resonance imaging studies allows for a more accurate diagnosis in cases of early pyogenic infection, as well as determining the most effective approach to treatment. In some cases, ultrasound guidance can be used to avoid a formal surgical approach, reducing wound complications and morbidity and mortality. The addition of image-guided percutaneous procedures is a very useful tool for the treatment of infectious diseases and a great help to the orthopedist.

Keywords: Pyomyositis; childhood; ultrasound; drainage.

Level of Evidence: V

Piomiositis de los obturadores tratada con drenaje percutáneo guiado por ecografía en un niño. Presentación de un caso

RESUMEN

El objetivo de esta presentación es dar a conocer el manejo de la miositis piógena del músculo obturador interno en un paciente pediátrico que fue tratado mediante un drenaje percutáneo guiado por ecografía. Se trata de un niño de 5 años de edad, con manifestaciones clínicas y valores de laboratorio de infección muscular profunda en el obturador interno. Se identificó específicamente con resonancia magnética, es un área de difícil acceso quirúrgico, por lo cual se realizó un tratamiento percutáneo guiado por ecografía que permitió drenar el contenido purulento de la zona afectada. La resonancia magnética hizo posible lograr un diagnóstico más acertado en los casos de infección piógena temprana y, a su vez, decidir la vía de abordaje más adecuada. En ocasiones, se puede optar por la guía ecográfica con la cual se evita el abordaje quirúrgico formal y así disminuyen las complicaciones de la herida y la mayor morbimortalidad. La adición de procedimientos percutáneos guiados por imágenes es una herramienta muy útil para tratar enfermedades infecciosas y una gran ayuda para el ortopedista.

Palabras clave: Piomiositis; infancia; ecografía; drenaje.

Nivel de Evidencia: V

INTRODUCTION

Pyomyositis of the obturator internus muscle is a rare disease that is difficult to diagnose and treat and can be confused with intra-articular infections. It usually occurs in children and after trauma or muscle injury due to overexertion.¹

Although the exact pathogenesis is not known, pyomyositis is associated with muscle injury and bacteremia. It is believed that transient bacteremia may develop an infection in the context of a pre-existing muscle abnormality affecting the muscle's innate defense to infection, parasitosis, or trauma.^{2,3} Other underlying conditions

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that may predispose to this disease are: malnutrition, diabetes mellitus, human immunodeficiency virus infection, inflammatory bowel disease, autoimmune diseases, chronic liver diseases, rheumatological conditions or intravenous drug use.⁴

Regardless of age group, *Staphylococcus aureus* is the main cause in 90% of cases; therefore, the initial antibiotic treatment should include a broad-spectrum agent with adequate coverage for *S. aureus*, and should be modified according to the results of the cultures and sensitivity tests; likewise, the treatment will depend on the characteristics of the clinical picture and the structures affected.^{4,5}

As this is an infrequent condition, the diagnosis is often delayed, leading to serious complications and prolonged treatment. The prognosis is directly proportional to the time of detection. Although case history and laboratory tests can guide the diagnosis, the key is diagnostic imaging. Magnetic resonance imaging is preferred to easily delimit and locate abscessed areas, although computed tomography may also be useful. The use of imaging studies makes it easier to exclude intra-articular diseases and to determine the possibility of performing percutaneous draining.^{6,7}

Ultrasound is considered one of the main initial evaluation techniques in patients with muscle disease, because it is easily accessible and allows the radiologist or orthopedist to identify injuries and perform guided procedures.

The objective of this presentation is to present the management of a case of pyogenic myositis of the obturator internus muscle in a pediatric patient who was treated with percutaneous drainage guided by ultrasound.

CLINICAL CASE

The patient is a 5-year-old, mixed race child with no significant personal pathological history. He attended the emergency service with his parents, because, six days before, he had fallen from his own height, which caused minor trauma to the medial side of his thigh. The condition progressed and was accompanied by moderate pain (visual analog scale 5/10) which was continuous and poorly defined, as well as progressive limping associated with an unquantified high temperature.

The physical examination revealed a heart rate of 109 beats/min, a respiratory rate of 20 breaths/min, a temperature of 36.6 °C, oxygen saturation of 96% and anthropometric measures appropriate for age. He had a pale, asthenic appearance and antalgic posture. The gait is claudicant with a flexed hip. There is no erythema in the extremities, but there is slight edema in the left thigh and an increase in volume in comparison to the contralateral thigh, as well as severe pain on superficial and deep palpation in the left groin, with no limitation of flexion or hip rotations, and pain and limitation of extension.

The anteroposterior and axial radiographs of the hip showed no lytic changes or periosteal changes that could indicate an infection (Figure 1).



Figure 1. Radiographs of the pelvis (AP) and bilateral hip (axial). There are no signs of bone damage. Preserved osteoarticular relationships.

The results of the laboratory tests were: elevation of acute-phase reactants: C-reactive protein 24 mg/dl, erythrocyte sedimentation rate 19 mm/h; leukocytosis 23,200 g/l, mild neutrophilia 74.8% and mild lymphopenia 19.5%.

An ultrasound and a CT scan were performed to locate a pelvic infectious source, which was identified in the obturator internus muscle. An abscessed injury that could be drained was observed (Figure 2). We did not have the possibility of performing an initial magnetic resonance, since, in our environment, it is not possible to use it early.

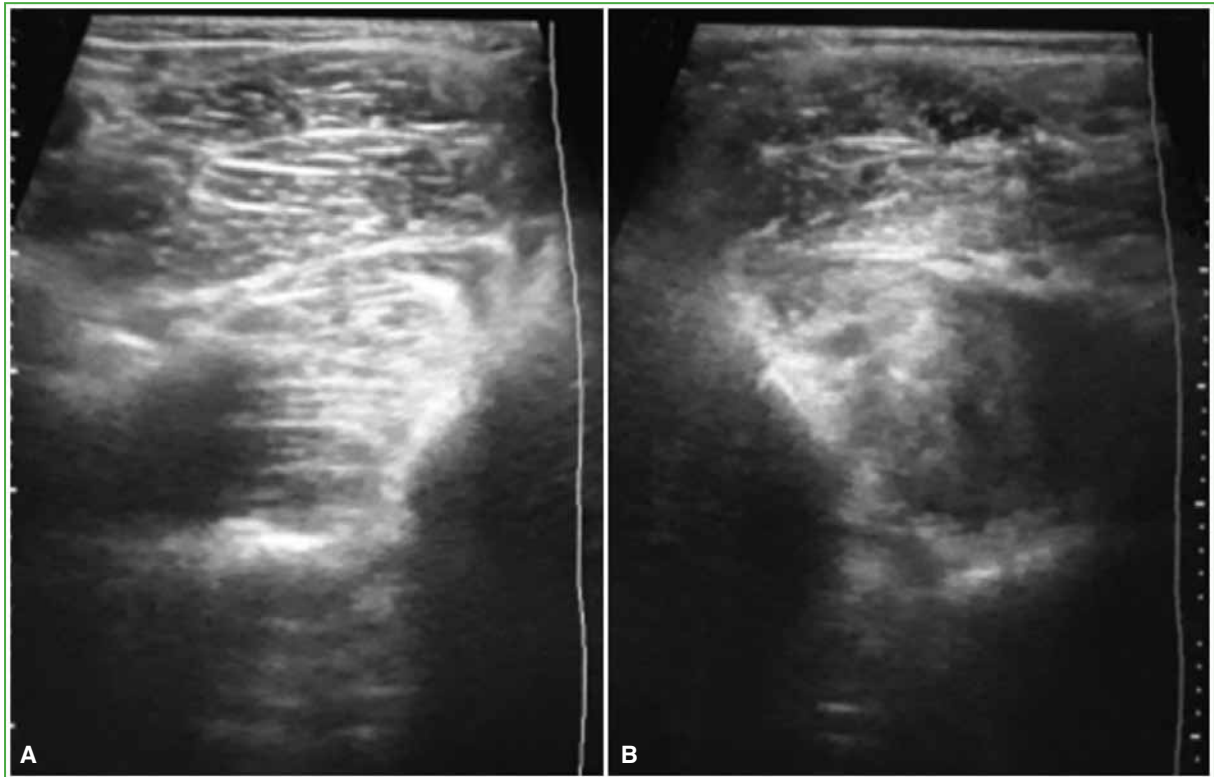


Figure 2. Comparative soft-tissue ultrasound. **A.** Unaltered right obturator externus muscle. **B.** Diffusively heterogeneous left obturator externus muscle, loss of fibrillar echotexture with intramuscular collection.

After characterizing the lesion, an emergency surgical procedure was performed together with the imaging service. Following an ultrasound-guided hip arthrocentesis in which no purulent fluid was collected, an ultrasound-guided percutaneous puncture of the abscess in the deep inguinal area was performed. A frankly purulent thick discharge was obtained from the obturator (5 cc) at the intrasubstance muscle location, which was sent for culture. The procedure was very helpful, because it allowed us to ensure that the infectious condition was extrarticular (Figures 3 and 4). Due to the patient's presenting symptoms, a joint puncture was performed; the first possibility was hip involvement, and the method of choice was arthrocentesis, which ruled out joint involvement. The intramuscular collection was identified using computed tomography; nonetheless, we believe it is necessary for epidemiology to rule out that it comes from the hip; thus, the procedures were carried out in the order listed above.

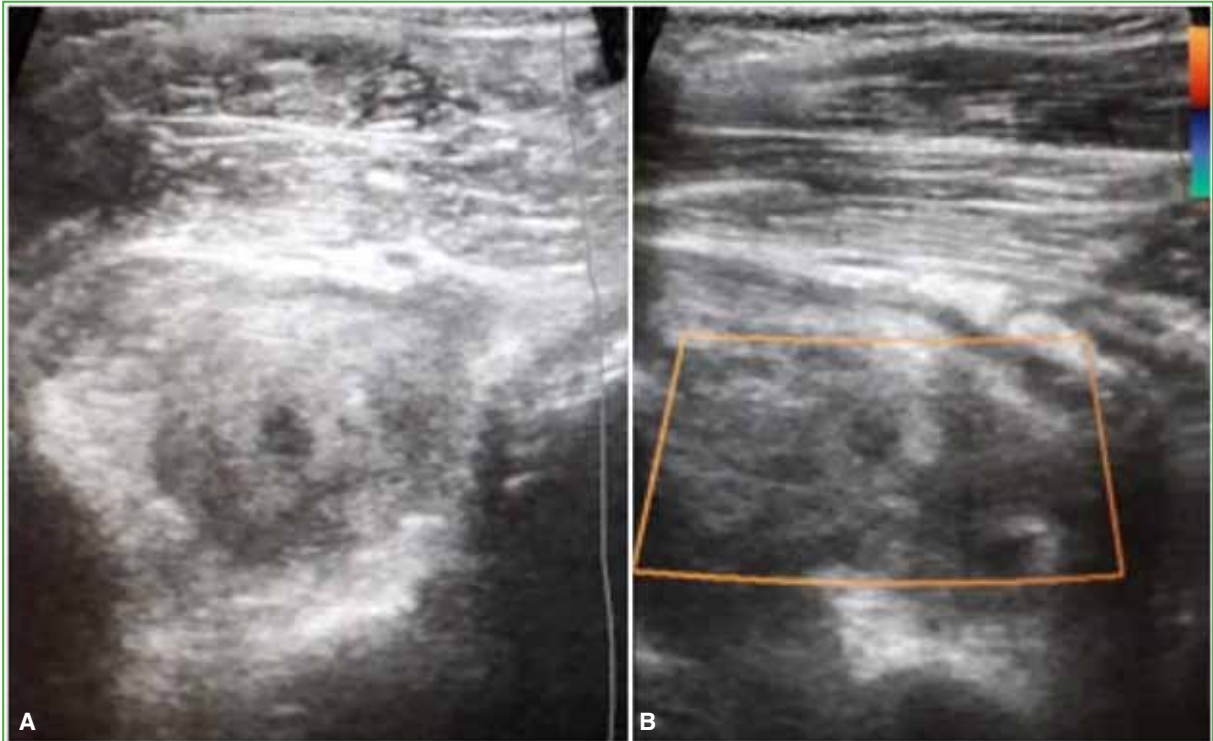


Figure 3. Soft-tissue ultrasound. **A.** Diffusely heterogeneous left obturator externus muscle, loss of fibrillar echotexture with intramuscular collection. **B.** Color Doppler shows no increase in vascularity.



Figure 4. Clinical picture of the contents of the abscess drained by ultrasound.

During hospitalization, blood cultures were negative. Oxacillin 500 mg was administered intravenously every 6 hours. On the third day of treatment, the culture result reported oxacillin-resistant *S. aureus*, so the drug was changed to vancomycin 200 mg, every 6 h and gentamicin 38 mg, every 8 h, for 16 days.

The patient had significant improvement; pain and inflammatory markers decreased considerably, and he had no more fever peaks.

Pain, gait disturbance and periarticular muscle contracture resolved gradually, and inflammatory markers normalized. In the radiographic controls, no relapses were observed. Six days after draining, the MRI revealed an area of edema in the obturator internus muscle, but with no relapse of the collection (Figure 5). The edema gradually decreased after clinical improvement. The patient was discharged with the indication of cephalexin 350 mg, orally, every 8 hours, for 10 days and followed up on an outpatient basis.

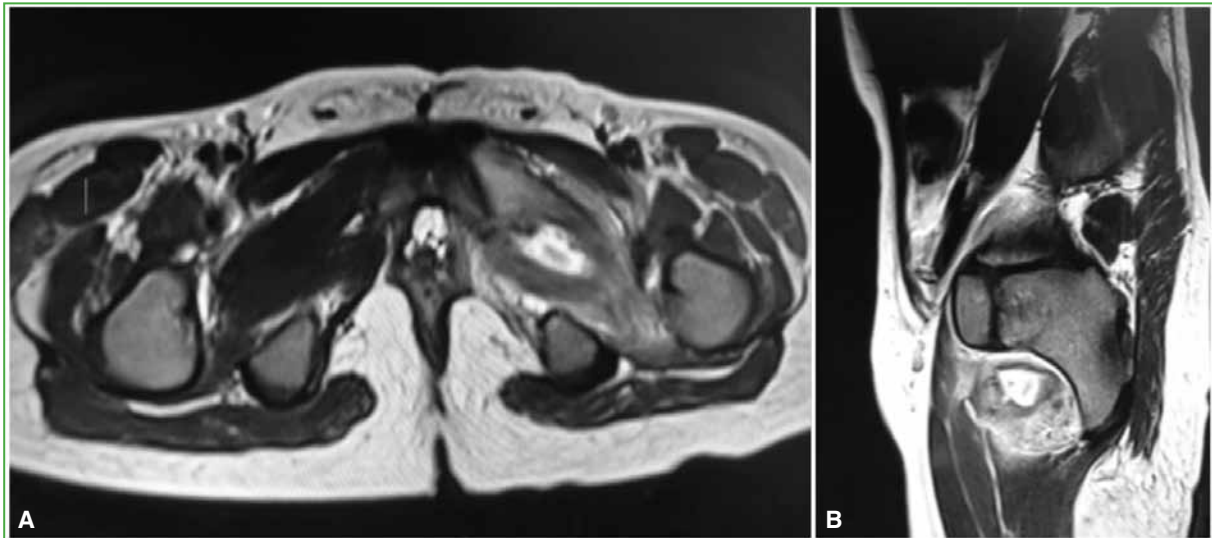


Figure 5. Magnetic resonance imaging of the pelvis enhanced in T2 sequence. **A.** Axial section. **B.** Sagittal section. Pyomyositis of the left obturator muscles, increased signal intensity of the obturator muscles, and intramuscular collection predominantly in the obturator externus muscle.

After 24 hours, hip movements improved considerably. The values of C-reactive protein and erythrocyte sedimentation rate decreased. Within a week, the patient was able to walk without support, and the acute-phase reactants normalized within 10 days.

Ultrasonounds and clinical and laboratory controls at the first, third and sixth months showed no alterations in the fibrillar pattern of the obturator internus muscle, nor did they show signs of a recurrence of the infection. A gradual reduction in muscle edema was observed. The ultrasound at six months was normal and, after a year of follow-up, the patient had no symptoms and the condition had healed.

Despite ultrasound and computed tomography of the abdomen, pelvis and lower back area, as well as laboratory tests to detect rheumatological and autoimmune diseases, including human immunodeficiency virus infection, no findings related to immunosuppression were found. Joint fluid cultures to detect tuberculosis were also negative.

DISCUSSION

Pyomyositis is a disease in tropical climates that is difficult to diagnose due to its nonspecific presentation. Its prevalence is higher in males during childhood, as in the above case.⁷⁻⁹

Muscle damage occurs during trauma, falls or strenuous exercise and is the most common predisposing factor in immunocompetent patients (25-50%).¹⁰ The most common pathogens are *S. aureus* (90%) and group A beta-hemolytic streptococcus, so initial antimicrobial treatment should be covered for gram-positive cocci.¹¹

The difficulty posed by the diagnosis of pyomyositis is due to the variety of differential diagnoses of intra-articular and extra-articular infections that must be taken into account. Multifocal involvement is considered to be common (46.34%).^{12,13} However, in this patient, this was not the case, possibly due to early diagnosis.

The time between the clinical manifestations of pyomyositis and the start of antibiotic therapy has a substantial influence on the patient's prognosis. The clinical presentation and inflammatory markers perform poorly to distinguish different types of infections (pyomyositis, septic arthritis, osteomyelitis, among others). If pyomyositis is suspected, an MRI should be performed, given its high sensitivity, to detect this infection in the early stages.¹² In the institution where the patient was treated, as well as in many hospitals, it is not immediately possible to count on this imaging study. In order to evaluate an acute musculoskeletal infectious disease, basic studies, such as radiographs and ultrasound, should be requested based on appropriate clinical suspicion.¹³ When magnetic resonance imaging is not available, computed tomography is useful by weighing the high dose of radiation a pediatric patient can receive and using it only when ultrasound is not diagnostic. The key distinction is between intraarticular and extraarticular infectious diseases. In this case, arthrocentesis and ultrasound-guided puncture confirmed the definitive diagnosis of obturator pyomyositis and excluded extraarticular conditions.¹⁴

Treatment depends on the stage of the infection at the time of diagnosis. In the initial stage, characterized by the absence of specific muscle alterations, antibiotic therapy is sufficient, then, when abscess formation is confirmed or bacteremia develops, together with antibiotics, image-guided percutaneous drainage or surgery are required.⁷

Ultrasound in the diagnosis and management of pyogenic pyomyositis has been little studied, despite the fact that it is an emerging condition that can cause catastrophic complications. In a study of 47 children with a suspected skin and tissue infection based on physical examination, ultrasound changed therapeutic management in nine of these patients.¹³ In another study with 50 patients, therapeutic management changed in 11 patients after ultrasound.¹⁴

According to a systematic review with 361 patients, the administration of antibiotics for seven days was effective in 143 cases and 218 required drainage. When the collection is <1 cm, outpatient antibiotic therapy is recommended, and drainage is advised when the collection is >1.¹⁵

CONCLUSIONS

Early management of this disease is essential for a good outcome; likewise, it is essential to exclude an intra-articular condition to avoid inadequate treatment. Ultrasound-guided drainage is an effective, low-risk method for obtaining samples for culture, draining purulent contents, and guiding antibiotic therapy. We consider that ultrasound is a safe, low-cost study with great diagnosis-therapeutic applicability that should be included in orthopedist training.

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REFERENCES

1. Pannunzio ME, Praino ML, Carballo CM, Medranda AC, Orlando MN, Biondi EJ, et al. Piomiositis en niños: experiencia en un hospital pediátrico de referencia en Argentina. *Rev Chil Infectol* 2019;36(3):371-5. <https://doi.org/10.4067/S0716-10182019000300371>
2. Planchet J, Urbina Y, Barreto O, Correa J. Piomiositis, artritis séptica y osteomielitis aguda por *Staphylococcus aureus* meticilino resistente de la comunidad en paciente pediátrico. *Rev Digit Postgrado* 2021;10(3): e321. <https://doi.org/10.37910/RDP.2021.10.3.e321>
3. Altmayer S, Verma N, Dicks EA, Oliveira A. Imaging musculoskeletal soft tissue infections. *Semin Ultrasound, CT MRI* 2019;41(1):85-98. <https://doi.org/10.1053/j.sult.2019.09.005>
4. Kavukçu S, Koşay C, Çakmakçı H, Öztürk Y, Anal Ö. Primary pyomyositis mimicking transient synovitis of the hip in a child: A case report. *Turkish J Rheumatol* 2012;27(2):128-31. <https://doi.org/10.5606/tjr.2012.019>
5. Elzohairy MM. Primary pyomyositis in children. *Orthop Traumatol Surg Res* 2018;104(3):397-403. <https://doi.org/10.1016/j.otsr.2017.12.005>
6. Valderrama-Beltrán S, Cortés JA, Caro MA, Cely-Andrade L, Osorio-Pinzón JV, Gualtero SM, et al. Guía de práctica clínica para el diagnóstico y manejo de las infecciones de piel y tejidos blandos en Colombia. *Infectio* 2019;23(4): 318-46. <https://doi.org/10.22354/in.v23i4.805>
7. Karakatsanis A, Lykoudis P, Nastos C, Chronopoulos E, Koutoulidis V, Polymeneas G, et al. Bilateral obturator pyomyositis with visceral involvement in an immunocompetent adult patient treated without surgery. *Surg Infect (Larchmt)* 2014;15(5):651-5. <https://doi.org/10.1089/sur.2012.147>
8. Henríquez-Camacho C. La ecografía clínica en el diagnóstico diferencial de las infecciones del aparato locomotor. *Acta Reum* 2018;4(1):1-2. <https://doi.org/10.3823/1330>
9. Yahalom G, Guranda L, Meltzer E. Internal obturator muscle abscess caused by *Klebsiella pneumoniae*. *J Infect* 2007;54:157-60. <https://doi.org/10.1016/j.jinf.2006.09.011>
10. King R, Laugharne D, Kerslake R, Holdsworth B. Primary obturator pyomyositis: A diagnostic challenge. *J Bone Joint Surg Br* 2003;85(6):895-8. PMID: 12931815
11. Bertrand SL, Lincoln ED, Prohaska MG. Primary pyomyositis of the pelvis in children: a retrospective review of 8 cases. *Orthopedics* 2011;34(12):e832-e840. <https://doi.org/10.3928/01477447-20111021-07>
12. Angelis S, Trellopoulos A, Kondylis AK, Mirtsios H, Katsimantas A, Solakis EP, et al. Multifocal osteomyelitis localization after pyomyositis in children: Importance of timely response. *Cureus* 2019;11(4):e4463. <https://doi.org/10.7759/cureus.4463>
13. Levitt DL, Byer R, Milleret AF. Point-of-care ultrasound to diagnose pyomyositis in a child. *Pediatr Emerg Care* 2019;35(1):69-71. <https://doi.org/10.1097/PEC.0000000000001711>
14. Sivitz AB, Lam SHF, Ramirez-Schremp D, Valente JH, Nagdev AD. Effect of bedside ultrasound on management of pediatric soft-tissue infection. *J Emerg Med* 2010;39(5):637-43. <https://doi.org/10.1016/j.jemermed.2009.05.013>
15. Vij N, Ranade AS, Kang P, Belthur MV. Primary bacterial pyomyositis in children: A systematic review. *J Pediatr Orthop* 2021;41(9):e849-e854. <https://doi.org/10.1097/BPO.0000000000001944>

Hair Tourniquet Syndrome in the Pediatric Population: A Case Report

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ABSTRACT

Tourniquet syndrome is a rare condition that usually affects the pediatric population. It consists of a decrease in blood supply due to circumferential strangulation of some parts of the body, mainly fingers or toes, external genitalia or other appendages. In most cases, the causative agent is usually a strand of hair, although other elements have been described, such as synthetic fibers from the patient's clothing. The aim of this study is to report a case of a patient with hair tourniquet syndrome and to review the available literature. The patient is a 3-month-old female with hair tourniquet syndrome, with involvement of the fourth toe of the right foot, who was brought to the emergency department for significant soft tissue edema. The patient evolved favorably after removal of the causative agent (hair strand) from the base of the fourth toe and recovery of irrigation was complete. Although tourniquet syndrome is a rare entity, early diagnosis and treatment is essential to avoid potentially severe complications.

Keywords: Tourniquet syndrome; children; foot.

Level of Evidence: IV

Síndrome del torniquete capilar en la población pediátrica: reporte de un caso

RESUMEN

El síndrome del torniquete es un cuadro poco frecuente que ocurre, por lo general, en la población pediátrica. Consiste en la disminución del aporte sanguíneo por estrangulación circunferencial de algunas partes del cuerpo y suele comprometer dedos de los miembros superiores o inferiores, genitales externos u otros apéndices. En la mayoría de los casos, el agente causal suele ser una hebra de cabello, aunque se han descrito otros elementos, como fibras sintéticas de la indumentaria del paciente. El objetivo de este artículo es presentar el caso de una paciente con síndrome del torniquete y analizar la bibliografía disponible. Se trata de una lactante de 3 meses de edad con síndrome del torniquete por cabello, con compromiso del cuarto dedo del pie derecho, que fue traída al servicio de urgencia por un importante edema de partes blandas. La paciente evolucionó favorablemente luego de la extracción del agente causal (hebra de cabello) de la base del cuarto dígito y la recuperación de la irrigación fue completa. Si bien es un cuadro poco frecuente, es imprescindible tener un alto índice de sospecha y realizar un diagnóstico precoz para indicar un tratamiento oportuno y evitar complicaciones potencialmente graves para el paciente.

Palabras clave: Síndrome del torniquete; niños; pie.

Nivel de Evidencia: IV

INTRODUCTION

Hair tourniquet syndrome is a rare condition that usually occurs in children <1 year of age, with an estimated incidence of 0.02%.¹ It consists of the decrease in blood supply due to circumferential compression of the circulation and often involves appendicular structures of the upper and lower limbs and external genitalia, among other sites.² In most cases, the causative agent is usually a strand of hair, although other elements, such as synthetic fibers from the patient's clothing, have been described.³ Edema and enlarged soft tissues around the tourniquet area make it difficult to directly see the object causing the compression, so a detailed anamnesis and physical examination is important. Failure to diagnose this condition can lead to severe consequences, such as infection or loss of the affected structure due to amputation.⁴ A high index of suspicion should be maintained and early treatment should be administered. Due to its low incidence, there are few published reports describing limb involvement.

The aim of this article is to present the case of a girl with hair tourniquet syndrome and its evolution.

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CLINICAL CASE

The patient is a 3-month-old patient, born at 33 weeks gestation, with neonatal anemia, on supplemental iron treatment and neurorehabilitation. The family consulted the emergency department of our institution because the girl had persistent edema of the fourth toe of the right foot, without being able to specify the time of evolution. Physical examination revealed congestive edema of the fourth toe, erythema, and pain to the touch and passive mobilization (Figure 1).



Figure 1. Clinical images at admission.

A strand of hair around the finger was noted as the cause of the strangulation. The strand was extracted under local anesthesia by means of a 1 cm longitudinal cut with a No. 11 scalpel blade, in the dorsomedial region (Figure 2), parallel to the axis of the finger.

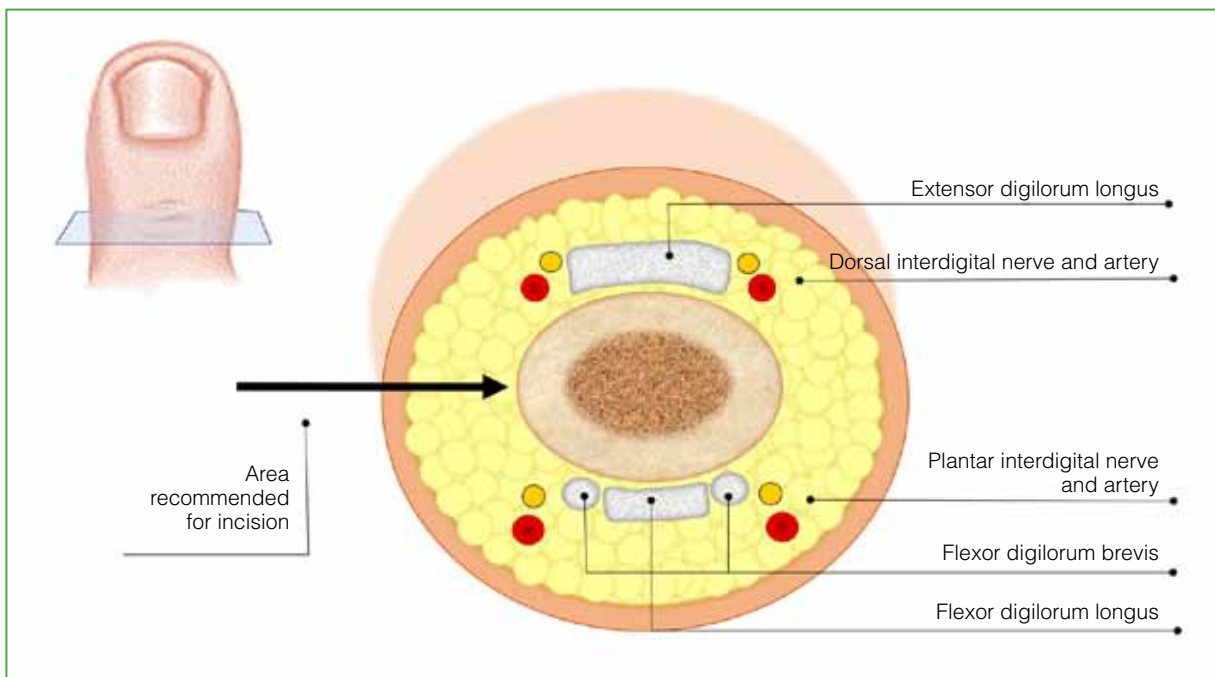


Figure 2. Diagram showing the suggested incision site for tourniquet removal.

After hair removal, distal perfusion improved and edema decreased within a few minutes (Figure 3). The patient was monitored the next day in the outpatient clinic of the Children’s Orthopaedics and Traumatology Service and a good evolution of the condition was confirmed. At the last follow-up at 10 days, the distal circulation of the finger had completely recovered, she had no edema, and she was discharged.



Figure 3. Clinical images during follow-up.

DISCUSSION

In 1971, Quinn⁵ first introduced the concept of “tourniquet syndrome of the fingers”, where he described this condition exclusively on the toes of the lower extremities. However, the term “hair tourniquet syndrome” was coined by Barton et al.⁶ in 1988, in a series of 66 patients, in which they described more broadly the involvement of fingers, toes and external genitalia due to strangulation caused by a strand of hair. Other authors have reported isolated involvement of different structures, such as the base of the neck, the pinna, and components of the oral cavity, such as the tongue and uvula.^{1,7-9}

The incidence is estimated to be around 0.02%.¹ Digit involvement is usually more common in children <1 year of age, in the first months of life, while in older children and the elderly, it usually occurs in other locations, such as external genitalia.¹⁰ In a review of more than 210 cases, Mat Saad et al.¹¹ reported that 44.2% of patients had genital (penile) involvement, 40.4% had toe involvement, 8.57% had finger involvement, and 6.83% had other site involvement. Although it usually presents as an isolated condition (with involvement of a single structure), simultaneous involvement of two or three digits has been described.¹²

It has been proposed that this syndrome occurs when a constrictive agent, mainly a hair from the mother or a thread from the infant's clothing^{3,13} curls around the finger, hinders lymphatic and venous drainage, and causes edema. This would increase the tension of the tourniquet and lead to increased venous congestion and ultimately compromise of arterial circulation with subsequent ischemia and necrosis of the finger.^{14,15} In some more severe cases, the tourniquet can cut the skin and cause bone erosion.¹¹ Strahlman¹⁶ proposed the theory of a direct relationship between the telogen effluvium experienced by the mother in the postpartum period due to hormonal imbalance and hair tourniquet syndrome. It is also believed that it would be related to the type of clothing with which the child is dressed, especially in the winter season.¹⁷ Although its origin is usually accidental, there are some cases associated with child abuse¹⁸ and religious practices of some cultures,^{19,20} which is why it is important to obtain a detailed anamnesis and perform a complete physical examination of each patient. The presence of knots in the strands or threads of the tourniquet should alert the physician to the possibility of abuse.²¹

The diagnosis is clinical and a high index of suspicion should be taken into account in a child with edema, discoloration and pain in any of their digits. Many times the tourniquet may not be visible and irritability may be the only sign, mainly in infants. Treatment should be immediate and consists of complete removal of the causative agent. When the tourniquet cannot be seen due to edema, a small longitudinal incision with a scalpel is indicated in the dorsal region of the finger.²² If there are doubts or if the resection is incomplete, surgical exploration with the use of magnifiers is required in some cases.

According to some published series, the complication rate is approximately 50%¹¹ and is related to the omission or delay in the diagnosis of the syndrome or to insufficient extraction of the hair strand. The most common complications are: infection, necrosis, gangrene and amputation. Differential diagnoses of this condition include: amniotic band syndrome, spontaneous or inhum dactylolysis and some keratodermas.²³

Hair tourniquet syndrome is a rare entity in the pediatric population, but it is potentially dangerous and requires the medical professional involved in the consultation to have a high index of suspicion. Early diagnosis and timely treatment are essential to avoid serious complications; Therefore, it is important to alert caregivers and instruct pediatric health personnel on the detection and management of this syndrome.

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

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REFERENCES

1. Claudet I, Pasian N, Debuissou C, Salanne S, Rekhroukh H. Tourniquet syndrome: Interest of a systematic analysis of families' social conditions to detect neglect situations. *Child Abuse Negl* 2009;33(9):569-72. <https://doi.org/10.1016/j.chiabu.2009.03.003>
2. Cevik Y, Kavalci C. Hair tourniquet syndrome. *Ann Saudi Med* 2010;30(5):416-7. <https://doi.org/10.4103/0256-4947.67088>
3. Uygur E, Çarkçı E, Ünkar E. Can washing socks without flipping inside out cause hair tourniquet syndrome? A claim with two case reports. *J Pediatr Orthop B* 2017;26(2):193-4. <https://doi.org/10.1097/BPB.0000000000000348>

4. García-Mata S, Hidalgo-Ovejero A. Hair tourniquet syndrome of the toe: report of 2 new cases. *J Pediatr Orthop* 2009;29(8):860-4. <https://doi.org/10.1097/BPO.0b013e3181b7ff14>
5. Quinn NJ Jr. Toe tourniquet syndrome. *Pediatrics* 1971;48(1):145-6. <https://doi.org/10.1542/peds.48.1.145>
6. Barton D, Sloan G, Nichter L, Reinisch JF. Hair-thread tourniquet syndrome. *Pediatrics* 1988;82:925-8. PMID: 3186385
7. Dey R, Zameer MM, Vinay C, Rao, S. Hair tourniquet of the uvula. *J Indian Assoc Pediatr Surg* 2022;27(2):261-2. https://doi.org/10.4103/jiaps.JIAPS_365_20
8. Sylwestrzak MS, Fischer BF, Fischer H. Recurrent clitoral tourniquet syndrome. *Pediatrics* 2000;105(4 Pt 1):866-7. <https://doi.org/10.1542/peds.105.4.866>
9. Schneider K, Kennebeck S, Madden L, Campbell A. Hair tourniquet of the circumvallate papillae: a potentially “hairy” situation. *Pediatr Emerg Care* 2013;29(8):924-5. <https://doi.org/10.1097/PEC.0b013e31829ec4c7>
10. Haddad FS. Penile strangulation by human hair: report of 3 cases and review of literature. *Urol Int* 1982;37(6):375-88. <https://doi.org/10.1159/000280843>
11. Mat Saad AZ, Purcell EM, McCann JJ. Hair-thread tourniquet syndrome in an infant with bony erosion: a case report, literature review, and metaanalysis. *Ann Plast Surg* 2006;57(4):447-52. <https://doi.org/10.1097/01.sap.0000222571.98387.71>
12. Mackey S, Hettiarachy S, Dickinson J. Hair-tourniquet syndrome-multiple toes and bilaterality. *Eur J Emerg Med* 2005;12(4):191-2. <https://doi.org/10.1097/00063110-200508000-00009>
13. Alpert JJ, Filler R, Glaser HH. Strangulation of an appendage by hair wrapping. *N Engl J Med* 1965;273(16):866-7. <https://doi.org/10.1056/NEJM196510142731608>
14. Parlak M, Karakaya AE. Hair-thread tourniquet syndrome of the hypertrophic clitoris in a 6-year-old girl. *Pediatr Emerg Care* 2015;31(5):363-4. <https://doi.org/10.1097/PEC.0000000000000341>
15. Corazza M, Carla E, Altieri E, Virgili A. What syndrome is this? Tourniquet syndrome. *Pediatr Dermatol* 2002;19(6):555-6. <https://doi.org/10.1046/j.1525-1470.2002.00233.x>
16. Strahlman RS. Toe tourniquet syndrome in association with maternal hair loss. *Pediatrics* 2003;111(3):685-7. <https://doi.org/10.1542/peds.111.3.685>
17. Martonovich N, Khatib M, Assaf M. Hair tourniquet syndrome: A retrospective study. *Pediatr Dermatol* 2022 Sep 30. <https://doi.org/10.1111/pde.15151>
18. Klusmann A, Lenard HG. Tourniquet syndrome-accident or abuse? *Eur J Pediatr* 2004;163(8):495-8; discussion 499. <https://doi.org/10.1007/s00431-004-1466-1>
19. Singh B, Kim H, Wax S. Strangulation of glans penis by hair. *Urology* 1978;11(2):170-2. [https://doi.org/10.1016/0090-4295\(78\)90100-0](https://doi.org/10.1016/0090-4295(78)90100-0)
20. Thomas AJ, Timmonjs JW, Perlmutter AD. Progressive penile amputation tourniquet injury secondary to hair. *Urology* 1977;9(1):42-4. [https://doi.org/10.1016/0090-4295\(77\)90282-5](https://doi.org/10.1016/0090-4295(77)90282-5)
21. Webley JA, Scheif DR, Coleman J. Tourniquet syndrome: an unusual presentation. *Ann Emerg Med* 1981;10(9):494-5. [https://doi.org/10.1016/s0196-0644\(81\)80288-0](https://doi.org/10.1016/s0196-0644(81)80288-0)
22. Serour F, Gorenstein A. Treatment of the toe tourniquet syndrome in infants. *Pediatr Surg Int* 2003;19(8):598-600. <https://doi.org/10.1007/s00383-003-1034-1>
23. Aslantürk O, Özbey R, Yılmaz Ö, Ergen E. Hair tourniquet syndrome of toes and fingers in infants. *Acta Orthop Traumatol Turc* 2019;53(4):306-9. <https://doi.org/10.1016/j.aott.2019.04.010>

Non-accidental Trauma to the Thoracolumbar Spine in a 10-month-old Child

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ABSTRACT

We present the case of a 10-month-old boy with a chronic thoracolumbar spine fracture-subluxation without neurological damage caused by an unknown mechanism of non-accidental trauma. To assess stability, we used the scoring system for thoracolumbar injuries according to Vaccaro et al. We performed a segmental pedicle osteosynthesis. We analyzed and compared our case with others in the available literature. We updated UNICEF data on child violence in Argentina, but not before clearly defining the subject, and the legal framework, and providing a brief historical review.

Keywords: Children; non-accidental trauma; thoracolumbar spine.

Level of Evidence: IV

Trauma no accidental de columna toracolumbar en un niño de 10 meses

RESUMEN

Presentamos el caso de un niño de 10 meses con fractura-subluxación inveterada de la columna toracolumbar, sin daño neurológico, a causa de un trauma no accidental por mecanismo desconocido. Para evaluar la estabilidad espinal se utilizó el sistema de clasificación de la gravedad de las lesiones toracolumbares de Vaccaro. Se realizó una osteosíntesis pedicular segmentaria. Se analizó y comparó el caso presentado con otros publicados. Se actualizaron los datos registrados por Unicef sobre violencia infantil en la República Argentina, no sin antes definir claramente el tema, el marco legal y realizar una sucinta reseña histórica.

Palabras clave: Niños; trauma no accidental; columna toracolumbar.

Nivel de Evidencia: IV

INTRODUCTION

Child abuse is a complex socio-cultural problem that affects various social groups, cultures, and ethnicities in the world. According to the World Health Organization, it encompasses any form of abuse or neglect affecting a child under the age of 18. It encompasses physical injury, emotional harm, sexual abuse, neglect, and economic or other exploitation that undermines or is likely to impair the child's health, development, or dignity or endangers the child's survival in the context of a relationship of responsibility, trust, or power.¹ In other words, a clear violation of human rights. A more subtle and complex form is Münchhausen syndrome by proxy or factitious disorder imposed on another.² The common denominator of this violence is the asymmetry between the one who exercises power and the victim. In recent years, the term child abuse has been replaced by the euphemism non-accidental trauma (NAT).

Childhood violence has existed from the dawn of civilization. Children thrown into the Nile River in Ancient Egypt as tribute to the fertility of the land; those offered to the red-hot arms of Moloch (Leviticus 18:2, King James Version); the slaughter of the Innocents ordered by Herod the Great (Matthew 2:16-18 King James Version); the silk belt used by some sultans and viziers in the Ottoman Empire to hang, according to Muhammad's interdiction, minors with the right of succession; in Greece, the sexual subjugation exercised by teachers to the detriment of ephebes; the sacrifice of children in the pre-Hispanic societies executed by the Mexica priests in

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Tenochtitlan and the Mayans at Chichen Itza; the death and burial of infants from Inca royalty or *capacocha* (in the Quechua language, royal obligation).³ In the Modern Age, and particularly in the Contemporary Age, examples abound, notoriously after the Industrial Revolution and the overcrowding in the big cities, the genesis of the proletariat, the imposition of biopower and the exploitation of child labor. In the United States, public interest in child abuse began with the case of Mary Ellen Wilson, an abused child who had to be defended by the American Society for the Prevention of Cruelty to Animals in the absence of ad hoc legislation. Many hidden secrets of the European disciplinary society of the 19th and 20th centuries were uncovered by Sigmund Freud's psychoanalysis.

In 1989, the Convention on the Rights of the Child recognized the rights of all persons under the age of 18. These include protection from all forms of violence or negligent treatment. Our country ratified the Convention with constitutional status in 1990 and 1994, the last year of the enactment of the National Act on Protection against Family Violence No. 24,417, which regulates the obligation of health personnel to report the abuse, both at the state and private levels. In 2005, National Act No. 26,061 on the Comprehensive Protection of the Rights of Children and Adolescents (NNyA, in Spanish) was approved.

UNICEF, in collaboration with the Ministry of Justice and Human Rights of the Nation, presented data on child and adolescent violence reports from October 2021 to September 2022. Out of a total of 9,970 cases, 6,770 (45%) occurred in the family environment. In 90% of the cases, the aggressors were, in descending order, the father, mother or stepfather. 63% of the complaints came from the Buenos Aires Metropolitan Area. Violence camouflaged as domestic discipline culture is very significant between the ages of two and four (72.9%). Seven out of 10 children suffer from these methods in Argentina.⁴ Ironically, while 95% of individuals polled oppose corporal punishment, more than 70% use it.⁴ With the onset of puberty comes an upsurge in sexual and psychological abuse of girls. The types of violence are often interrelated. NAT accounted for 33% of the total.⁴ According to the REUNA database of the province of Buenos Aires (Unified Statistical Registry of Children and Adolescents [in Spanish: *Registro Estadístico Unificado de Niñez y Adolescencia*]), 43.7% of the 5,341 allegations of violence in 2010 were related to physical abuse, primarily in males, while sexual abuse happened primarily in females.⁵ In both databases, the prevalence of lesions by anatomical areas or topographic discrimination is not detailed.

According to the literature, the prevalence of spinal trauma in childhood is 2%. Its causes, in order of frequency, are: traffic accidents, high-energy sports injuries, and NAT. About 50 cases of pediatric thoracolumbar fractures have been published, 38% of them attributed to NAT in children under two years of age.^{6,7} Unfortunately, omission or late diagnosis affects more than one-third of victims. In this regard, long bone fractures have been reported in 77% and head trauma in 50% of cases.^{2,8}

The purpose of this research is to present a 10-month-old child with NAT of the thoracolumbar spine in the context of the previously indicated social problem. The traumatic pathophysiology of the region is described in depth, and the treatment is analyzed and discussed in relation to relevant specialty publications. This is an observational, retrospective study.

CLINICAL CASE

In December 2015, the paternal grandparents of a 10-month-old child consulted because they had noticed a lump in the thoracolumbar region of their grandson, a premature child of a 19-year-old; gestational age of 28 weeks, birth by cesarean section due to the possibility of preterm labor, APGAR 3/6, and birth weight 1,125 g. He spent 75 days in an intensive care unit and was on mechanical ventilation for 14 days. The mother suffered from a complex postpartum psychiatric condition that resulted in aggressive behavior towards the people around her. The grandparents suspected that their grandson had been shaken, as they never noticed external stigmata, such as bruises or other surface lesions. It was a family from the middle socioeconomic class. The corresponding report was made.

The child's overall examination revealed normal maturation patterns for his age, weight 7,800 g, and height 68 cm. Clinically structured thoracolumbar kyphosis with Frankel E neurological status was observed. No other musculoskeletal involvement, extraskeletal injuries, or congenital pathologies were detected (Figure 1).

Radiography revealed a T12-L1 subluxation, an L2 flexion fracture, a thoracolumbar hinge kyphosis of 25°, and a <20° inversion of physiological kyphosis or thoracic lordosis, indicating the inveterate nature of the lesion (Figure 2).



Figure 1. Clinical aspect. Note the thoracolumbar hump.

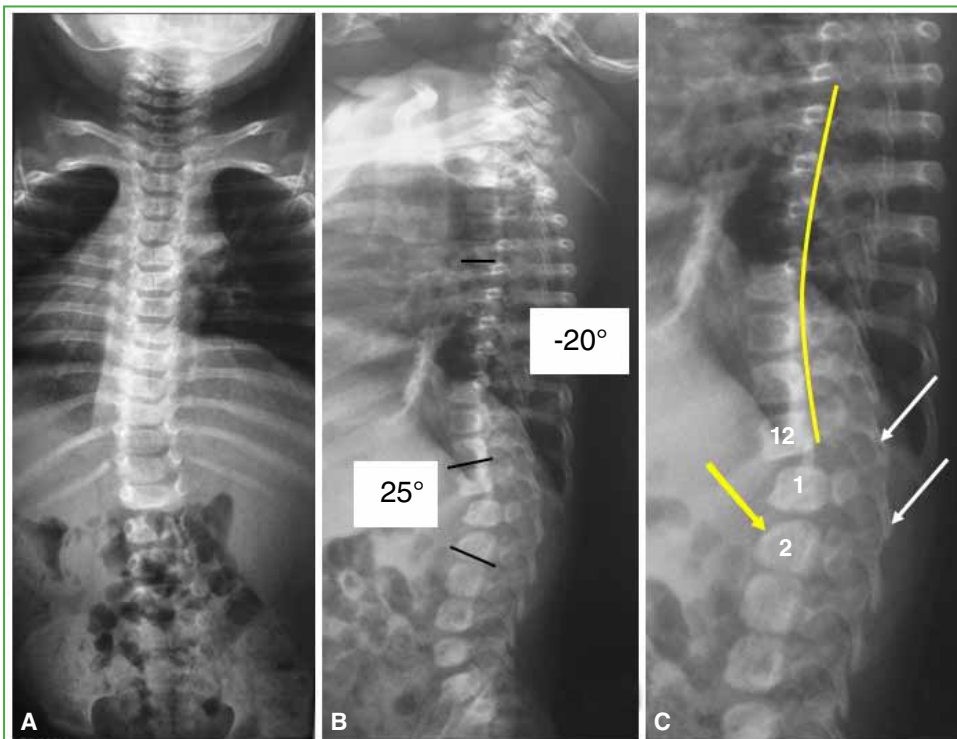


Figure 2. Initial radiographs. **A.** Anteroposterior. **B and C.** Lateral (standard and extended). Fracture of the body of L12 (yellow arrow), decreased facet contact (white arrows). T12-L1 sublaxation. 25° hinge kyphosis, -20° thoracic lordosis.

Magnetic resonance imaging did not provide data of interest and computed tomography was essential to verify a left facet denudation of T12-L1-L2 and to detail the anatomical aspects of the pedicles (Figure 3).

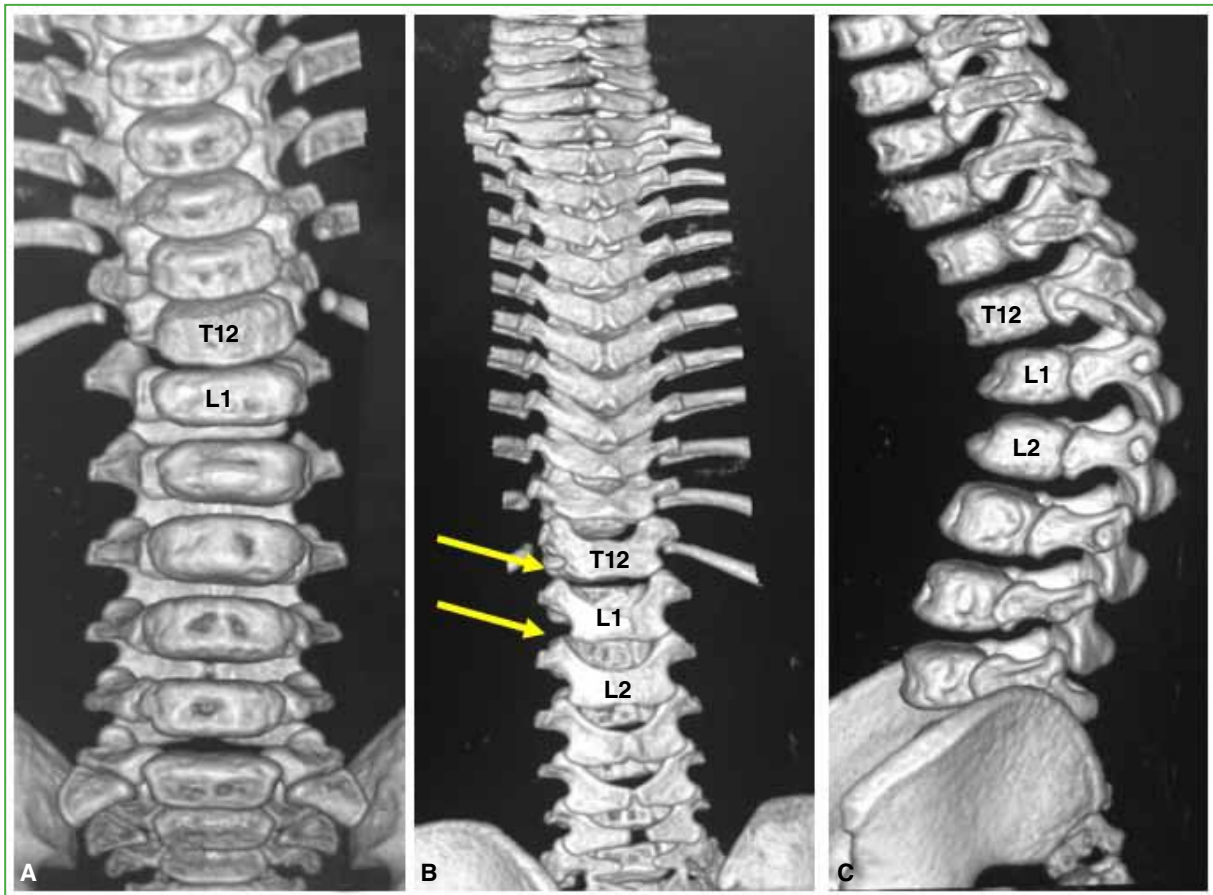


Figure 3. 3D reconstruction by computed tomography. A. Note that compression fractures of the L1 and L2 vertebral bodies are asymmetrical. B. Right facet denudation (yellow arrows). C. Sagittal plane. Subluxation of T12-L1 and very low contact of T12-L1-L2 facets.

This was a child with NAT sequelae of the thoracolumbar spine as a result of flexion-distraction. The Vaccaro classification system, validated for the pediatric population by Daniels et al. and Savage et al., was used to assess spinal stability, and the sum of the scores defined instability (Table).⁹⁻¹¹ Therefore, osteosynthesis from T12 to L2 was performed with titanium polyaxial pedicle screws, 3.5 mm in diameter by 14 mm in length, and 4 mm diameter rods. Intraosseous palpation and an image intensifier in the coronal-sagittal-oblique planes were used to control placement. An autologous iliac graft was added (Figure 4).

A neurophysiologist carried out multimodal neurological monitoring. The immediate and late postoperative evolution was satisfactory. Because of the child's restless personality, a thermoplastic spinal orthosis was prescribed to be worn during the day for one year. The current follow-up is seven years and the child's neurological status is normal (Figure 5).

Table. Classification of thoracolumbar Injuries and severity score

Parameter	Score
Morphology	
Compression	1
Burst	2
Translation-rotation	3
Distraction	4
Neurological status	
Intact	0
Nerve root injury	2
Complete spinal cord or conus medullaris injury	2
Incomplete spinal cord or conus medullaris injury	3
Cauda equina	3
Posterior ligamentous complex integrity	
Intact	0
Indeterminate	2
Disrupted	3

Therapeutic recommendations: <3, orthopedic treatment, 4, debatable, ≥5, surgery.



Figure 4. Clinical and radiographic appearance 2 months after surgery.

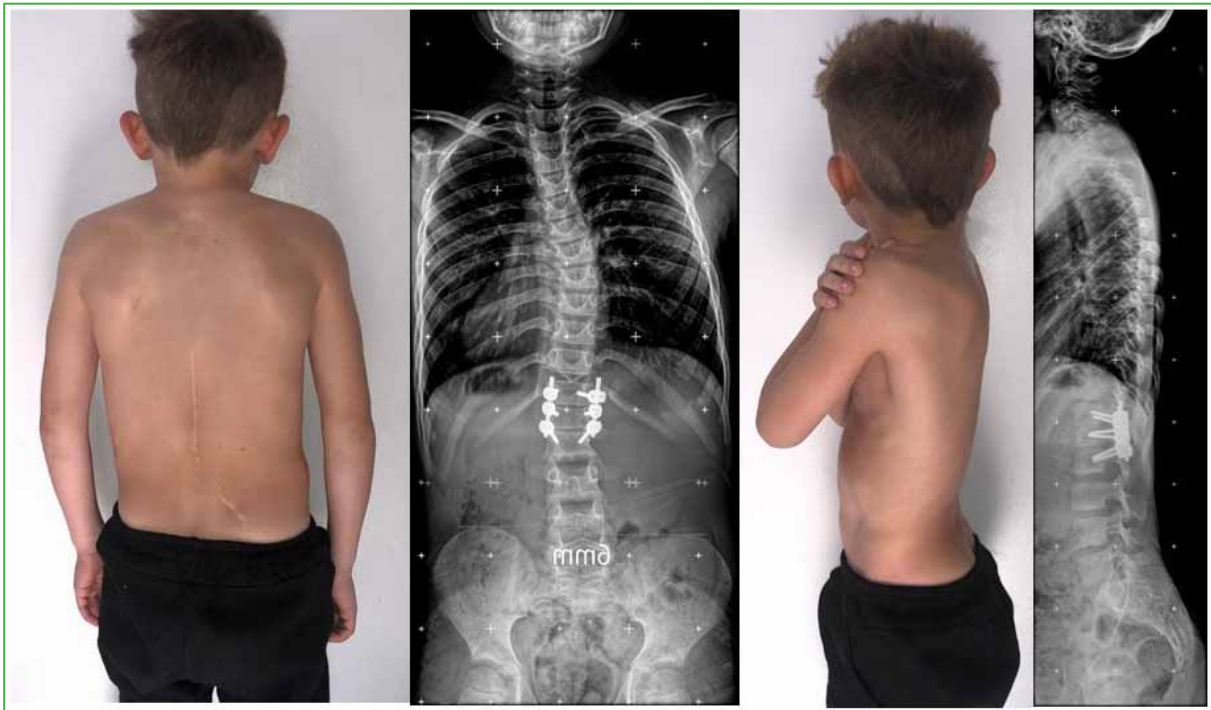


Figure 5. Clinical and radiographic appearance after 7 years of follow-up.

DISCUSSION

The most common etiologic kinetic mechanisms of thoracolumbar spine NAT in children are flexion and flexion-distraction caused by shaking or tossing the child. There are few published cases of hypertension NAT. The increased viscoelastic component of the tissues, and hence the better capacity to dissipate energy, explains several anatomical aspects of the injuries. The spinal cord, which lacks this characteristic, is more vulnerable to intrinsic injury.

Some postmortem investigations describe the penetration of chondrocytes and epiphyseal ground substance into the bone marrow stroma as a result of compressive forces, while the addition of a flexion-distraction vector is the cause of dilaceration and hemorrhages of the posterior capsuloligamentous complex and a variety of epiphysiolyses of the vertebral body similar to those described by Salter-Harris for long bones.^{12,13} SCIWORA (Spinal Cord Injury Without Radiologic Abnormality) is exceptional in the thoracolumbar spine.¹⁴

In addition to neurological damage, these injuries can be associated with chylothorax or hemothorax, retroperitoneal hematoma, dilaceration of the superior mesenteric artery or aorta, injuries to the pancreas, spleen or liver, among others.^{6,10} In a prospective study of 50 children with neurological thoracolumbar fractures, 58% reported suffocation due to respiratory distress, regardless of the radiographic finding, despite the fact that magnetic resonance imaging was very eloquent in detecting the lesion and with a very high statistical sensitivity in all of them.¹⁵ One-third of traumatic spinal injuries often coexist with others in adjacent or distant segments. The association or history of traumatic brain injury is very significant. As a result, it is critical in early children to compare sagittal and coronal sutures measured by computed tomography to the standardized ones available in the literature; any increase is significantly predictive of NAT.¹⁶

A thorough evaluation of the child in accordance with institutional practice, hospitalization, and reporting of suspicion to the appropriate committee are all required.

In terms of treatment, the common denominator in the literature is the lack of consensus. Sieradzki et al. obtained an excellent result with reduction and hyperextension casting in a 14-month-old child without neurological damage.¹⁷ Other authors do not recommend orthopedic treatment if kyphosis is $>20^\circ$, since severe ligament

damage would condition the reproduction of the deformity.¹⁸ Other publications refer to surgical reduction as a standalone procedure or with the addition of sublaminar wiring.⁶ Bode et al. performed pedicle osteosynthesis in an 8-month-old infant and based this indication on the greater stability of screws compared to hooks.¹⁹ From an anatomical point of view, the use of pedicle screws is absolutely possible and they have scientific support in young children.^{20,21} Thornley et al. recently performed pedicle screw fixation on an unstable flexion-rotation injury in a 2-year-old child with neurologic compromise and respiratory failure due to severe chylothorax. The evolution was excellent. After 18 months of follow-up, when they considered that the injury was healed, they removed the implant.⁶ Crossing the neurocentral synchondrosis in young children could, theoretically, induce a deformity, spinal stenosis, or alter the growth of the vertebral body or pedicles; however, several scientifically rigorous publications have refuted this concept.²³⁻²⁵ Although some animal research has suggested this, others have rejected these hypotheses.²³ In other words, there is no concrete academic support that justifies the withdrawal of osteosynthesis.

Radiographic and magnetic resonance imaging measurements of the spinal canal and the size of the instrumented pedicles were taken from our patient, which were compared with published data, and no anomalous effects were found.^{21,22,25}

The ideal therapeutic option is supported by scientific evidence. Our indication was based on the analysis of the injury according to the TLICS (Thoracolumbar Injury Classification System) which takes into account the following items: morphology or type of injury, appearance of the posterior ligament complex, and neurological status.⁹⁻¹¹ A value equal to or greater than four implies instability and, consequently, the need for fixation. Our patient had a score of six. We also consider the recommendations already referred to by Arkader et al.

In conclusion, NAT can include only the spine, other bones or organs, and be coupled with psychological or sexual trauma. Even in the absence of neurological damage, the sensation of suffocation while breathing is predictive of thoracolumbar injury. It is vital to consider potential associations, as some pose a high risk of death. Pedicular osteosynthesis in young children is feasible and safe; a detrimental effect on growth has not been demonstrated. The TLICS is useful for analysis and therapeutic indication. In addition to the trauma, the doctor will be immersed in a social tragedy, his or her inescapable duty is to report the incident and protect the child.

Civilization aspires to be synonymous with evolution, and today's humanity coexists with a marvelous technological-scientific revolution, but the atrocious drama of child abuse persists, as do its potentially harmful consequences: cognitive deficit, psychiatric diseases, endocrine alterations, and a proclivity to drug use in adolescence, delinquency, and the perpetuation of the violence spiral.

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REFERENCES

1. Organización Mundial de la Salud. Maltrato infantil. 2022. Available at: <https://www.who.int/es/news-room/fact-sheets/detail/child-maltreatment> [Consulted: March 23, 2023].
2. Romano Yalour N, Fernández C. Maltrato infantil. En Romano O, Fernández C (coord.). *Lo esencial en Ortopedia y Traumatología*. La Plata: EDULP; 2023, cap. 22 [Press]
3. Pinto Cortez C. Perspectiva histórica en el estudio del maltrato infantil. *Poiésis* 2009;9(17). Available at: <https://revistas.ucatolicaluisamigo.edu.co/index.php/poiesis/article/view/166> [Consulted: March 23, 2023]
4. UNICEF y Ministerio de Justicia y Derechos Humanos, Argentina. Serie Violencia contra Niñas, Niños y Adolescentes. Fascículo N.º 9. Un análisis de los datos del Programa "Las Víctimas Contra las Violencias" 2020-2021. Available at: <https://www.unicef.org/argentina/informes/serie-violencia-contra-ninas-ninos-y-adolescentes#> [Consulted: March 23, 2023]

5. Sanchez NI, Cuenya L. Estudio sobre maltrato infantil en niños y adolescentes de la Provincia de Buenos Aires. *Revista Argentina de Ciencias del Comportamiento* 2011;3(3):8-15. <https://doi.org/10.32348/1852.4206.v3.n3.5200>
6. Thornley P, Peterson D, Kishta W. Child abuse with thoracolumbar fracture-dislocation treated with pedicle screw fixation in a 2-year-old: A case report. *JBJS Case Connect* 2021;11(4). <https://doi.org/10.2106/JBJS.CC.21.00129>
7. Jauregui JJ, Perfetti DC, Cautela FS, Frumberg DB, Naziri Q, Paulino CB. Spine injuries in child abuse. *J Pediatr Orthop* 2019;39(2):85-9. <https://doi.org/10.1097/BPO.0000000000000877>
8. Kemp AM, Joshi AH, Mann M, Tempest V, Liu A, Holden S, et al. What are the clinical and radiological characteristics of spinal injuries from physical abuse: a systematic review. *Arch Dis Child* 2010;95(5):355-60. <https://doi.org/10.1136/adc.2009.169110>
9. Vaccaro AR, Lehman RA Jr, Hurlbert RJ, Anderson PA, Harris M, Hedlund R, et al. A new classification of thoracolumbar injuries: the importance of injury morphology, the integrity of the posterior ligamentous complex, and neurologic status. *Spine (Phila Pa 1976)* 2005;30(20):2325-33. <https://doi.org/10.1097/01.brs.0000182986.43345.cb>
10. Daniels AH, Sobel AD, Ebersson CP. Pediatric thoracolumbar spine trauma. *J Am Acad Orthop Surg* 2013;21(12):707-16. <https://doi.org/10.5435/JAAOS-21-12-707>
11. Savage JW, Moore TA, Arnold PM, Thakur N, Hsu WK, Patel AA, et al. The reliability and validity of the Thoracolumbar Injury Classification System in Pediatric Spine Trauma. *Spine (Phila Pa 1976)* 2015;40(18): E1014-8. <https://doi.org/10.1097/BRS.0000000000001011>
12. Kleinman PK, Marks SC. Vertebral body fractures in child abuse. Radiologic-histopathologic correlates. *Invest Radiol* 1992;27(9):715-22. <https://doi.org/10.1097/00004424-199209000-00013>
13. Aufdermaur M. Spinal injuries in juveniles. Necropsy findings in twelve cases. *J Bone Joint Surg Br* 1974;56(3):513-9. PMID: 4417629
14. Carroll T, Smith CD, Liu X, Bonaventura B, Mann N, Liu J, et al. Spinal cord injuries without radiologic abnormality in children: a systematic review. *Spinal Cord* 2015;53(12):842-8. <https://doi.org/10.1038/sc.2015.110>
15. Leroux J, Vivier PH, Ould Slimane M, Foulongne E, Abu-Amara S, Lechevallier J, et al. Early diagnosis of thoracolumbar spine fractures in children. A prospective study. *Orthop Traumatol Surg Res* 2013;99(1):60-5. <https://doi.org/10.1016/j.otsr.2012.10.009>
16. Mitchell LA, Kitley CA, Armitage TL, Krasnokutsky MV, Rooks VJ. Normal sagittal and coronal suture widths by using CT imaging. *AJNR Am J Neuroradiol* 2011;32(10):1801-5. <https://doi.org/10.3174/ajnr.A2673>
17. Sieradzki JP, Sarwark JF. Thoracolumbar fracture-dislocation in child abuse: case report, closed reduction technique and review of the literature. *Pediatr Neurosurg* 2008;44(3):253-7. <https://doi.org/10.1159/000121475>
18. Arkader A, Warner WC Jr, Tolo VT, Sponseller PD, Skaggs DL. Pediatric chance fractures: a multicenter perspective. *J Pediatr Orthop* 2011;31(7):741-4. <https://doi.org/10.1097/BPO.0b013e318222f1b0b>
19. Bode KS, Newton PO. Pediatric nonaccidental trauma thoracolumbar fracture-dislocation: posterior spinal fusion with pedicle screw fixation in an 8-month-old boy. *Spine (Phila Pa 1976)* 2007;32(14): E388-93. <https://doi.org/10.1097/BRS.0b013e318067dcad>
20. Zindrick MR, Knight GW, Sartori MJ, Carnevale TJ, Patwardhan AG, Lorenz MA. Pedicle morphology of the immature thoracolumbar spine. *Spine (Phila Pa 1976)* 2000;25(21):2726-35. <https://doi.org/10.1097/00007632-200011010-00003>
21. Ruf M, Harms J. Pedicle screws in 1- and 2-year-old children: technique, complications, and effect on further growth. *Spine (Phila Pa 1976)* 2002;27(21):E460-6. <https://doi.org/10.1097/00007632-200211010-00019>
22. Olgun ZD, Demirkiran G, Ayvaz M, Karadeniz E, Yazici M. The effect of pedicle screw insertion at a young age on pedicle and canal development. *Spine (Phila Pa 1976)* 2012;37(20):1778-84. <https://doi.org/10.1097/BRS.0b013e3182553ae0>
23. Kahraman S, Karadereler S, Cobanoglu M, Yilar S, Mutlu A, Ulusoy LO, et al. Does pedicle screw fixation under age 5 cause spinal canal narrowing? A CT study with minimum 5 years follow-up. *Eur Spine J* 2016;25(6):1665-73. <https://doi.org/10.1007/s00586-016-4484-6>
24. Wang X, Zhang SJ, Zhang YZ, Li XH, Zhang ZF, et al. Three-dimensional digitizing and anatomic study of lumbar vertebral canal and pedicle in children. *Wideochir Inne Tech Maloinwazyjne* 2018;13(4):518-24. <https://doi.org/10.5114/wiitm.2018.77554>
25. Hinck VC, Clark WM Jr, Hopkins CE. Normal interpediculate distances (minimum and maximum) in children and adults. *Am J Roentgenol Radium Ther Nucl Med* 1966;97(1):141-53. <https://doi.org/10.2214/ajr.97.1.141>

Subcoracoid Impingement: Diagnosis and Ultrasound-guided Injection in Throwing Athletes

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ABSTRACT

Subcoracoid impingement is a rare condition, therefore, its diagnosis poses a challenge to the orthopedic surgeon. It manifests with dull pain in the subcoracoid region and pain on palpation in the coracoid process as a result of impingement of the subscapularis muscle between the coracoid process and the lesser tubercle of the humerus. The objective of this technical note is to describe an alternative diagnosis and ultrasound-guided injection for throwing athletes with subcoracoid impingement.

Keywords: Coracoid process; athletes; conservative treatment.

Level of Evidence: IV

Pinzamiento subcoracoideo: diagnóstico e inyección guiada por ecografía en atletas lanzadores

RESUMEN

El pinzamiento subcoracoideo es un cuadro poco frecuente y, por lo tanto, su diagnóstico plantea un reto al cirujano ortopédico. Se manifiesta con un dolor sordo en la región subcoracoidea y dolor a la palpación en el proceso coracoideo, como resultado del pinzamiento del músculo subescapular entre el proceso coracoideo y el troquíen del húmero. El objetivo de esta nota técnica es describir una alternativa diagnóstica y la inyección guiada por ecografía para atletas lanzadores con pinzamiento subcoracoideo.

Palabras clave: Proceso coracoideo; atletas; tratamiento conservador.

Nivel de Evidencia: IV

INTRODUCTION

Subcoracoid impingement is a rare condition that manifests in an isolated and nonspecific manner, making its diagnosis a challenge for the orthopedic surgeon. It is considered a cause of anterior shoulder pain as a result of subscapularis muscle impingement between the coracoid process and the lesser tubercle of the humerus.^{1,2} In addition, it has been linked to anterosuperior rotator cuff injuries.²

It is found in those who undertake repetitive shoulder movements, such as overhead or combined internal and external rotation, as seen in numerous sports.³ In throwing athletes, subcoracoid impingement can be multifactorial, among the most frequent causes are abnormal shoulder biomechanics during throwing, hypermobility of the glenohumeral joint, muscle weakness or imbalances, and a prominent coracoid arch. Biomechanically, coracohumeral space pressure increases in the abduction-external rotation position rather than in internal rotation; this movement is considered an antecedent in throwing athletes.⁴ Clinically, it is characterized by a dull ache in the subcoracoid region and, on palpation, in the coracoid process.²

Ultrasound is a useful imaging study for the diagnosis and treatment of patients with subcoracoid impingement.⁵ Treatment should be conservative, with activity adjustments, rotator cuff and scapula stabilizing musculature strengthening, and ultrasound-guided injections that can be useful for proper compliance with rehabilitation in throwing athletes, though arthroscopic surgery is another option with good results.^{6,7}

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The objective of this technical note is to describe a diagnostic alternative and ultrasound-guided injection for subcoracoid impingement in throwing athletes.

CLINICAL CASE

The patient is a 17-year-old male, right-handed, throwing athlete. He began with pain in the anterior side of the shoulder in the abduction-external rotation position, as well as difficulty performing overhead motions and pain upon palpation in the coracoid region.

Procedure

The procedure was performed with the patient's informed consent.

After asepsis and with the patient seated, an ultrasound probe was placed in the plane of the longitudinal axis of the subscapularis muscle. In a previous ultrasound, the medial and anterior coracoid space had been located, and two injections were administered (2 cc of levobupivacaine plus 2 cc of triamcinolone acetonide for each injection).

The needle was introduced at a 45° angle from lateral to medial, in the plane of the ultrasound probe, and placed in the coracohumeral space, avoiding the subscapularis muscle, and the therapeutic substance was administered. The injection was then administered directly through the anterior coracoid process under ultrasound guidance with the needle in the perpendicular plane, avoiding lateral and medial inclinations (Video). A physical examination was performed after the injection and improvement of the clinical condition was observed.

DISCUSSION

In a patient with shoulder pain, subcoracoid impingement can be diagnosed by physical examination.^{8,9} However, additional studies (ultrasound) may be indicated to corroborate the diagnosis and even to treat the condition.⁵ When subcoracoid impingement is suspected, Masala et al. recommend plain radiographs followed by magnetic resonance imaging of the shoulder.¹⁰ This study allows better visualization of the coracoid morphology, measurement of the coracohumeral distance, the coracoglenoid and coracohumeral angles, and the height of the lesser tubercle of the humerus, key points for the diagnosis of this entity.¹¹⁻¹³

The administration of ultrasound-guided injections as a non-surgical treatment for patients with subcoracoid impingement is considered a successful alternative for pain in throwing athletes. Escamilla et al. suggest, as a first line of therapy, to apply ultrasound-guided infiltrations together with a rehabilitation program.¹⁴

CONCLUSION

Ultrasound-guided injection is a therapeutic alternative that achieves good outcomes in throwing athletes with subcoracoid impingement, and allows them to reintegrate, immediately, without pain, to their throwing activities.

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REFERENCES

1. Goldthwait JE. An anatomic and mechanical study of the shoulder-joint, explaining many of the cases of painful shoulder, many of the recurrent dislocations, and many of the cases of brachial neuralgias or neuritis. *Am J Orthop Surg* 1909;s2-6(4):579-606. Available at: https://journals.lww.com/jbjsjournal/Citation/1909/06040/AN_ANATOMIC_AND_MECHANICAL_STUDY_OF_THE.1.aspx

2. Gerber C, Terrier F, Ganz R. The role of the coracoid process in the chronic impingement syndrome. *J Bone Joint Surg Br* 1985;67(5):703-8. <https://doi.org/10.1302/0301-620X.67B5.4055864>
3. Mallac C. Uncommon injuries subcoracoid impingement. *Sports Injury Bulletin* Available at: <https://www.sportsinjurybulletin.com/uncommon-injuries-subcoracoid-impingement/> [Consulted: February 25, 2022]
4. Yamamoto N, Muraki T, Sperling JW, Steinmann SP, Itoi E, Cofield RH, et al. Contact between the coracoacromial arch and the rotator cuff tendons in nonpathologic situations: a cadaveric study. *J Shoulder Elbow Surg* 2010;19(5):681-7. <https://doi.org/10.1016/j.jse.2009.12.006>
5. Tracy MR, Trella TA, Nazarian LN, Tuohy CJ, Williams GR. Sonography of the coracohumeral interval: a potential technique for diagnosing coracoid impingement. *J Ultrasound Med* 2010;29(3):337-41. <https://doi.org/10.7863/jum.2010.29.3.337>
6. McKernan MJ, Schickendantz MS, Frangiamore SJ. Diagnosis and management of subcoracoid impingement. *J Am Acad Orthop Surg* 2021;29(3):100-7. <https://doi.org/10.5435/JAAOS-D-20-00008>
7. Martetschläger F, Rios D, Boykin RE, Giphart JE, de Waha A, Millett PJ. Coracoid impingement: current concepts. *Knee Surg Sports Traumatol Arthrosc* 2012;20(11):2148-55. <https://doi.org/10.1007/s00167-012-2013-7>
8. Ferrick MR. Coracoid impingement. A case report and review of the literature. *Am J Sports Med* 2000;28(1):117-9. <https://doi.org/10.1177/03635465000280010501>
9. Freehill MQ. Coracoid impingement: diagnosis and treatment. *J Am Acad Orthop Surg* 2011;19(4):191-7. <https://doi.org/10.5435/00124635-201104000-00003>
10. Masala S, Fanucci E, Maiotti M, Nardocci M, Gaudio C, Apruzzese A, et al. Impingement syndrome of shoulder. Clinical data and radiologic findings. *Radiol Med* 1995;89(1-2):18-21. PMID: 7716306
11. Yu JF, Xie P, Liu KF, Sun Y, Zhang J, Zhu H, et al. Identification of diagnostic magnetic resonance imaging findings in 47 shoulders with subcoracoid impingement syndrome by comparison with 100 normal shoulders. *Med Sci Monit* 2022;28:e936703. <https://doi.org/10.12659/MSM.936703>
12. Asal N, Ahan MH. Radiological variabilities in subcoracoid impingement: Coracoid morphology, coracohumeral distance, coracoglenoid angle, and coracohumeral angle. *Med Sci Monit* 2018;24:8678-84. <https://doi.org/10.12659/MSM.911470>
13. El-Amin SF 3rd, Maffulli N, Mai MC, Rodriguez HC, Jaso V, Cannon D, et al. Coracoid impingement and morphology is associated with fatty infiltration and rotator cuff tears. *J Clin Med* 2022;11(9):2661. <https://doi.org/10.3390/jcm11092661>
14. Escamilla RF, Hooks TR, Wilk KE. Optimal management of shoulder impingement syndrome. *Open Access J Sports Med* 2014;5:13-24. <https://doi.org/10.2147/OAJSM.S36646>

Case Resolution

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Case presentation on page 592.

DIAGNOSIS: Upper cervical spinal traumatic injury.

DISCUSSION

If this girl had been traveling in the family car with a child restraint system appropriate for her age, this case would not have been published; however, in Argentina, these devices are used in barely one-third of the cases. According to Unicef and the Argentine Society of Pediatrics, the leading cause of death in early childhood is related to traffic accidents. The neurological condition of this patient is compatible with a central spinal syndrome with a motor deficit at the C5 metameric level for the upper limbs and C4 for the phrenic nerve, neither of which corresponds to the injured vertebral sector. Anatomic-metameric dissociation is common in pediatric spinal trauma due to viscoelastic tissue differences. Thermalgesic sensitivity was difficult to assess because of the child's age, but she reacted to the nociceptive stimulus.

The incidence of traumatic injuries of the upper cervical spine in childhood is very low, but the prevalence is close to 80%, with significant morbidity and mortality. In the first years of life, the C2-C3 spinal segment is subjected to a variety of mechanical stresses, as it is a hinge area between two dissimilar anatomical and functional regions: the craniocervical hinge and the subaxial spine. In general, ligament injuries prevail. In half of the publications referring to neurological involvement, no radiographic abnormality has been found, which configures the entity called SCIWORA. This diagnosis was ruled out in this girl, because a unilateral facet subluxation was corroborated by tomography (Figure 4). Decades ago, a radiologist named Leonard Swischuk wrote a report on the diagnostic value of the C1-C3 spinolaminar line in children, the diagnostic ranges of which are shown in Figure 1. Since then, this radiographic parameter has been reproduced literally in specialty publications and books without additional consideration. In more than one third of children <10 years of age, a physiological subluxation according to Swischuk's line is observed without any antecedents, although it has been mentioned sporadically in acquired torticollis. In addition to trauma, a pathologic line has been linked to Down syndrome and other diseases such as odontoid fracture and sagittal instability of C1-C2. In several published cases of unilateral or bilateral C2-C3 subluxation (and in this infant), the spinolaminar line was strictly normal, which constitutes a false negative. It is therefore advisable to add other radiographic evaluations: a translation of C2 over C3 greater than 4 mm, an alteration of the spinal axis in kyphosis, widening of the C2-C3 interspinous space, and an incongruent relationship of the articular facets. In this girl, along with ligament damage and joint instability, there was also an epiphysiolysis of the axis body. In many post-mortem investigations and kinetic cadaveric reproductions, Salter-Harris type I or II physeal injuries have been described, with significant mechanical instability, associated with posterior capsuloligamentary damage.

Any doubt regarding the facet relationship warrants a CT scan with paramedian sagittal slices. The CT scan dispels the doubt raised by the X-ray taken on admission regarding the facet relationship: it confirms the instability and supports the indication for surgical reduction and stabilization.

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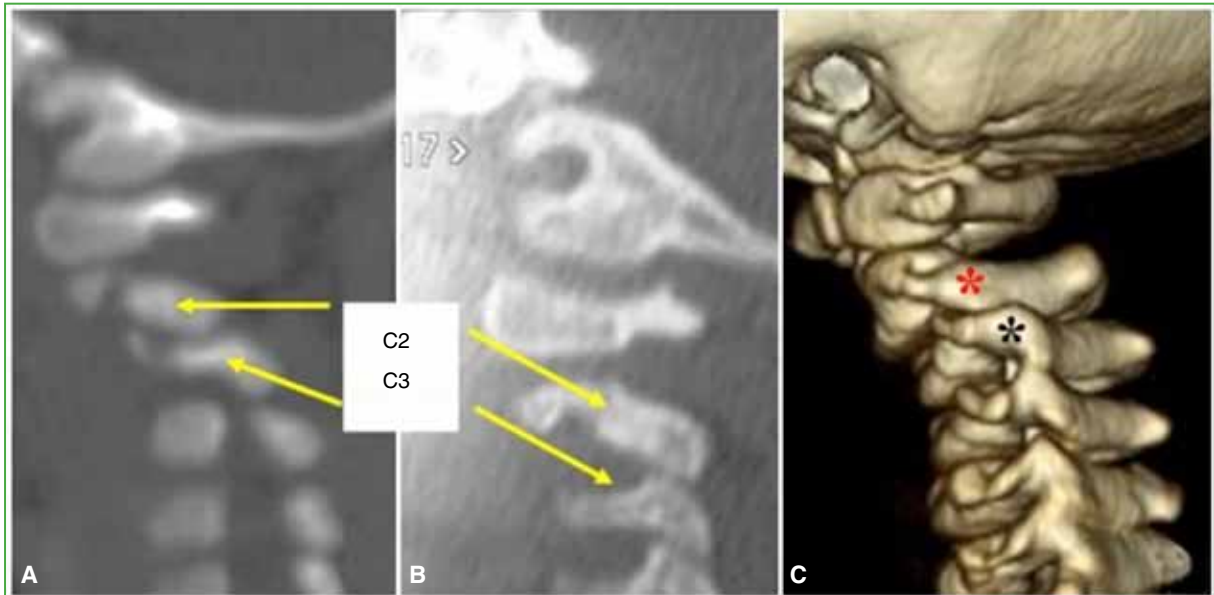


Figure 4. Computed tomography of cervical spine, paramedian sagittal slices. **A.** Fixed left subluxation of C2-C3 with small fracture of the upper end of the C3 facet. **B.** Normal right facet relationship. **C.** 3D reconstruction. C2 (red asterisk) and C3 (black asterisk) facets.

However, this imaging study is not systematically recommended in patients with spinal trauma, because its ionizing effect has been associated with the development of long-term cancer in children. Its precise indication is a score ≤ 8 on the Glasgow scale. Routine MRI is not recommended either, because in addition to the cost and the need for sedation, there is a significant prevalence of false positives. Its indication depends on the damage or deterioration of the associated neurological state.

CONCLUSIONS

The spinolaminar line described by Swischuk is invaluable for evaluating the upper cervical spine in infants and toddlers. However, there are false negatives or, on the contrary, alterations related to anomalies of other structures that do not express the C2-C3 segment. The compromise or progressive deterioration of neurological function is an indication for MRI, but it is not a systematic methodology, as is CT, which is reserved for very justified cases.

REFERENCES

1. Swischuk LE. Anterior displacement of C2 in children: physiologic or pathologic. *Radiology* 1977;122(3):759-63. <https://doi.org/10.1148/122.3.759>. PMID: 841068
2. O'Neill C, Wenzel A, Walterscheid Z, Carmouche J. Distinguishing Pseudosubluxation from true injury: A case of C2-3 and C3-4 subluxation in a pediatric patient. *J Am Acad Orthop Surg Glob Res Rev* 2021;5(12). <https://doi.org/10.5435/JAAOSGlobal-D-20-00238>
3. Herman MJ, Brown KO, Sponseller PD, Phillips JH, Petrucelli PM, Parikh DJ, et al. Pediatric Cervical Spine Clearance: A Consensus Statement and Algorithm from the Pediatric Cervical Spine Clearance Working Group. *J Bone Joint Surg Am* 2019;101(1):e1. <https://doi.org/10.2106/JBJS.18.00217>
4. Karlin LI, Jordan EM, Miller PE, Shore BJ. Prevertebral soft tissue thickness of the cervical spine in children: An insensitive but specific aid in the diagnosis of occult trauma. *J Pediatr Orthop* 2022;42(8):e901-e909. <https://doi.org/10.1097/BPO.0000000000002218>

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